Dialogue and big ideas of science education: exploring the discourses produced by Chilean schoolteachers and teacher educators in and around a continuous professional development programme

Paulina Bravo González

UCL Institute of Education

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I declare that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Paulina Bravo González

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This thesis, not including acknowledgements, references, and appendices is 109.878 words.

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Abstract

This thesis examines the production of Chilean science schoolteachers' and teacher educators' subjectivities in and around a continuous professional development (CPD) programme focused on big ideas of science education. The framework of big ideas is now part of the Chilean school science curriculum.

Drawing on the sociopolitical turn in science education and on my practice as a teacher educator working in a team providing CPD, I designed an intervention to explore the gap between how the curriculum is designed and how both schoolteachers and teacher educators understand it, teach it, and ultimately bring it to life. I worked with 11 colleagues to design and deliver CPD focussed on big ideas with 21 schoolteachers. I also conducted classroom observations and interviews with two schoolteachers to further explore their conceptualisations and practice in teaching big ideas.

Using dialogue as an analytical tool, I explored the different types of discourse that emerged: i) during a design meeting before the CPD; ii) during the implementation of the CPD; and iii) around two of the schoolteachers' experiences of teaching big ideas in the classroom. Dialogical analysis of key events afforded the opportunity to depict different subjective positionings of those participating in the CPD. My analysis articulates two main ideas. First, I describe changes in subjectivities: teacher educators produce different positioning in relation to their institution, and their different identities combine and differentiate at different moments; and schoolteachers shifted their pedagogical and epistemological positionality because of the work around activities they undertook. Secondly, the conceptualisation of the big ideas framework and its role in the curriculum is contested between the levels of policy, the CPD, and teachers' school-based practice. By problematising the contested understanding of big ideas between these levels, I argue that there is a chain of exclusions for these conceptualisations to exist.

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Impact statement

This research contributes to problematising the way we think about teacher educators and schoolteachers in continuous professional development (CPD) programmes in Chile's social and political context. Specifically, I contribute with an account of the science schoolteachers' and teacher educators' subjectivities produced in and around a CPD focused, amongst others topics, on big ideas of science education which is a recent change of the Chilean science curriculum. My main argument is that these distinctive and changing professional identities are produced in the encounter with others in the CPD space, as a response to the discursive context in which this encounter occurs. The exploration of these subjectivities is noteworthy, especially in the case of teacher educators whose practice is less problematised in the science education literature.

The question of subjectivity in science education is related to the recent 'call' to pay attention to the sociopolitical discourses rarely studied within the field. Particularly, this research illustrates and articulates a version of the sociopolitical turn that has to date predominantly been theory-based by providing data on the empirical experience in and around a CPD course using a methodology to analyse the subjectivation process through dialogue. Dialogical analysis is described as useful to unpack subjectivity and how it is produced. My theorisation of dialogue is a concrete contribution to the science education field on how because by focusing on different aspects of language and the discursive context in which dialogue occurs, it is possible to provide a way to pay attention to the body and the material, attempting to acknowledge important aspects such as culture and power relations. At the same time, dialogue is seen in my research in another layer which contributes to my subjective change as a teacher educator working with university colleagues providing CPD courses. In this thesis, the analysis is therefore the result of a recursive movement of interpretations between linguistic aspects, such as the spoken word, and the discursive context where those words were uttered. Overall, this methodological thinking I advance in my work has the potential to impact the way the sociopolitical turn of science education is conducted, highlighting the use of dialogue for the exploration of schoolteachers and teacher educators' subjectivities in a CPD course.

At a political level, this research expands narrow understandings of, on the one hand, schoolteachers positioned as 'teachers-as-problem', which in Chile could be related to teachers historically and persistently being considered as technicians (curriculum implementers) and, on the other hand, teacher educators, whose professional development is usually not considered, restricted to mainly giving the necessary support to guarantee that the curriculum and its changes are 'implemented appropriately'. This research calls into question some issues related to centralised control and colonisation of curricular development by problematising the conceptualisations of big ideas in different contexts (policy, university, and school/classrooms), where schoolteachers are assumed as having limited professional agency.

Lastly, my work underlines the often dismissed fact that science educators (schoolteachers and teacher educators) are political subjects whose identities should inform the science education field as recursive attempts to reimagine absent possibilities of what it means to be a science person and what science education is and can be.

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CHAPTER 1: Introduction

This thesis examines the production of Chilean science schoolteachers' and teacher educators' subjectivities in and around a continuous professional development (CPD) programme. Before considering the research problem, I start this thesis by situating it in the Chilean context. This context is presented in four layers, in a journey moving around present and past events related to the educational system in Chile. One way of introducing the focus of my thesis is by starting, as a first layer, with a current dispute related to respectability towards schoolteachers to then move into a second layer, in a deeper exploration of teachers' professionalisation and training and how they have been seen historically by society. Then, I explore a third layer of curriculum development – centralised and controlled – at different times and under different State regimes, to finally narrow the context of the problem through a fourth layer, specifically about science education and the science curriculum. In each layer, I intertwine my experience to trace the link between the context and my research problem.

Currently, and especially considering a recent national mobilisation since October 2019 in Chile, schoolteachers have been vocal on different aspects of Chilean society such as corruption and the serious inequalities that have been increasing since the return to the democracy after a civil-military coup between 1973 and 1990. The upheaval of 2019 that has been called '*Chile Woke Up*' may have begun to open the opportunity for schoolteachers themselves to problematise different aspects of education, such as the case for science educators to question the sociopolitical dimension of the field.

Thus, in what follows I explore some historical events in Chile, attempting to map both the context of this research and the research problem. I argue that considering this context could be a productive way to interrogate the science education field by unpacking tensions and conundrums of its sociopolitical dimension. I finish the chapter with an account of the significance of this study and by presenting the structure of the whole thesis.

1.1 Chilean context: a journey from present to past times

1.1.1 Current dispute: dialogue that falls on deaf ears

Using recent news depicted in local Chilean media, I am going to articulate an ongoing discussion related to the beginning of the school year – usually in March – after one year of the COVID-19 pandemic in Chile, which exemplified an important issue for my research.

In mid-January 2021, the Minister of Education, Raúl Figueroa, stated that the beginning of the school year should be on the 1st of March considering "presence as general rule" (1[1]), even though the numbers of new cases for COVID-19 were running at 4,000 persons per day, which was similar to the situation at the beginning of the pandemic in May 2020. On 12th February, the right-wing government under President Piñera said that the schedule for COVID-19 vaccination of schoolteachers would be moved forward to the 15th February – it had been

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[1] In here the references to the local media are shown with a number. The list of references used here is presented at the beginning of the References section.

scheduled for the 22nd – to facilitate the return to face-to-face lessons from the 1st March. In doing so and according to the president, attempting "to make up for lost time and assure all of our children the quality education they so badly need and deserve" (2). Conversely, the president of the Teachers' Union, Carlos Díaz, stated that "there is no possibility to return to the schools in March" (3) because not enough teachers would have been vaccinated, and many schools are used as vaccination centres. Díaz also pointed out that the Teachers' Union was not consulted before the President's announcement which is an "irresponsibility on the part of the government since it is central in a measure like this before communicating it, to obviously create the conditions to make it effective" (3).

The Minister of Education, Figueroa, answered to the Teachers' Union that they should "prioritise in their action the wellbeing of the students" (4). Following Figueroa's intervention, a right-wing party MP, Iván Moreira, in a morning TV show, said that the problem is that the Teachers' Union is more "focused on doing politics rather than the children's education" and he added that "many teachers had been on holiday the whole past year" (5). In the same vein, the Minister of Economy, Lucas Palacios, in an interview stated that "in the case of teachers, it is striking that they seek in any case to not work, it is a unique case in the world, and I would say a case to study" (6). The same day, the president of the Teachers' Union pointed out that the MP Moreira should take back what he had said because "the senator is lying (…) the whole country has been watching the huge amount of work that the teachers did last year as the *first line*[2] of education"; regarding the Minister of Economy Palacios, Díaz pointed out that "the Minister is affecting the teachers' honour" (7). Díaz added that "the teachers of Chile want to come back to the schools as soon as possible, because we know that face-to-face teaching is irreplaceable", pointing out that what the teachers want is to find the best date and conditions, including the whole school community in the discussion because with the government "the dialogue has fallen on deaf ears" (7). On 18th February the Teachers' Union handed a formal letter to the president asking for the resignation of the Minister of Economy; however, nothing happened. In the middle of this controversy, on 21st February, a philosophy teacher protested peacefully alone on the 'dignity square' – renamed after the 2019 mobilisation – with a poster that reads "lazy, me? The police are lazy looking the whole day at a fake horse" referring to a statue that is in the square (8). This teacher was attacked by the police, resulting in serious eye trauma which is now been investigated.

What we have here, regardless of the facts of the matter[3], is a set of oppositional discourses, one positioning teachers as uninterested in the welfare of children, lazy, and inappropriately involved in politics; the other presenting teachers as hard working, caring and unheard. In a broader sense, this current dispute has noteworthy parallels with my thesis. Schoolteachers

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[2] The expression of the *first line* came up during the mobilisation of 2019 where there was a line of people in front of the whole group marching, who were confronting the repression by the police force.

[3] In September 2020, 57% of the teachers (in a survey with 2,657 teachers) pointed out that they felt extreme wear and tear due to the crisis after five months of long-distance education (Said, 2020, September 2). According to a recent survey (CIAE, 2020) teachers have created new pedagogical practices, placing the focus of technology and motivation of students while also trying to approach them in different ways and platforms. Besides, 77% (out of 4,109 teachers) reported being stressed, 87% of teachers said they were suffering from being overwhelmed, 83% from sleep disorders, 72% having difficulty enjoying their daily activities, and 62% experiencing poor concentration (Delibera, 2020).

are not, or are very seldom, consulted; decisions on educational issues are taken by those who are not part of the day-to-day reality of education; there is a lack of respect for schoolteachers'; there is a disconnect between policymakers and what happens in the school setting; schoolteachers' involvement in policy matters is seen as inappropriate; and the schoolteachers' honour – and even their bodies – are hurt. Ultimately, there is colonisation of both the teachers' profession and their classrooms.

1.1.1.1 A bit about my background

Even though the current dispute described above occurred after data collection in this study, it mirrors both my research and the space I have been inhabiting with my research experience. My initial training is not in pedagogy; I´m a biologist; I have been working as a teacher educator in science education since 2008 which makes me feel close to the teaching profession. From about 2010 until now (2022) I have been participating in a group of science teachers, named PRETeC (Spanish acronym for 'Teachers Reflecting on a Transformative Science Education', see PRETeC, 2018), who meet to share their teaching practice twice per month. I consider the people in this group as my colleagues whom I greatly admired and who also teach me a great deal about their experience as schoolteachers. I´m bringing this up because the work in the science education field, the work with schoolteachers and my political investment (explained below) are intertwined with my experience since I was a student to the present time when I work as a teacher educator in the field. This engagement makes me look critically at the rich parallels with the current dispute, such as consultation, respect, and involvement of schoolteachers in the education setting in Chile, reflected in my thesis. I now turn to the second layer of context, namely, the teachers' professionalisation and training.

1.1.2 Chilean teachers: history and training

To raise the importance of teachers' voice, in this section I mostly made use of the work of Iván Núñez Prieto, a history teacher who between 1970 and 1973 was the Superintendent of Public Education in Allende´s government[4]. After the dictatorship, Núñez worked as a consultant of curricular reforms in different governments, and currently he is one of the most important historians of teacher professionalism in Chile.

Núñez (2007) stated that teachers' professionalisation in Chile is an unfinished process. According to Núñez, this truncated process is related to a shift from non-teacher people (those undertaking teaching with no specific training) at the origin of school in Chile – around 1810, the first part of independence – to a development process as public servants with a technician character defined as 'worker in education' from around 1940 to 1970, without a clear professional identity. The origin of the public education system in Chile is in between the colonial era and the first steps of independence. People from the Catholic Church oversaw teaching without more preparation than knowing how to read and write, basic mathematics and some cultural elements. Around 1813, the first governors understood that school education should fall under the responsibility of the new State. They developed guidelines entitled "regulation for teachers of first letters" stating that the profession was a mix of "order

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[4] Salvador Allende was the democratically elected president during 1970-1973 before the coup d'état.

of merit" and "republican priesthood" (Núñez, 2007, p. 152). The requirements for teaching were: 1. Patriotism, 2. Catholicism and 3. Morality. The people working in the recently formed and precarious public system were called 'preceptors' who, as the origin of the word suggests, were mandated by the Catholic Church to teach even though some of them were lay people. The lay preceptors were paid by the church or the public sector; however, they did not have the same working conditions as other public servants.

According to Núñez, in 1842 with the first 'Normal School for Men'[5] the notion of adequacy came up, distinguishing the teachers who received the training at normal schools, later named 'normalists', from the ones who did not receive that training who were called "impromptu" teachers (p. 152). Around this time, the process of professional development was to improve and control the knowledge of these impromptu preceptors. The rising group of 'normalists' were in charge of visiting the impromptu preceptors to monitor what they did while giving them instruction in pedagogical techniques. There were also other initiatives known as "in-service training" (Núñez, 2007, p. 153) to impromptu preceptors. The 'normalist' teachers became either visitors or headteachers of schools. Between 1880 and 1910, 82% of primary teachers were women; however, woman preceptors did not occupy visitor or headship roles but mostly occupied the assistants' roles.

The role of the State was primarily related to the education of the elite. The *Universidad de Chile* (the University of Chile founded in 1842) was responsible for the development of what was called secondary education while also overseeing primary education till 1860. Primary teachers were mostly working-class people; conversely, secondary teachers were from the elite, mostly professionals, which could be related to the historical and persistent hierarchical perception between secondary and primary teachers in Chile.

In 1889 there was the creation of the Pedagogic Institute of the Universidad de Chile, the aim of which was to train secondary teachers in pedagogical, academic, and disciplinary aspects. According to Núñez, this was the first time that the State considered the pedagogical training of teachers as necessary with a training of four or five years to become State teachers (*profesores de estado*). In this sense, there were three types of teachers, allocated roles within the three segments of education: the so-called impromptu teachers (without training either at normal schools or the university) mostly in technical education; normalists (trained at normal schools) mostly in primary education; and State teachers (trained at the university) in secondary education. Currently, the public education system is organised into these three segments. With a strong State between the 1940s and 1970s, teachers were developed as public servants and were therefore subject to all the accompanying bureaucracy (performance around norms, hierarchization, expected uniformity). In this period, the increase in the numbers of teachers with or without a title also meant a deterioration in working conditions. Besides, these teachers were never legally recognised as professionals, equivalent to other civil servants with titles. This under-recognition continued in 1960 (in an Administrative Statute) and in 1978 (in the Law of the teacher career) which perpetuated the role of teachers as employees of education, not as professionals. According to Núñez, due to the absence of

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[5] Named after the French institution *École Normale* where the term 'normal' is related to an institution to learn the norm or method to teach.

regulatory recognition, teachers are historically considered as technicians (with nuances between impromptus, normalists, and State teachers) and as such teacher professionalisation remains unfinished.

At the beginning of the dictatorship in 1973, normal schools were closed, depositing the responsibility of primary education training to the universities as well as secondary education; the three types of teachers were no longer trained. According to the Rettig report, teachers were greatly repressed during the dictatorship period; 103 teachers were victims of State terrorism; 58 of these were executed and 45 disappeared (González, 2015).

Since the 1990s and considering an era of the reforms after the dictatorship, the Ministry recognised two problems in the educational system: the first related to management in the schools, and the second to teachers' professionalisation and their pre-service and in-service training. The solution that they suggested was to create what was called 'Technical Tables' (academic committees to develop academic subjects and pedagogical issues) (González, 2015), and other initiatives (financial incentive for teachers, system of the quality of education), meaning that teachers became the target of every reform. When the target was identified, the Brunner report of 1994 stated that the problem of the educational system was teachers' capabilities, where the quality of the educational system has the limit in the teachers' quality, namely, 'teacher-as-problem' (Thompson & Cook, 2014). In this understanding, the context and working conditions remain oblivious to the system because, under the premises of neoliberalism, extra-school variables are omitted, putting the focus inside the schools and on individuals.

Under current Chilean working conditions, a teacher develops his/her practice where the relationship between teaching hours and non-teaching hours is 75%-25%. Likewise, more than the 50% of the teachers' work between 10 and 30 weekly hours outside their contracted time, the size of classes is 32 students average, and 40% of teachers free time is spent on school-related tasks (González, 2015). The average salary is 50% less than any other professional with the same number of years as an undergraduate; at the start of their career, teachers receive a third less than other professionals; by the fifth year 40% of teachers have dropped out the profession. Primary teachers have lower salaries than secondary teachers (ibid).

In terms of professional development, in 2016 alongside the recently enacted Law for Strengthening Public Education, another law was enacted to create the National System for Teacher Professional Development (SNDPD is its acronym in Spanish). In this law, it seems that the standardised test and assessment is occupying a central role in the professional development of teachers (Cavieres-Fernández & Apple, 2016; Sisto, 2012), which is in line with teachers being the target for improvement of the educational system. Even though the law is focused on the assessment offering monetary incentives, there is a consensus between the Ministry of Education, the Teachers' Union, and teachers in general regarding the necessity of a law that could organise their professional development around autonomy, reflection, and collaborative work to develop their pedagogical knowledge (Cavieres-Fernández & Apple,

2016). According to the coordinator of continuous professional training of the CPEIP[6], Claudia Lagos, the current challenge of professional development is around teachers' agency to identify both personal challenges and what is needed in terms of training under the idea of self-efficacy, awareness, and self-assessment (Lagos, 2020). There is the idea of individual autonomy placed on the 'target' teacher rather than a collective autonomy where the professional learning is distributed. Besides, the CPEIP coordinator recognises that the previous understanding of professional development was centred on the notion of lack of knowledge, meaning that a teacher entered a CPD course because he/she was lacking some knowledge and the programme would resolve that deficit. However, the new framework for understanding professional development, according to Lagos (2020), is designed to recognise the professional trajectory of the teachers because they are "historical subjects and social beings" that do not start a CPD from zero experience. Even though this CPEIP's understanding is moving away from the idea of lack of knowledge, is still imposing the responsibility on teachers as individuals, without considering the conditions in which they experience their practice.

1.1.2.1 A bit about my background

Technical Tables (the above-mentioned academic committees to develop academic subjects and pedagogical issues) have been running to this day. I took part in a Technical Table in 2014 related to teaching science using scientific inquiry as a strategy. As a result, since 2015 I have been participating as a teacher educator in an ongoing project with the Ministry of Education named 'National Inquiry Professional Development[7]' (NIPD) which is the focus of part of my research. NIPD has been running under a collaboration agreement updated every two years between the Ministry and 13 universities in different regions of Chile with the aim of delivering CPD courses, mostly on scientific inquiry (more on this in Chapter 3). In my experience of working in CPD programmes, the focus has been always the schoolteachers as the 'target'; however, during the experience of working on my PhD, I shifted to focus also on my role and the roles of my colleagues from the university in this kind of programmes. Then my question turned to the teacher educators' role. As part of NIPD, the Ministry asked the university to conduct a CPD programme which involved a recent incorporation in the science curriculum, namely, the big ideas of science education. In what follows I provide a brief narration on curricular development in Chile, finishing with this recent incorporation of the big ideas.

1.1.3 Curricular development: from dictatorship to current changes

Like most Latin-American countries, Chile suffered a dictatorship in the twentieth century, in its case between 1973 and 1990, which reshaped the political, economic, and social landscape. The coup d'état of 1973, in which the armed forces led by Augusto Pinochet overthrew the democratic government of President Salvador Allende, was at the epicentre of the conflict.

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[6] CPEIP is the acronym of 'Centre for Perfection, Experimentation and Pedagogical Research' of the Ministry of Education created in 1967 and aiming to support an educational reform of that time. Since then, CPEIP has been involved in the professional development of teachers, at the beginning offering courses and currently coordinating and overseeing what other institutions, such as universities, are offering.

[7] Pseudonymised.

Politically and economically, from the 1990s, Chile has evolved from a left-wing highly controlled economy to one of the most neoliberal countries in the world (Davis-Hamel, 2012). Besides, Chile is singled out as the first country to conduct a rigorous market reform in education (Ball, 2008), leading to the development of the educational system through free market principles (González, 2015). Consequently, there has been a shift towards privatisation where education was (is) seen as a commodity and not as a right for all in society. The privatization of the education system is based on three pillars: i) Voucher system (subsidising system according to enrolment and attendance); ii) Local administrators (public and private as those responsible for both technical and pedagogical issues); and iii) Freedom of education (anyone can open/organise/maintain an educational institution while the State gave the responsibility to the parents to be consumers in this market). Within the neoliberal reforms there were multiple shifts in the relationship between central control and local/school control which also affected different aspects of the curriculum and the science programme as well. At the beginning of the dictatorship (1973), the national curricular policies were redefined in the curriculum in order to, in the case of science, reduce the scientific training of the students while erasing topics opposed to the dictatorship's ideology, such as the theory of evolution (Navarro, 2014).

In 1980, the idea of 'flexibility' and freedom in education were introduced in the curriculum; however, it was an apparent flexibility designed to benefit the growth of the private sector in education[8] under market-oriented principles. In this period, it was possible for every school to delete subjects and reduce hours in their study plan. In the last days of the dictatorship (1990), the LOCE Law (Constitutional Organic Law of Education) was approved which stated that the Ministry of Education should design the learning aims and common content from primary to secondary education, and that individual schools could create their own plans and programmes but, if they did not achieve this, the Ministry would provide general guidelines. In that sense, the National Curriculum applies to all schools, but private schools generally have also their own guidelines. In LOCE the most important aspect was to establish some boundaries and limitations to the State in educational aspects such as learning aims and common content, promoting a neoliberal way of understanding and enacting education, transferring the responsibility of the State to local authorities, parents, and private sector. In line with a neoliberal understanding of having a State acting as a subsidiary if the private sector cannot act, LOCE defined minimum requirements in terms of common content in primary and secondary education (at the start and end of every level) which needed to be taught at each year of schooling, facilitating movement between schools, and limiting the reorganisation of content.

At the beginning of 1992, with Patricio Alwyn elected as the first president after the dictatorship, a group within the Ministry of Education presented the new aims and minimum content for a new educational system. Within this document, the first controversial issue arose, involving the right-wing party and the Catholic Church, who rejected crosscutting aims and topics related to human rights, the environment, and sexuality. To reach a consensus, this

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[8] This is more alarming when considering social inequalities in Chile. In 2013, the richest 5% of the country earned 285 times more than the poorest 5% of the country (Gonzalez, 2015, p. 20).

first proposal was redefined, where those topics should be presented as optional instead of a mandatory content. In this proposal the programmes for primary and secondary education were separated, creating a disconnection between these two age ranges. From this time until now (2021), the curricular reforms for primary and secondary education are designed by two different groups in the Ministry, separating the responsibility and the product of making the guidelines for the whole period of schooling (Donoso, 2005; Gysling, 2003).

In 1997, a curricular reform was implemented in Chile, for primary and secondary education. This reform was the first one after the dictatorship that also contributed to weakening the public educational system (Gonzalez, 2015) as well as the dictatorship. A committee for the modernization of the Chilean education was created in 1994. Among other actions this committee established that secondary education needed to focus on general skills and preparation for students' future work life. From 1996, a curricular framework with crosscutting aims and minimum mandatory content for teaching was created (Cox, 2001; Donoso, 2005). The new curriculum's framework for primary education was released in 1996 while the framework for secondary education was released in 1998. Fundamental crosscutting aims were established for primary education, with a curricular network in every subject and minimum compulsory content. At the level of secondary education, a complete redefinition was made by a group formed from different political, pedagogical, and economical actors in education. A new document from this group was reviewed in a national consultation in schools. However, the consultation gave the schools only a single day to read and to reflect on a 100-page report (Donoso, 2005). In this new document, secondary education was separated into scientific-humanistic training and technical-professional training. The central aim of this new approach was to generate "a curriculum which prepares [students] for life" (Gysling, 2003, p. 15). Curricular decisions were made during this period without consideration of teachers' experience and/or incorporation of their voices as 'consultants' and without real time for reflection or development of an informed opinion (Donoso, 2005). Pre-primary education was not even included in the discussion.

As part of this reform, in 2002 curricular programmes were redefined as a complete, centralised, and thorough set of guidelines with examples of teaching and resources for primary education. In the words of the one coordinator of the curriculum unit of the Ministry of Education, the reform was necessary because of the rapid technological changes, globalisation, and the growth in scientific and technological knowledge; thus, it was argued that an informed, flexible, and adaptable society was needed (Cox, 2012). In this reform, the motto was to 'take the reform to the classroom' (Cox, 2001; Donoso, 2005). The curricular reform at every level was based on a constructivist approach and a rhetoric of teacher professionalisation, although mostly related to monetary incentives. Teachers had the obligation to take the reform to the classroom but without proper preparation. Donoso (2005) pointed out that the reform did not reach the classroom and teachers did not change their practice. This may be related to the kind of professional development that took place where the teachers were treated as technicians and not as reflective professionals. At this time, most CPD programmes were mandatory for teachers and sometimes implemented without considering the level of schooling or their context. Despite this period being called a 'return to democracy', none of these governments changed the LOCE, keeping the same ideas around

funding and institutional organisation from that time (Donoso, 2005). In so doing, these governments deepened the market-based educational system while the State role in education became subsidiary to the private sector. In 2014, the private sector represented 62.5% of the schools (14.5% private and 48% semi-private) with only 37.5% of schools exclusively for public education (González, 2015).

In 2006 and then in 2011, the discomfort started to show with secondary students organising extensive strikes all over the country with massive support from the population; those striking were seeking the derogation of the LOCE and crucial changes in the funding system for public schools. The students' mobilisation in 2011 has been considered "the most relevant social mobilisation in Chile since the restoration of democracy in 1990" (Bellei, Cabalin & Orellana, 2014, p. 426). The students involved demanded that education should be not a commodity for profit but a social right, and that the educational system be placed "beyond the educational market" principles (ibid., p. 431). Even though the teachers had recently been vocal critics, problematising the neoliberal agenda and participating in the social movement against them, in these mobilisations they felt absent while the students were key actors (Acuña, 2020). This may be related to the impoverished image around teachers developed during the dictatorship.

President Michelle Bachelet (2006-2010) created the Presidential Advisory Council on Education with the principal actors of the educational system and representatives of the student movement. After many conflicts, mostly related to the left-wing party trying to remove the element of profit in education and the right-wing party trying to keep it, the Council reached agreement in derogating the LOCE. Thus, in 2009 the new law called the General Law of Education (LGE) was enacted; in 2011, the Law of Quality Assurance in Education was enacted (Cox, 2012), and in 2016, the Law for Strengthening Public Education was enacted. The implementation of these laws sought to redefine the role of public education in Chile, attempting to bring public schools back into State hands. In October 2020, there was a national referendum, resulting in approval to change the constitution created during the dictatorship, opening for the first time the opportunity to fundamentally change Pinochet's legacy.

1.1.3.1 A bit about my background

In the university, during my undergraduate period and then as a casual worker and up until my current role in the department of science education, I have been specially called to participate in the two national mobilisations in 2006 and 2011. These mostly aimed to change educational laws from the dictatorship, but also disputed internal institutional issues such as the involvement of every entity at the university – teachers, students and other staff members – in institutional decisions, as well as the casualisation of many workers' contracts of employment, including my own. From my political engagement, I argue that there is a link between this political dimension, the science education field, and the work with schoolteachers, considering the centralised and controlled curriculum and the way that is developed. For instance, to ask how recent changes do not incorporate teachers' conceptualisations, nor consult them about their experience as a valid resource to conduct those changes, which is the usual way that changes have been made in the Chilean curriculum and specifically, in this case, in the science curriculum.

1.1.4 Science curriculum: current changes

In many countries, on-going changes in the science curriculum are related to the 'big ideas of science education'. The term 'big idea' was coined by a group of science educators, teachers, and scientists from seven different countries under the leadership of Wynne Harlen, who developed a set of key ideas with the intention to promote the understanding of the natural world. They produced two short books; the first one is called *Principles and Big Ideas of Science Education* (2010) and the second one, *Working with Big Ideas of Science Education* (2015). The purpose of their work was to address the problem of the negative perception by students towards science by teaching them these key ideas (Harlen, 2010, 2015a, 2015b). Harlen (2010) identified 14 big ideas of science education, yet three of these were omitted when the big ideas were being incorporated into the Chilean curriculum.

In 2012, the big ideas framework was incorporated into the Chilean science curriculum alongside other changes to year 11 and 12 of schooling. By 2019, the approach was incorporated into every level of schooling except pre-primary education. This incorporation proceeded without any consultation. Instead, the Ministry of Education asked selected Chilean universities to act as a conduit for the new curriculum through the implementation of CPD programmes. The Chilean Curriculum states that the focus of science education is the scientific literacy of students so that they can participate in an informed way in the decisions and actions that affect their own wellbeing and the wellbeing of society (Mineduc, 2015). In the same document, the Ministry declared that in order to cover the huge amount of scientific knowledge, students should be taught about science in an integrated way and, to take advantage of the limited time of learning, science education should consider the 'big ideas' approach proposed by Harlen and collaborators. What is incorporated in the Chilean curriculum is similar to the proposal of Harlen (2010) but slightly different; in particular, the curriculum omits without explanation big ideas (2) Objects can affect other objects at a distance, (6) The solar system is a very small part of one of millions of galaxies in the Universe and (7) Organisms are organised on a cellular basis. In this decision, schoolteachers were asked neither if they had experience teaching with big ideas nor about their conceptualisation of the notion.

1.1.4.1 A bit about my background

In a preliminary exploration during the first year of the PhD, I conducted a questionnaire asking a group of Chilean schoolteachers about their experience of teaching with big ideas (Bravo & Reiss, 2021). The schoolteachers declared that they found great value in teaching with the approach. In this exploration, schoolteachers referred to having experience teaching with the big ideas even though some of them were not familiar with the notion before; however, when reading about the purpose of the big ideas' framework, they felt that this was the natural way to teach science in their classrooms. Furthermore, many of the teachers referred to the omitted big ideas as important ones to teach in their classrooms and as they were informed by the original report directly; they did not notice that the curriculum did not include some of them. With this information in mind, I started to wonder how schoolteachers conceptualise the notion of big ideas and how they teach it. Besides, as some teachers declared the use of

the omitted big ideas, I wondered how the Ministry decided that these omitted big ideas were not important. In sum, this first exploration was the starting point to question the colonisation of both the teachers' profession and their classrooms.

1.2 Situating the problem internationally

It is possible to provide a broader context and the significance of the issues raised in Chile for education more internationally. This broader context will be developed and examined more critically in the Chapter 2.

There is a close association between science and how to present it, as mapped in the science curriculum. Indeed, some academics have noted that ideas and principles embedded in the science curriculum can be traced to the mid ninetieth century (DeBoer, 2000; 1991; Sikorski, & Hammer, 2017). Over the decades, discussion about what to teach and how to teach it has evolved, moving from definitions of truth and objectivity towards the influence of science in social, cultural, and political dimensions (Wallace, Higgins & Bazzul, 2018). Recently the conversation about the significance of science education has been linked with school, teachers, and students, particularly its connection with students' interests and broader pedagogical concerns (Mujtaba & Reiss, 2014). Analysing the science curriculum requires investigation of its core components and relationship with teachers and the context of teaching (Hökkä, Eteläpelto & Rasku-Puttonen, 2010).

Accordingly, international evidence indicates that for many educators teaching science relates to individual and social wellbeing (Reiss & White, 2014); for others is about developing a democratic society (Yeh, Erduran, & Hsu, 2019), while some authors have identified the role of science education in creating critical skills (Osborne & Dillon, 2008). The current discussion about science education concerns two complementary arguments. On the one hand, a strategy for the development of social scientific literacy; on the other, acknowledgement of the importance of integrating Science, Technology, Engineering and Mathematics (STEM) disciplines under a common epistemological umbrella (Martín-Páez et al. 2019). Both foci have been criticised as being restricted and colonising (Carter, 2016), with scholars advocating the inclusion of broader perspectives, recognising the characteristics and needs of diverse societies (Gandolfi, 2021; Tovar-Rodríguez, 2019). The political dimension of science education has grown exponentially during the last decade, frequently led by academics from the Global South, who have argued about the necessity to engage in situated conversations about curriculum design and its implication for local development and social empowerment (Calsado, 2020).

Across disciplines and latitudes, most educational systems are engaged in ongoing curricular reforms (Bantwini, 2010). While the question *What to teach?* is frequently at the front of the conversation, the question *Who decides what to teach?* is gaining traction (Jenkins, 2020). Globally, a commonplace of debate is the distance between curriculum developers and curriculum implementers (Saracaloğlu et al., 2010), which in most cases leaves teachers in a passive role (Couso, 2016). Previous researchers have explored this distance, with some critical voices advocating major participation of the teaching community, in favour not only of greater educative experiences for students but also the role and wellbeing of teachers (Bencze &

Hodson, 1999; Smith & Girod, 2003). However, evidence indicates that while teachers are consulted, frequently their voices are ignored by policymakers, rendering the teachers' role only as implementers, executors or information providers, leading to mistrust, and creating difficulties for curriculum implementation (Choi, 2006; Saracaloğlu et al., 2010).

A modern approach to science education and its curriculum is the recent adoption of the big ideas and big questions conceptual framework. Overall, the word 'big' is frequently used to explain a curriculum characterised by its shared presence across individuals' mindsets (Billingsley, 2020), its conceptual depth (Lawson et al., 2020) and its explicative capacity (Stavinschi, 2009). Billingsley and Hazeldine (2020) argue that as the science curriculum is closely connected with current sociopolitical challenges, engagement with a diverse body of knowledge is needed to understand the complexity of socio-scientific phenomena and provide answers to its challenges and consequences. Thus, big ideas and big questions can provide a framework that facilitates the conversation between the curriculum and daily experiences as well understanding how different disciplines relate and interact (Billingsley et al., 2018). Moreover, Gamoran (2016) illustrated the pedagogical opportunities of this approach where *smaller questions* could connect with others, creating a *bigger question*, growing in size and complexity. Initiatives such as Big Questions in Classrooms (BQiC) have shown promising results with teachers and students in England, challenging traditional approaches not only to science education but to schooling as well. These strategies expand the limits of the classroom and single disciplines in favour of meaningful learning experiences (Billingsley et al., 2018).

For over a decade, a complementary approach to *big questions*, labelled *big ideas in science education,* has expanded across the globe. Harlen (2010) and a group of science educators, teachers, and scientists from seven different countries pointed out that the assumption behind big ideas is the recognition of core scientific principles guiding science education, allowing communication and integration across disciplines and among the levels of complexity on the curriculum, as well as addressing the fragmentation of scientific knowledge in the science curriculum amongst other issues (Harlen, 2010). Several advantages have been reported using the framework of big ideas, including the facilitation of collaboration across subjects in the curriculum (Harlen, 2010), its connection with students' contexts (Eleftheria et al., 2016; Osborne, 2011) and the possibilities of introducing graduality in the curriculum progression as well as offering a powerful pedagogical tool to teachers planning their teaching (Mitchell et al., 2017). Furthermore, big ideas could foster teachers' curriculum ownership, as there is some evidence that the adoption of big ideas is both situated and specific to schools and even classrooms. The integration of big ideas demands educators moderate the relationship between curriculum and the particular characteristics and needs of the students, highlighting the importance of developing a unique learning experience (Bravo et al., 2019). Despite its apparent benefits to teachers and students, implementing big ideas in the science curriculum is not without its challenges. As Mitchell et al. (2017) noticed, the innovation that big ideas bring into the classroom requires professional capacity and organisational resources, both components with limited abundance in most educational settings. Nonetheless, Mitchell's evidence indicates that teachers rapidly connect with the big ideas curriculum, suggesting the potential to effectively escalate it through professional development strategies.

While being developed by different authors from diverse parts of the world, big questions and big ideas share some crucial principles. Initially, both concepts seek to move away from curriculum fragmentation into curriculum integration, create links among disciplines, and propose a systemic organisation of knowledge (Billingsley et al., 2018; Stavinschi, 2009). Moreover, adopting these big notions in the curriculum facilities the conversation about the limitations and possibilities of science, fostering teachers' and students' active stance as scientific practitioners (Billingsley et al., 2018). Finally, big questions and big ideas can contribute to curricular and professional decision-making in schools, bridging the connection of science with humanities and other subjects, allowing teachers and administrators access to the tools to create a cohesive school mission (Billingsley & Hazeldine, 2020).

The most common strategy to address such curricular changes (e.g. big ideas in science education) is through teachers professional development. A large body of knowledge agrees about the central contribution of continuous professional development (CPD) strategies to support curriculum reform (Phasha, Bipath, & Beckmann, 2016; Subitha, 2018). It is suggested that CPD programmes have the potential to enhance teacher and school capacities; however, this requires some conditions such as funding, time, and talent from the CPD provider, elements often absent or limited in traditional programmes (Subitha, 2018; Vaillant, 2016). Besides, usually professional development is undertaken *on* teachers, so that they change their practices, and not *with* them (Vaillant & Cardozo, 2016). The professional development of teachers is also contested, as academics have argued about the importance of considering the contextual characteristic of schools, teachers, and students when designing and implementing these strategies (Clarke & Hollingsworth, 2002; Mitchell, 2013). Furthermore, a CPD programme that is disconnected from teachers' experiences could negatively affect teachers' professionalism (Núñez, Arévalos & Ávalos, 2012) and skills, reducing their repertoire of pedagogical strategies to a few selected practices or recipes (Suárez & Metzdorff, 2018).

As discussed earlier, the implementation of the big questions and the big ideas framework could be related to teachers' professional development opportunities. Nonetheless, little is known about the characteristics, options, or limitations of CPD programmes in these curriculum domains. Drawing from the tradition of science education CPD courses, at least three primary considerations are relevant to problematise. First, the relationships among personal, professional, and social domains appear central to enhancing teachers' science-based knowledge. Bell and Gilbert (2005) found that in the intersection of these domains is the possibility for improvement, recognising that teachers' development relies upon the capacity to reflect on their own practices. This process is stronger when it is implemented in collaboration with peers. Second, Aldahmash et al. (2019) argue that 'effective'[9] CPD programmes are highly connected with school and classroom characteristics, giving special attention to continuous organisational support. Headteachers, curriculum designers, and other leaders have the potential to make substantial contributions to CPD programmes, providing tools, resources, and data to sustain pedagogical changes. Third, a growing body of knowledge is challenging the characteristics of traditional CPD programmes, particularly their essential components such as length, frequency, and teachers' level of autonomy to participate in them

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[9] In section *2.3.1.1 Professional development's features and aims: development or learning?* There is a discussion regarding this very idea of effectiveness.

(or not) (Lumpe, 2007; Van Driel et al., 2012). Evidence suggests that isolated workshops with disengaged participants have little impact on professional development. Moreover, the need to create and maintain a community of practice, underpinned by mutual trust, appears key to enhance professional practice and teacher motivation for continuous learning. Having positioned the issues raised to Chile in a broader context, in the following section I will develop the research problem of this study and its noteworthiness.

1.3 Research problem and significance of this study

This thesis is developed in the science education field with a sociopolitical lens (as discussed in the following chapter), attempting to explore issues related to centralised control and colonisation in curricular development, the role and aims of CPD programmes, and the subjectivities of science schoolteachers and teacher educators produced in those programmes.

The research problem is connected to the context previously developed, as follows. Usually, curricular changes are made without including schoolteachers' and, what is more, the policymakers provide little time for educators to reflect on those changes (Donoso, 2005). To ensure proper implementation of the curriculum, too often the Ministry conducts Technical Tables (academic committees to develop academic subjects and pedagogical issues). As a result, selected institutions, such as universities, are called to prepare and conduct CPD programmes with schoolteachers. In doing so, on the one hand, the schoolteachers are positioned as 'teachers-as-problem', which in Chile could be related to teachers being considered historically as technicians and with a sense of unfinished profession (Núñez, 2007) rendering their role, internationally as well, as implementers, executors or information providers. On the other hand, the aims of the CPD programmes are restricted to a specific topic (i.e. update the teacher's knowledge in the curricular change), which also narrows down the position of the teacher educators. Specifically, this thesis examines the production of Chilean science schoolteachers' and teacher educators' subjectivities in and around a CPD programme focused on the big ideas of science education as a recent science curricular change. Drawing on my practice as a teacher educator working in a team providing CPD courses, I participated in a programme called NIPDE (anonymised name meaning National Inquiry Professional Development Expounded), funded by the Ministry of Education. This course had 11 whole-day sessions and was designed and led by a university team of 12 colleagues, of whom I was one, with 21 science schoolteachers forming the participant group. I also conducted classroom observations and interviews with two schoolteachers, and interviews with policymakers and the leading team, to further explore conceptualisations, practice, and conditions – at school and policy level – when teaching big ideas.

The framework of big ideas is now part of the school science curriculum in Chile (as well as elsewhere); however, in the case of Chile neither schoolteachers nor teacher educators were consulted about this incorporation. It has been suggested that schoolteachers implement the curriculum as it is designed by curriculum developers while teacher educators facilitate this implementation through CPD programmes (Ryder & Banner, 2013). Nevertheless, there is a gap between how the curriculum is designed and how schoolteachers and teacher educators understand it, teach it, and ultimately bring it to life. This subjective engagement with the curriculum is noteworthy, especially in the case of teacher educators whose practice has been

less problematised in the science education literature. The question of subjectivity in science education is related to the recent call to pay attention to the sociopolitical discourses rarely studied within the field (Bazzul, 2012). Thus, my analysis attempts to acknowledge the schoolteachers' and teacher educators' subjectivities; researching this CPD programme opened the opportunity to explore those dynamics amongst its participants.

Science education has typically been depoliticised in comparison to other subjects (Bazzul & Siry, 2019). In this thesis, I argue that there is a connection between science education and the sociopolitical dimension, producing a point of intersection which led me to problematise, for example, the sociopolitical dimension in my practice as a teacher educator, the practices of my colleagues and the way we conceptualise CPD programmes in science education, as well as curricular development and the big ideas in science education. In so doing, I explore what science education is, and the potentialities of "what may also be, but not yet is" (Moura, 2021, p. 1). In here, I can see the heart of the questions that I am posing in my research, in relation to unpacking the power relationships that are part of the Chilean sociopolitical context, for example, in the scientific understanding of teaching and learning in the curriculum, in a teacher professional development course at the university between schoolteachers and teacher educators or the teaching of big ideas in a classroom. In my position as a teacher educator, I feel especially called to understand what it means to be a science educator in Chile who is at the same time critical of the dominant practice and discourse in science and in my political context. In doing so, I want to stress that it is not just the experience of the schoolteachers participating in the CPD programme but also the question of the professional development of the teacher educators involved on it, such as myself.

1.4 Structure of the thesis

In this introductory chapter (**Chapter 1**) I have articulated the context of this research from recent and past events in Chile, from which the research problem emerged; I have included my experience to trace the relationship between the context, the problem of this study, and I have mapped the issues raised to Chile in a broader international context. In **Chapter 2**, Literature Review, I expand on the main concepts of this research. Particular attention is given to the sociopolitical turn of science education, exploring in particular key notions of the turn such as subjectivity. I explore literature about the science education curriculum, CPD programmes, and teacher education with special attention to teacher educators and the role of the university regarding CPD programmes. I finish this chapter by presenting the overarching research questions. In **Chapter 3**, Methodology and Methods, I start by discussing the ontological and epistemological positions of my study, Then, I justify my approach and discuss how I came to analyse the data. I also explain how during my analysis I began to appreciate a subjective change which was shaping my research. I argue that this change was due to both the exploration of the sociopolitical turn within science education and an openness to different areas or perspectives that resonated with my research. In doing so, I explain how the analysis was conducted, how the data fed into the findings and how I used and developed a conception of dialogue to explore the different types of discourse that emerged in and around the CPD programme at the university and at the schools. Finally, there is a section on reliability and dependability in coding and interpreting to show in detail the process of analysis and the ethics

of interpretation associated to my work. In **Chapter 4**, the first chapter of findings, I explore the discussion around the question of 'how are we going to implement the course?' posed by the university team. In doing so, I aim to unfold the subjectivity of my colleagues and myself as teacher educators designing a CPD programme, the main theme that emerged. I attempt to connect my analysis and the literature review on the sociopolitical turn and its key concepts. In **Chapter 5**, the second findings chapter, I enter the implementation of the course depicting the subjectivity of the schoolteachers around activities on the creation of research questions by schoolteachers themselves. Similarly, I show a discussion linking my analysis to the literature review on the sociopolitical turn and the section on continuous professional development. In **Chapter 6**, the third and final findings chapter, I move the analysis into the classroom of two teachers participating in the CPD programme. In doing so, I attempt to depict the teachers' subjectivities when teaching big ideas of science, produced in a scenario where discourses of the curriculum, university and the schools are at play. I end this chapter with a discussion connecting my analysis to the literature on the sociopolitical turn, curricular development and big ideas in science education. After each findings chapter there is in an Appendix what I came to call an *Interlude*, which, as in a play, is a short pause between chapters (acts) to show an iterative process of thinking with theory. The Interlude after Chapter 4 provides notions of vertical and horizontal discourses (Basil Bernstein) and 'knowing how we know' (Humberto Maturana and Francisco Varela); the Interlude after Chapter 5 is about the pedagogy of the question and generative themes (Paulo Freire) and subjectivity and positionality (Judith Butler); after Chapter 6 the Interlude focuses on policy implementation/enactment (Stephen Ball). Finally, **Chapter 7** provides the conclusion of the thesis. Here, I draw together three arguments which constitute the conceptual and methodological contributions of this thesis. I also provide recommendations for areas worthy of exploration through further research. I finish this chapter by highlighting the limitations of my study.

CHAPTER 2: Literature review

Introduction to the literature review: sociopolitical[10] approaches to science education

There has been a recurrent 'call' for more explicit and collective engagement between science education and the sociopolitical dimension (Bazzul, 2012; Carter, 2014; Roth, 2008; Tolbert & Bazzul, 2017), in acknowledgment of the limited study of political discourses within the field (Pedretti & Nazir, 2011). The call to bring the political nature of science to the spotlight has been made for some time by philosophers of science (Lather, 2012), feminist critiques of science (Stefanidou & Skordoulis, 2014), and cultural studies using postcolonial theory in science education (Carter, 2004; 2008; O'Hern & Nozaki, 2014). Similarly, there have been efforts to intersect social justice with both the nature of science (Erduran, Kaya & Avraamidou, 2020) and pedagogical content knowledge (Dyches & Boyd, 2017), as a way to put social justice at the heart of the school science curriculum (Levinson, 2018). There has also been a broader understanding of the nature of science to include the social-institutional, political, and economic dimensions of science (Dagher & Erduran, 2016; Erduran, Kaya & Dagher, 2018; Kaya et al., 2018; Yeh, Erduran & Hsu, 2019). Nevertheless, there are still narrow views of science and science education that cannot longer continue if the field wants to respond positively to contemporary movements towards critical and cultural studies (Lather, 2012) in a changing world (Adams et al., 2018); such a response may also help resolve the sense of disaffection that students can have in the relationship between school science and their lived experience (Levinson, 2018).

Carter (2014) stated that the theorisation of this political dimension in science education, by exposing, for example, the neoliberalism in its discourse, could open the door for 'better' science education; it could also help identify potential sites "of/for resistance to neoliberalism" (Williams & Tolbert, 2021, p. 71). The starting point of this more explicit call is the recognition of the extensive research within science education while there is less research that includes other frameworks, meaning that science education might remains 'thin' (Trifonas, 2012). In other words, the sociopolitical turn is calling for transgressing/trespassing boundaries (Wong & Dillon, 2020), troubling the hermeticism in science education that has avoided seeing itself under the lens of social, critical, or philosophical theories (Kayumova, 2015).

This sociopolitical call in science education has been mostly theorised from current social, economical, and political struggles. My proposal is to explore empirically the turn in the case of Chile, a country troubled by inequalities (Torres & Bravo, 2021), while trying also to draw conclusions relevant to the wider, global context. The work of Latin American scholars such as Freire, regarding critical pedagogies, possibilities for resistance to the pervasive hegemony of the neoliberal foundations are well-known in general education; however, they are less thoroughly explored in science education (Carter, 2014; Tolbert & Bazzul, 2017). Then, as the aim of the turn is to question the missing explicit awareness of the sociopolitical within the

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[10] In this thesis, the word 'sociopolitical' is written without a hyphen (socio-political) to illustrate the unavoidable interconnection between the social and the political.

field of science education (Pereira, 2019), this thesis uses the sociopolitical turn as a stance to understand aspects, such as the production of subjectivities, power relationships, hierarchies, and control of curricular development that could be influencing experiences in and around a CPD programme.

In this chapter, I examine the sociopolitical turn to examine my thesis via this lens. Firstly, I engage with a key concept of the sociopolitical turn (subjectivity) and examine how the turn is being addressed (i.e. empirical and theoretical approaches). Secondly, I explore literature in science education about the curriculum, with special attention to big questions and big ideas of science education. Thirdly, I explore literature related to CPD programmes in science education, problematising the role of the university and teacher educators in them. In each of these sections I have drawn my positionality in relation to the sociopolitical approach. Finally, I will also position my thesis in relation to the reviewed literature, identifying its gaps and potential contribution.

2.1 Key concepts of the sociopolitical turn

There are two key aspects of the sociopolitical turn that are particularly relevant to my study. The first is related to the transgression of boundaries between fields (e.g. Pereira, 2019) by bringing attention to notions such as subjectivity. The second goes further, attempting to understand the subjectivation process by the exploration of power-sensitive questions, unpacking social and political aspects of that production (Kayumova, 2015).

Pereira (2019) sees the transgression of boundaries between fields – 'boundary work' – as an ongoing process of "demarcation, negotiation, and disruption" of the borders between science education and other fields (p. 359). In terms of power-sensitive questions, others argue that it is important to rethink the postcolonial and feminist question in science, previously posed by feminist theorists such as Sandra Harding and Donna Haraway (Kayumova, 2015; Pollock & Subramaniam, 2016). These feminist theorists posed the exploration of sensitive questions in science such as: How is knowledge produced? Who is privileged or marginalised in that knowledge production? And what purpose does knowledge in science serve (Harding, 1991; 2008)? In addition, how does the role of science researchers challenge the power relation within claims such as the objectivity of scientific knowledge (presuming that knowledge is partial and situated within our experience (Haraway, 1988))? In *re*examining these roles and *re*thinking the benefits of using theories from other fields, fixed claims in science education could be both challenged and *re*conceptualised, promoting a more nuanced understanding where science is situated in social, historical, and political power relations (Kayumova, 2015).

Following this transgression – reexamining, rethinking, reconceptualising – in this thesis I attempt to contribute with an account of science schoolteachers' and teacher educators' subjectivities produced in and around a programme of CPD focused, amongst others topics, on big ideas of science education as a recent change of the Chilean science curriculum. The exploration of these subjectivities is noteworthy, especially in the case of teacher educators whose practice and professional development is less examined in the science education literature. The question of subjectivity in science education is related to the 'call' to pay

attention to sociopolitical discourses rarely studied within the field and to transgress boundaries between disciplines. I am positioned in relation to the sociopolitical turn both from my role as a teacher educator working in a university and by my use of the different theories of subjectivity. Thus, as the notion of subjectivity is key to developing my argument, in what follows I provide a layered account of different conceptualisations of the term.

2.1.1 Subjectivity: in science, sociological perspectives, and in science education

2.1.1.1 Subjectivity in science

There is a key debate on how subjectivity has been typically understood in science. There is a perspective whereby subjectivity is understood as opposed to objectivity, which is seen as the way to access what is supposedly real and true (Ratner, 2002); subjectivity is therefore seen as 'bias' of the subject who would nonetheless be able to stand outside the object of study. Conversely, another perspective recognises objectivity as an important yet problematic concept (Gunton, Stafleu & Reiss, 2021), attempting its reconceptualization by including the subject in the same critical plane as the research project where both are socially situated (Harding, 1991).

There is a shared conception of subjectivity in science in tension with objectivity where the subject stands outside what is studied. Smuts (2006) stated that "[i]n Western culture, the "objective" and "subjective" perspectives are viewed as different and competing approaches to determining what is real" (p. 116). Smuts draws on the writing of C. P. Snow, who in 1959 described the tension between "objective (science) and subjective (literature, art, etc.) approaches to scholarship", making a distinction where subjectivity did not have place in science. The objectivity-subjectivity tension in science can still be found in later works. Mario Bunge[11] – who positioned himself as a realist materialist – stated that there is a scientific method which includes "always to measure and to register the phenomena" from the outside world as a key feature of the factual sciences (1995, p.14). Bunge described that by some other elements of doing science, like observation and experimentation where scientists should not consider their own experience as a plausible setting, scientific knowledge is always clear and precise; controlling variables has the utmost importance; and scientific knowledge is generalisable and universal, amongst other assertions. Along the same lines, Scheffler (1982) in his book *Science and Subjectivity* stated that the purpose of that work was to defend objectivity, so needed in science because otherwise "there can be no science" (p. vii). In Scheffler's words, science should have "devices of control" (p. 2) to promote the scientific attitude of impartiality and detachment, in order to 'limit' subjectivity, which, according to Wallace (2004), could taint scientific observations. Curtis (2012) stated that "[w]hile the evidence-based approach of science is lauded for introducing objectivity to processes of investigation, the role of subjectivity in science is less highlighted in scientific literature" (p. 95).

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[11] On a personal note, I bring Mario Bunge into this discussion because he is a Latin American (Argentinian) philosopher and physicist whom I read during both my undergraduate degree in biology and my master's degree. At that time, what struck me about Bunge was his effort to make a distinction between what he called formal, factual, and non-science while putting factual science above all. Now I *re*read his effort as going in the complete opposite direction of what the sociopolitical call is trying to do, which has also become my effort.

Even though Curtis makes a point of the importance of considering the subjectivity of the researcher, the way Curtis conceptualises subjectivity is in relation to biases made by individuals who instead of focusing on 'objective external processes' – echoing Bunge – make hypotheses considering their prior experience, ultimately posing this situation as a 'problem'. Curtis – echoing Scheffler – finishes the article by calling on geologists and other scientists not to be 'ashamed' of their own subjectivity due to a supposed lack of scientific rigour; instead, he argues "we [scientists] *should* strive to develop methods to quantify and sometimes to reduce its effects" (italics in the original, p. 96).

The call to reduce the alleged effect of subjectivity is quite contested in other understandings of scientific processes. According to Gunton et al. (2021) "[o]bjectivity as-unbiasedness tells us what objectivity precludes (e.g., bias, idiosyncrasy, perspective, and values), but not, more positively, in what it consists" (p. 2); this offers a way to reconceptualises the notion of bias. Lather (2012) pointed out that "[s]cientists firmly believe that as long as they are not conscious of any bias or political agenda, they are neutral and objective, when in fact they are only unconscious" (p. 1022). Conversely to the position of not considering one's own experience, detachment, and reduction of subjectivity, Lather called on researchers to embrace both the limits of their own knowing and the affective response to their research work towards the constitution of a *new scientific subjectivity*, arguably applied to researchers who can challenge the power relation within claims of objectivity of scientific knowledge, understanding that such knowledge is partial and situated within our experience (Haraway, 1988). Kincheloe and Tobin (2009) gave a similar encouragement to researchers to "employ reflexive methods to identify the epistemologies, ontologies, and axiologies that are salient in their scholarship" (p. 513), because the very absence of explicating your position as researcher or science educator would show your own obliviousness. In a similar effort to contest the supposed antagonism between objectivity and subjectivity while exploring the consensus views in Nature of Science (NOS), Erduran (2014) pointed out that a positivist approach has lead to a tension between objectivity and subjectivity, where subjectivity is considered to be related to individual biases that interfere with objectivity, while more contemporary approaches try to reconceptualise that tension towards a social articulation of scientific processes and practices (see also Erduran, 2015; 2020).

Harding (1991) reconceptualised objectivity – separating it from objectivism – including the subject in an attempt to bring together the agent and the object of knowledge on what she called strong objectivity, which "conceptualizes the value of putting the subject or agent of knowledge in the same critical, causal plane as the object of her or his inquiry" (p. 161). This strong objectivity could be positioned alongside the notion of strong reflexivity, which in Harding's words:

> require that the objects of inquiry be conceptualised as gazing back in all their cultural particularity and that the researcher, through theory and methods, stand behind them, gazing back at his own socially situated research project in all its cultural particularity and its relationships to other projects of his culture — many of which (policy development in international relations, for example, or industrial expansion) can be seen only from locations far away from the scientist's actual daily work. (p.163)

Harding's strong objectivity and strong reflexivity might be a call to take a careful look into cultural particularities (by 'gazing back'), as well as how research projects are socially situated. In doing so, science can be done ethically where all the voices are taken into consideration; otherwise, it can become a sort of "scientism favouring powerful voices in the world" (Weaver, 2018, p. 131). At this point, the notion of subjectivity in science as something that is not to be reduced but rather taken into consideration meets sociological perspectives in relation to teachers' subjectivity.

2.1.1.2 Subjectivity from sociological perspectives applied to teachers' subjectivity

There is a conceptualisation of subjectivity, particularly relevant to my study, which highlights the socially situated understanding of the term wherein the encounter with other – whether the social structure, language or an-other – could be what produces subjectivity; that is, subjectivity emerges in the interplay between individual agency and social structure.

Michel Foucault and Judith Butler are two key theorists who have been influential in the sociopolitical turn's understanding of subjectivity (e.g. Bazzul, 2012). According to Foucault (1988), the subject is not the result of an experience: "It is experience which is the rationalization of a process, itself provisional, which results in a subject, or rather, in subjects" (p. 253). In Foucault's understanding, the process of this constitution of the subject means that subjectivity is "only one of the given possibilities of organization of a self-consciousness" (p. 253). Subjectivity has been defined "as the lived and imaginary experience of the subject" (Butler, 1997, p. 122) within a contingent historical and political context (Heyes, 2010). Thus, it is shaped in a discursive tension with power and knowledge (Phillips, 2011). There is a relation amongst the subjects and how they experience what is lived, what is their context, which discourses circulate and what is their affective response to them. This affects the agency of the subject in ways that are not always predictable as there is an ambivalent relationship to ruling discourses (Moore, 2006). In that sense, subjectivity emerges within the bounds of power structures while it is not reduced to social determinism (Layton, 2008); this highlights a socially situated understanding of subjectivity (Zemelman, 1997).

For Butler, however, drawing on Foucault, the conception of the subject is distinct as it incorporates the role of the unconscious to build a richer understanding. For Butler (1997), becoming a subject necessarily entails becoming, at the same time, subjected (p. 83). In this understanding, and coming back to the emergence of the subject within the limits of power structures, there is a paradox in the sense that the autonomy of becoming a subject also entails becoming subjected to that power. According to Butler (ibid) "there is a necessary restriction in this subject production" (p. 84) in order for it to take place, which can be related to the above-mentioned paradox. Here, subject production does not mean that subjects are produced in one moment, nor in their totality; instead, there is a constant production, where the subject emerges in the process of being repeatedly produced (Butler, 1997). For Butler, this very idea of repetition is also indicative of the necessity of constantly being rearticulated, which could be related to remaining inarticulable; thus, there is an acknowledgement of subjects' incoherence and incompleteness. As there is an expected coherence or a discourse of coherence in the notion of identity of the subject, Butler (2005) suggests that identity can never be totalised, which can be related to the acknowledgment of the subject's own limits – echoing Lather's new scientific subjectivity – and, perhaps, the acknowledgment of the failure

of its own definition and the limits of acknowledgment itself. In this sense, subjects are by definition undone; yet, they can experiment with the possibility of going beyond their limits (Foucault, 1997). What is interesting about this perspective and can be applied to this thesis, even though it is not incorporating the unconscious, is that from this standpoint there is an acknowledgement that the encounter with *Otherness* – whether the social structure, language or an-other – is what produces subjectivity (Lagos-Serrano, 2021; Layton 2008).

Another understanding of the subject is posed by Freire and by Ball specifically in the relation to teachers' subjectivity. In Freire (1970), under the notion of education as a 'banking model', there is a divergent relationship between a teacher-subject who deposits knowledge on an object-student as a container who receives that knowledge. According to Freire, that complex relationship can be shifted by a dialogical pedagogy where there is a reconciliation in the relationship towards both being at the same time teachers and students. In his account of teacher subjectivity in high-stakes accountability educational systems (e.g. schools and universities) Ball (2003) suggests that the teacher's responses to control measures leave a plethora of meanings that are permeated to the teachers' everyday life environments. This surplus of the teachers' subjectivity is elusive, due to the impossibility of completely articulating it, which also permeates, in an ambivalent manner, their profession with responses of both resistance and capitulation.

Thus, for Foucault (and I would say Ball as well) subjectivity is the formalisation of an experience of self-knowledge whatever it may be as one of the possibilities of a self-organisation which results in a subject. For Butler, with the incorporation of the unconscious, there is an incompleteness of the subject which is referred to as 'opacity' where the "opacity of the subject may be a consequence of its being conceived as a relational being, one whose early and primary relations are not always available to conscious knowledge" (p. 20); thus, there is something in crisis in the subjective experience which could emerge in the relation to the other. Now for Freire, the reconceptualization of the student positioned as a subject – rather as an object in the banking model of education – is able then to change their reality because of an effort of *"conscientização"* leaving behind the status of objects while becoming historical subjects (Freire 1970, p. 170). In here there is a contrast to Butler, because for Butler, even though it would be interesting to understand the new position in the teacher-student-subject relationship, what could be more related to her understanding of the elusive dimension of subjectivity – the above-mentioned opacity – is when the subject experiences some sort of crisis – the fact of becoming a subject while at the same time becoming subjected.

How, then, are these abstract conceptions of subjectivity played out in specific educational institutions? The university – in Chile but also in other parts of the world – as well as other institutions has been increasingly permeated in recent times by a neoliberal business-like logic (Amigot & Martínez, 2013) where there is a transformation of public education to a market-oriented mindset, which produces new subjectivities. The privatisation of the university produces a subjective experience which positions students as consumers while academic staff have seen their remuneration and working conditions deteriorate as the university transforms into a 'fast' academia (Gill, 2009; Robertson, 2008). According to Gill (2009), there is a subjectivity of an academia "always on" available to respond to increasing requirements (p. 9). It has been argued that university workers feel more pressured, to the point of feeling that their working environment is toxic (Cannizzo, 2018). In the case of Chile, Fardella (2020) pointed out the subjectivity of a hyper-agentic academic experiencing the pressure of rankings,

productivity indices, and the promotion of competition among colleagues. According to Fardella (ibid.), the relationship between the neoliberal agenda and the subjectivity produced in this scenario is unavoidable. In this context, there is the subject production of the "hyper-productive" academic with multiple publications and projects (ibid., p. 2306) which echoes a Foucauldian understanding of subjectivity. Such hyper-productive staff attempt to minimise the influence of their institutional context in favour of maximising their agency, meaning that they do not recognise as overwhelming the university's requirements; rather, they assume the requirements as a personal task. Fardella (ibid.) concluded that there is a satisfaction involved in this hyperproduction that can even disguise the precariousness of these subjects' context. As pointed out by Butler and Athanasiou (2017), the neoliberal recognition is a way to allow the survival of the individual who, on the one hand, resists because of the promise of recognition while keeping hidden the conditions to obtain it; that is – echoing Ball – an ambivalent relation, manifesting both resistance and concealment.

In the context of the university too, there is another subject production that is neglected, namely, the teacher educators' subjectivity. Montenegro (2016) pointed out that the path to becoming a teacher is frequently examined in research, whereas the path to becoming a teacher educator has been barely explored. Furthermore, research on the professional development of teacher educators is a "relatively young and under-researched area" (Vanderline et al., 2021). Montenegro stated that the identity of the teacher educator "frequently go[es] unnoticed in the field of teacher education" (ibid., p. 527), even though teacher educators as a group are raising awareness on the process of becoming life-long learners (Darling-Hammond, 2017; Van der Klink et al., 2017). Montenegro (2016) interviewed teacher educators who declared that they had not received support to become one, and their current knowledge on how to act as a teacher educator was self-made. It is noteworthy that in Montenegro's and Van der Klink et al.'s contributions, they mostly talk about teacher educators at an undergraduate level, which leaves more questions regarding the subjectivity of teacher educators in the space of continuous professional development – a focus of my thesis.

The observation of the elusive and paradoxical character of subjectivity – that is, the autonomy of becoming a subject while also becoming subjected because of power structures – and the acknowledgement of its social situatedness may be productive to my exploration of how the subjectivities of schoolteachers and teacher educators are produced and shift in relation to an institutional context. This productiveness could also help to "promote multiple 'other' becomings"/subjects (Bazzul, 2016, p. 8) or the possibility of "being from being more" (Freire 1970, p. 99) by the incorporation of notions from other disciplines – like a sociological perspective to subjectivity – towards addressing the sociopolitical call in the science education field. In what follows, I provide examples of the use of subjectivity in science education to situate the notion in the field of my work.

2.1.1.3 Subjectivity in science education

The notion of subjectivity in science meets the sociological perspective of the term, as something that is not to be reduced but rather taken into consideration; including the very acknowledgement of the incoherence and incompleteness of the constant production of the

subject. This reconceptualisation especially resonates with the way in which some science educators have empirically started to use the notion of subjectivity in science education.

Understanding that the "[S]cience discourse is not pure, cannot be pure even if it existed in a pure state" (Roth, 2008, p. 906) allows us to explore how discursive practices in science are shaped by power, institutions, and language, creating a particular experience and perception. In the case of science education, there is a reproduction of dominant discourses of what counts as knowledge and literacy in science. For instance, the work of Moje (1997) foregrounds the discourses in a chemistry classroom where there was a subjectivity of "the teacher as expert and producer of knowledge, whereas the students took up positions as consumers and demonstrators of knowledge" (p. 35). Moje states that these discourses are invisible to those who are reproducing them in the classrooms, showing the complexity of discursive practices and, therefore, the complexity of the autonomy of becoming a subject while being subjected to dominant discourses. Here, there is a point of intersection between subjectivity – as socially situated – and science education, where there is a subject production in a particular cultural context which is worth paying attention to. Bazzul (2014) pointed out that understanding the process of subject formation which happens in a particular cultural context (such as the science classroom) brings forth the grounds to reshape how we come to see ourselves and others. In this understanding, educational institutions – e.g. universities and schools – are central to the subjectivation processes of those involved in them, having a role in the *re*production of subjectivity (Bazzul, 2016). The discourses of those institutions might determine how people understand aspects of their identity, such as race or gender, while also validating political orientations and ethical actions.

Drawing on Foucault's theorisation of subjectivity, Bazzul pointed out that "'the subject' is not someone who is necessarily activated by particular truths in discourse but is itself constituted by particular truths in discourse" (Bazzul, 2012, p. 1010). He suggests that the subjective positions we take are produced by possibilities of thinking within discourses where truth and power circulate. Also drawing on a Butlerian perspective on subjectivity, Bazzul (2012; 2014) asserts that Butler's understanding of discourse analysis could be easily connected to, for example, the examination of textbooks in science education by questioning the nature of this subject formation through 'asking after' (Butler, 1997) its constitution. An example of a critical reflection on subjectivity and positionality in science education can be found in Louis and Calabrese-Barton (2002) who – as I see it, engaging with Harding's 'gazing back' – recognised issues not previously considered that emerged in their research with parents about science education reforms. What they realised was that there were some intersections between the parents' lives and their own lives, which led them to try to make sense of their own positionality in the research and to question their responsibility to respond either towards the parents and/or academia.

Particularly interesting in the context of this thesis is the invitation of Lather (2012) to develop a new scientific subjectivity as a way to *re-*"think politics and science anew toward an engaged social science, without certainty, rethinking subjectivity, the unconscious and bodies where I ask "what kind of science for what kind of politics?"" (p. 1021). Building on Lather´s questioning, I would pose a slightly more specific question: What kind of science education for

what kind of sociopolitical sphere? As subjectivities are everchanging in a permanent resignification process, and hence the subject is not a product (Butler, 1992), the question of its constitution – through asking after it and gazing back – in science education would also be unending, trying to uncover what conditions and discourses are producing these subjectivities at the same time as opening a possibility for reworking them (Bazzul, 2016). In my view, the use of such ideas in the settings of school or university classrooms in this thesis gives rise to a question concerning responsibility towards an ethical practice which could contrast with the neoliberal discourses – prevailing in the Chilean educational system – of these educational institutions (David et al., 2006). Drawing on the above, subjectivity in this thesis will be understood as the everyday relations that articulate how experience is lived in relation to a specific institutional context which highlights the socially situated understanding of subjectivity wherein the encounter with *other* (whether the social structure, language or an-other) could be what produces subjectivity.

Having discussed subjectivity as a key concept of the sociopolitical approach, in what follows I discuss empirical and theoretical explorations of the turn in research on science education.

2.1.2 Empirical approaches to the turn towards an activist stance

There are not many examples of the empirical 'use' of the sociopolitical lens in science education. In what follows I describe two pieces of empirical research using the concept of subjectivity. The first one is an analysis of biology textbooks in relation to the neoliberal discourse and the second one is an analysis of how a science teacher negotiates her practice under the discourses of standardised testing. I close the section with a discussion of an activist stance which resonate to the Latin American context.

Jesse Bazzul conducted critical discourse analysis of two biology textbooks engaging with the question of subjectivity produced in a neoliberal scenario. One of the textbooks was a typical book for the twelfth year of science education in Canada called *Nelson Biology 12*. In this book, he took, for example, a page where there is a 'box' with information that intended to explore an issue in science that reads "Competition is the key driving force behind science, followed by collaboration" (Bazzul, 2012, p. 1012). Bazzul noticed that the title is not presented as a question and presents the role of competition as more important than collaboration, which is the invitation to debate between the students; however, according to Bazzul, the possibilities of a neutral discussion get lost, while in the teacher's manual is presented as a suggestion the claim that "most students are not aware that competition drives science" (ibid., p. 1012). The relationship that Bazzul builds between the textbook and neoliberalism is that he could read the relation of the activity to the neoliberal discourse as, in his terms, competition is a "mantra of neoliberalism" (p. 1012) and in science, competition is also posed as a key aspect which is reinforced in the teacher's manual. Bazzul concluded that even though these materials – as well as other curricular material – alone cannot be responsible for the neoliberal discourse, they have an unavoidable role in the subject formation in a neoliberal context.

Maria Wallace (2019), also drawing on the notion of subjectivity, analysed the subjectivity of a beginning science teacher, trying to understand how she negotiates her practice under the discourses of standardised testing, teacher assessment, and effectiveness. Wallace conducted

an ethnographic study using what she calls 'ethnographic moments' to explore the experience of the beginning science teacher and a rubric that is used in teacher evaluation. As part of the ethnography, Wallace conducted participant observations which were held in the teacher's classroom from the start of the day to the end when the students leave the school. The analysis that Wallace undertook used excerpts of conversations between her and the teacher alongside extracts of the school evaluation rubric. For example, Wallace presented an excerpt of a conversation right before the second half of a science lesson started. In this excerpt, Wallace could read the relationship between institutional norms (making use of the rubric as well) and the subjectivity of the teacher regarding evaluation. According to Wallace, her presence in the classroom triggered in the teacher and her students the 'institutionalised gaze' of 'good' behaviour because when an external person enters the classroom it is (normally) only to evaluate what is happening there. Wallace used the concept of biopower to interpret the situation, stating that the narrative of the teacher and the rubric is reverberating to powerful subjectivity of a "highly effective teacher" (ibid. p. 974) who can keep the students in such good behaviour.

Wallace pointed out that her use of subjectivity combines a feminist poststructuralist understanding of subjectivity – language, power, and knowledge as well – as always already in a process, and a methodological turn to theory in science as a humanist subject. With both perspectives she opens up the possibility of reimagining the teacher's subjectivity under the pressure of effectiveness. Wallace's invitation to reimagine is perhaps related to Lather (2012)'s new scientific subjectivity in science education.

In Bazzul's and Wallace's experiences in practice of the sociopolitical turn, the mixture or varied use of different structural/poststructural, politicised approaches lead to a more critical and transformative science education (Bazzul, 2014) which also engages with the activist orientation of this sociopolitical call. The sociopolitical call has shifted to posing suggestions towards a more radical approach to science and technology education (Alsop & Bencze, 2014; Rodriguez, 2019) meaning to do something concerted to deal with a problem, for example, by understanding that the engagement in the sociopolitical turn could face a "growing ecological crisis and widening social inequality" (Bazzul, Bencze & Aslop, 2019 p. 2). This conceptualisation of the activist call especially resonates with the Latin American context because of both the growing inequalities (such as the case of Chile as well as other colonised countries), and the excluded and silenced knowledge production of those places that are non-dominant or have been colonised in the past.

There are different approaches of how to understand activism in science education; there are some authors that see the possibilities of activism in the school science curriculum and others in a broader sense that goes beyond the school. Hodson (2003) stated that action in science education could be addressed under two senses specifically regarding the school science curriculum. The first one related to how the science curriculum incorporates the interests, needs, and aspirations of the students at the school, and secondly how it is oriented explicitly to that sociopolitical dimension. Hodson (ibid.) proposed a curriculum with these two senses to 'produce activists' towards the involvement of the community. In turn, his proposal included the appreciation of the societal effect of technological and scientific changes, the recognition

of how some decisions in science and technology respond to particular interests of some groups marginalising others, meaning that it is linked with distribution of wealth and power, to develop the possibility to take action, and to develop the students' own views and positions regarding these problematic issues. Questions that remain regarding the role and possibilities of the science teachers in this call concern how the changes in the curriculum are implemented when those changes are externally informed. Furthermore, when the teachers are considered only as implementers rather than developers, how is it possible for them to realise that activism?

A contested understanding is suggested by Alsop and Bencze (2014), who pointed out the call in a sense that is broader than what happens in school science and goes to the public arena. These two authors asked a two-way question: "What might activism offer to science, technology and education? What might science, technology and education offer to activism?" (p. 1). However, they also made some suggestions for school science, specifically with what they called "four maxims for critical reworking science and technology education praxis" (p. 1). These maxims are (i) contextual conditions, (ii) political theory, (iii) subjectivities and agency, and (iv) morals and ethics. The book of which these two authors are the editors includes the discourse developed over a five-year project 'The Project for Activist Science and Technology Education' which was associated with the journal *Activist Science & Technology Education*, which aims to explore the theoretical and empirical possibilities, tensions, limitations, and experiences that the activist call is making to the science and technology praxis. It bears noting that this journal continues to contribute greatly to the role of activism in science education.

Bazzul and Tolbert (2019) argued that the activist call in science education should shift from conservative forms of research in science. According to them, too much scientific knowledge comes from Western research that is unproblematically applied to other contexts. In that sense, science education should have space for larger social movements and "non-dominant forms of knowledge" (Bazzul & Tolbert, 2019, p. 303), by adding diverse perspectives to the activist call coming from communities that have been marginalised.

2.1.3 Theoretical approach to the turn and theorising from Latin America

Science educators have been addressing this sociopolitical turn, mostly theoretically though with some empirical examples as previously developed. In the theoretical approach, there is mostly synergy of topics amongst the authors exploring the turn which may be related to its still early development. In so doing, there is agreement in the approach of some notions as well as first-time explorations of other notions. The following is a brief description of three key aspects: the use of theoretical tools from cultural studies and sociology; a focus on globalisation and neoliberalism; and the development of ethnographic approaches to explore silenced or excluded perspectives.

The theoretical exploration of the turn has been made by incorporating perspectives previously less discussed in science education. The work of Roth (2009) and other science educators is an example of exploring those perspectives. After a forum in 2008, Roth and others launched a book called *Re/Structuring Science Education* (Roth, 2009) which aimed to reunite sociological and psychological perspectives to rethink conceptual change. In that sense by applying

"cultural studies, cultural sociology, discursive (social) psychology" (ibid., p. vii), conceptual change was explored under some notions including dialogue (see also Roth, 2010b), discourse, culture, and history, attempting to bring sociological theories of knowing and learning into science education practices.

Others have brought to the spotlight issues related to the perverseness of globalisation and neoliberalism in science education. Early in this turn, Bencze and Carter (2011), after a political and economic analysis of some literature, pointed out that the school science, under the neoliberal project, is globalising students, reducing their role to either knowledge producers – such as scientists, engineers, or other workers of the STEM acronym – or citizens who would serve as consumers in the society, perpetuating mechanisms which may benefit economic groups. In a 2011 volume of the journal *Cultural Studies of Science Education* – a journal focused since 2006 on publishing research which makes a link between science education and cultural studies – globalisation was seen as a 'wicked' problem (Carter, 2011) because of the difficulty surrounding how it is defined, its multicausality, its social complexity and its unclear solution. Building on that discussion, Bazzul and Siatras (2011) pointed out that to overcome the pervasiveness of the neoliberal agenda there should be an incorporation of both the lens of what they referred as the 'post-structural subject' and critical pedagogical voices for change in science education. According to Carter (2014) this pervasive discourse of neoliberalism is so impregnated in society that it is referred as "the elephant in the room" (p. 25) because it is the current common way that we live, interpret, and understand the world. Carter (ibid.) pointed out that unpacking this discourse in science education could shift the unpolitical stance of the field at the same time as exploring some implications towards activism and resistance in science education.

The way that the sociopolitical dimension has been influenced by thinking with theory from other fields is an example of transgressing boundaries. For example, some concepts that have been used in this sociopolitical turn of science education are Foucault's notions of biopolitics (Bazzul, 2017; Carter, 2014; Wallace, 2019), governmentality (Carter, 2014) and subjectivity (Bazzul, 2012; 2013; 2014; 2015; Wallace, 2019). Of particular note are Deleuze and Guattari's notion of assemblage (Bazzul & Kayumova, 2016; Bazzul, 2018; Deleuze & Guattari, 1988 in Bazzul, 2018), Deleuzian horizons of difference and imminence (Deleuze, 1994 in Bazzul, Wallace & Higgins, 2018), the Derridian mobilisation of *différance* (Derrida, 1968 in Roth, 2009) and the feminist question in science (Harding, 1991) to name a few. Using ideas from these theorists from other fields allows the field of science education to think about itself critically and in depth (Bazzul, 2018), generating a struggle using alternative theories, ways of analysis, and methodologies (Kayumova, 2015).

Some science educators are concerned with issues of historically silenced groups or themes in science education. For example, the work of Brandt and Carlone (2012) incorporated cultural studies of how the interaction between contexts and political issues influences the science classroom. These authors (ibid.) used ethnography – not so common in the field – to highlight ethnical and linguistic aspects of groups that have been excluded from participation in the school science. Similarly, Fifield and Letts (2014), incorporating queer theories in science education, questioned how sexual education in science has been understood as binaries under

a heteronormative regime to avoid talking about diversities or sexuality, unpacking, for example, the phrase 'science for all'. Kayumova (2015) posed the same call to explore the sociopolitical dimension by incorporating both feminist and postcolonial questions in science as a critical lens to read how knowledge production is done in science education.

An example of a Latin American exploration of the sociopolitical in science education combines a Freirean pedagogy with a humanistic approach including dialogue in the classroom (Santos, 2009). Santos' (2009) call is to understand, through critical reflection, the political role of science education by questioning the banking model of schools 'depositing' knowledge while the students 'consume' it. Inside science education there are critical voices raised against this Freirean approach because of its presumption of a "unified, conscious, rational subject of humanism" (Lather, 2012, p. 1024), which is contested by notions of subjectivity, exploring how the limits of thought and action are constructed (Bazzul, 2014). Still, some Freirean notions of emancipation or the banking model of education resonate strongly, especially in the Latin American context (Santos, 2009; Torres-Olave, 2021) owing to its particular process of (de)colonisation.

The term 'decolonial' emerged to protest against both colonisation and the idea of occidental modernisation in the Latin American context (Walsh, 2013). The decolonial question is posed as a way to trouble, for example, dominant discourses about science, attempting rather to break the hermetic science education in practice, and shift it towards transformation. According to Walsh (2013), decolonial pedagogies are in line with critical pedagogies in the sense that decolonial pedagogies are part of a bigger decolonial struggle that can induce theorisation and reflection as non-linear movements that are rooted in the idea of new ways of transitioning and new ways of being. The recent sociopolitical call in science education can be theorised and put into practice from current social struggles towards possibilities of resistance (Carter, 2014); in that sense, the Latin American context could offer a rich scenario in which to develop this sociopolitical dimension of science education[12] which might add other perspectives, both of how knowledge is produced and how it is understood, attempting to decolonise school science (Higgins, 2016; 2018).

In the context of science education, acknowledging that scientific discourse is not pure could open the opportunity to ask who decides what knowledge is valid and why some categories of knowledge are universally accepted while others are not. In a recent example, Thomas and Vavrus (2019) pointed out their discomfort as facilitators in a CPD programme while explaining to the participating teachers why and who decided that Pluto is no longer a planet. From that discomfort they ask themselves "how might global norms about 'good' pedagogy reinscribe colonial hierarchies of knowledge and power?" (ibid., p. 2). These authors used the naturalistic approach based on the history of the people to problematise the statements of universality in

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[12] An important current crisis in Chile is what is happening since October 2019 regarding the possibilities to change the neoliberal model enforced during the Dictatorship. This struggle reached a major milestone on the 25th of October 2020 after a referendum in which almost the 80% of the population approved changing/rewriting the constitution created in the dictatorship. In that regard, science education should be involved in what is going to be the new form of the Chilean organisation by, for example, entering the discussion of the privatisation of the water in the country which has an effect of the cycle of life of all organisms.

relation to the colonial history of specific knowledge. They aim to produce a decolonial praxis in a teacher training programme, using what they refer to as reflexivities of discomfort.

Decolonial pedagogies are related to the understanding that teaching is not just instrumental (Walsh, 2013) and in Freire´s (1970) terms pedagogy is a methodology inside and outside the school as a social fight for liberation. Connecting Pereira's (2019) 'boundary work' in STS with the reflexivities of discomfort by Thomas and Vravus (2019), the recognition of the institutional border of the school and the university as a limit allows one to critically reflect on the disconformity that those 'walls'/boundaries could produce. This questioning may become decolonial by the Butlerian notion of 'asking after' the norms of knowledge production and its transmission, above all when the knowledge is understood as neutral and detached from its subjects with their different views of the world. As stated by Avraamidou (2020), positions that dispute those assumptions open spaces for "multiplicity, diversity, subjectivity, and hybridity" (ibid., p. 4) to experience and acknowledge the many possibilities of being a science person, a process always already embedded sociopolitically.

In sum, this thesis sits within a body of sociopolitical questioning as a lens to explore the subjectivities produced in and around a CPD programme as a way to provide an empirical illustration of the turn that has mostly been theoretically based. In doing so, I am positioned in relation to the sociopolitical turn both by my role as a teacher educator working in a university and by my use of subjectivity. Even though this illustration is regarding the Chilean context, the conclusions that I draw are applicable to a broader literature on science education. In the following two sections I develop the literature review of the topics related to this illustration, namely, the science curriculum and its development and changes, and CPD programmes in science education.

2.2 Science education, the science curriculum, and the big questions and ideas

The relationship between science and science education has been widely explored, yet less attention has been given to how both are conceptualised, resulting in some paradoxes in the field. Science deals with themes of the material world such as life and living things, matter, the universe amongst many others that are – or can be – compelling to many people (Millar & Osborne, 1998). Science has competed for a space in the school curriculum since the nineteenth century and most of the ideas that nowadays are part of science education came from that time (DeBoer, 2000; 1991; Sikorski, & Hammer, 2017). Thus, science education has been concerned with ideas such as objectivity and "the 'truth value' of scientific knowledge" (Bazzul, 2016, p. 2) while trying to engage with more recent worldwide concerns such as the environmental and ecological crisis, and social inequalities (Bazzul, Bencze & Aslop, 2019). During the twentieth century, the organisation of science education was dominated by psychological approaches to knowing and learning science, focused on the individual mind (Roth, 2009). In the late 1990s, it shifted to include a focus on social, cultural, and political aspects and more recently an understanding that "science education produces (and is produced by) particular material realities" (Wallace, Higgins & Bazzul, 2018, p. 201), putting into question the "taken-for-grantedness of a 'good/true/right science education'" (ibid, p.

201). Science education with its paradoxical ideas and organisation is becoming – or must become – a site of struggle (Bazzul, 2016), where the people working on it might interrogate both themselves and the field to realise that 'becoming' (Carter, 2014).

Interrogating them(our[13])selves and the field, is of value, by, for example, addressing the question that Millar and Osborne (1998) raised, namely "why does education in science matter?" (p. 7). To share with students the knowledge and products that science and technology have produced about the material world to develop a sense of decision-making ability or the empowerment and action in scientific issues are some of Millar and Osborne's sensible answers. Nevertheless, trying to understand, for instance, why the interest of students in science decreases as students move through compulsory education (Mujtaba & Reiss, 2014) or why science education is seen as irrelevant "for and by the learners" (Stuckey et al., 2013, p. 1), some authors have shifted to question how science and science education have been conceptualised (Carter, 2014). One illustrative area in which this question can be seen is the place of practical work which is also contested. As a strategy, practical work in science education is widely considered to be essential (Millar & Abrahams, 2009) to the point that it is identified as "*the* distinctive feature" in schools (Abrahams, 2011, p. 1). For some, practical work in laboratory lessons is associated with students following orders, becoming less able to both create a procedure and to understand the complex relationship between science, society, environment, and technology (Bencze & Hodson, 1999), voicing doubts as to its value. However, others have pointed out that practical work can be effective if it is seen as 'Minds on', by engaging mentally with scientific concepts and ideas, rather than just 'Hands on', where the engagement is through manipulating objects (Abrahams, 2011; Abrahams & Reiss, 2016).

Those kinds of contested understandings in science education move us to uncover how it might be in dispute. One way to explore this is through the science curriculum. A curriculum is seen as being at the heart of education because it supposedly embraces the integrated, holistic, and narrative nature of education while being a bridge between teachers and the social context (Hökkä, Eteläpelto & Rasku-Puttonen, 2010). How is that *heart* in science education? How is it developed and changed? How do teachers might respond to those changes? These are some of the questions that I develop in the following section.

2.2.1 The curriculum in science education

2.2.1.1 What is the science curriculum?

Many science educators working in many different contexts have wondered what the aim of science education is or should be. For some, its aim, as with education's aim in general, is related to enabling learners to "lead a life that is personally flourishing and to help others to do so too" (Reiss & White, 2014, p. 10). For others, there is significant consensus that 'the' aim is to achieve scientific literacy of the population (Yeh, Erduran, & Hsu, 2019), which means citizens who are informed and able to participate actively in a modern, democratic, and technological society (Holbrook & Rannikmae, 2009), engaging critically with science (Osborne

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[13] I'm positioning myself as a science educator trying to problematise my own practice. My initial training is as a biologist working on science education in professional development. I expand on my background in Chapter 3.

& Dillon, 2008). In 1998 Millar and Osborne produced a report called *Beyond 2000: Science education for the future* which also stated that scientific literacy is the primary goal. However, there is not a univocal voice as to what scientific literacy means (Vieira & Terneiro-Viera, 2016), and unfortunately, sometimes the term is seen as the preparation of *future* scientists, becoming irrespective of what students currently experience because they are considered as what they *can be* rather what they *are* (Aikenhead, 2005; Millar & Osborne, 1998). Even though the *Beyond 2000* report "had a major effect on curriculum development in England, Wales and Northern Ireland" (Reiss, 2018, p. 47) and was produced considering science education in that context, it is widely cited – 1972 citations on Google Scholar as of 30 November 2021 – and is also referenced in Latin America. A recent example of its use can be found in Colombia, where the importance of including Nature of Science in their curriculum was addressed (Ayala-Villamil, 2019), an emphasis which was not present before.

Even though scientific literacy is currently and worldwide singled out as the primary goal of science education (Vieira & Terneiro-Viera, 2016), for some the main aim should be the integration of STEM (Science, Technology, Engineering and Mathematics) disciplines, which, as a movement, appeared at the beginning of the 1990s (Martín-Páez et al. 2019). STEM attempts to connect scientific knowledge and economic growth when environmental problems and social issues are increasing (OECD, 2016). Freeman, Marginson and Tyler (2015) stated that STEM is related to learn or work in the disciplines of the acronym from the school level to, eventually, the disciplines at the university level. Nevertheless, according to Carter (2016) STEM has neoliberal foundations that could be "silencing other perspectives of science education" (p. 31), which is worrying considering its broader acceptance in science curriculums (Higgins et al., 2018). In South America, STEM education did not have a unique understanding which could be related to the external and diverse influence from some places in Europe, USA, and South Korea (Tovar-Rodríguez, 2019). In countries such as Argentina, Chile, Ecuador, and Colombia there is increasing interest in integrating STEM disciplines through both research within academia and in speeches from national educational institutions (ibid.). In Chile, STEM is part of the discourse of the national science curriculum which states: "students should develop competencies to live and work in jobs that do not yet exist"[14]. However, apart from just thinking on the *future* life of the students, there is no practical integration of the disciplines in the curriculum nor initial training of a STEM teacher. In a sense, STEM presents something of a blurred aim, and both it and the scientific literacy approach are informing from 'outside' the Latin American science curricula.

In Latin America during the 1960s and 1970s the concept of 'Latin American Thought on Science, Technology and Society' (or PLACTS in Spanish) emerged as a situated understanding of the STS (Science, Technology and Society) movement, aiming for endogenous technological development to overcome the social and economic inequalities of the region (Chacón, 2016; Jiménez, 2010). In broader terms, STSE programmes (adding the Environment to the STS

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[14] Web of the Ministry of Education in Chile https://www.curriculumnacional.cl/portal/Innovacion/Lineas-de-Innovacion/STEM-Aprendizaje-Basado-en-Proyecto-ABP

movement) tried to pose science and technology as complex and socially embedded endeavours examining critically the relationship amongst science, technology, society, and the environment (Carter, 2014). However, even though STSE – or PLACTS – offer/advance a desirable goal, "in practice it is often fraught with difficulties and marginalized" (Pedretti, 2003, p. 219). According to Chacón (2016), in the 1880s, PLACTS was seen negatively due to the neoliberal model which tried to stimulate a competitive technological market internationally where endogenous efforts were seen as inefficient and expensive. As Calsado (2020, para. 19) noted, "the marginalized are prohibited from exercising their right to self-determination" citing, though, how an indigenous community in the Philippines disputed the 'dominant' curriculum by building a decolonised STEM curriculum. Similarly, McKinley and Stewart (2012) pointed out that there are attempts to include indigenous knowledge in the science curriculum; however, it has resulted in a sort of "caricature" (p. 542) of that knowledge. In this sense, 'one' curriculum defines what is taught and what is not in something called 'selective tradition' which helps to maintain the privileged position, taking the knowledge of a particular group as the one that should be transmitted (Apple, 1986; Marano, 2004).

From the silenced PLACTS or the decolonised STEM curriculum arise dilemmas, for example, issues of power and knowledge in science education, questioning if the aims should respond to multiplicities or universalities (Wallace, 2018). Other efforts engaging politically and socially with issues of power are STEPWISE (Science and Technology Education Promoting Wellbeing for Individuals, Societies, and Environments), aiming for students to discuss their current understanding of socio-scientific issues, considering social, political, economic, and ethical dimensions (Bencze, 2017). The sustainable socio-scientific (S^3R) model put forward by Morin et al. (2014) and the Sociocritical Problem-Oriented model described by Marks and Eilks (2009) are other efforts that attempt to engage with local problems, towards a sense of ecojustice (Roth, 2010a) with a perspective which creates a confluence amongst "science, environment and health" (Dillon & Avraamidou, 2020, p. 4).

Apart from the questions surrounding its aims or situatedness, the science curriculum presents challenges to the teachers who are called upon to implement it. Teachers found that this is a difficult task as they are expected to teach a huge amount of knowledge in one academic year (Metz, 2012). In general terms, when the science curriculum is rigidly developed, teachers lack a sense of ownership which makes it more difficult for them to teach it in the way it was intended (Ogborn, 2002). Besides, in almost every country the science curriculum is fragmented (Duschl, Maeng & Sezen, 2011; Osborne, 2007) and presents a lack of progression between primary and secondary education (Harlen, 2015a). Comparing different science curricula, Hollins and Reiss (2016) undertook a review in eleven jurisdictions, concluding that those science curricula were changing, there are different ways to develop a curriculum, and that these eleven jurisdictions presented some differences but also some commonalities, such as the aims they pursued. At this point it bears problematising how the curriculum is developed.

2.2.1.2 How is the curriculum developed?

In broad terms, changes in curricula are never-ending (Bantwini, 2010). Curricular reforms aim to change educational systems which also touch the processes happening in classrooms (Couso, 2016), meaning that for schools and teachers "curriculum change is currently the lived reality" (Jenkins, 2020, p. 179). The development of the curriculum is in line with a technical-rationalist approach managed by Ministry people, with power and influence, who review what is already in it, to generate alternatives and make recommendations for teachers to implement (Bencze & Hodson, 1999). Those changes are made by others, namely, curriculum developers, rather than informed by the actual practice of teachers (who are positioned as curriculum receivers) and students in classroom activities (Saracaloğlu et al., 2010). In Latin America, the process of curriculum development started under the European influence of Spain and France, drawing on how liberals and conservatives viewed the educational system (Díaz-Barriga & Garduño, 2014) and it is described as a process without teachers' participation even if there is a collaborative design of curriculum materials (Couso, 2016). This results in a mismatch of what teachers and curriculum developers do.

Bencze and Hodson (1999) have pointed out the importance of 'changing practice by changing practice' as a way of conducting curricular developments – involving action research processes – with teachers assuming multiple roles to fulfil the requirement to generate those changes. Usually, teachers do not generate the curriculum, they just reproduce the content contained in it; at the most, they make additions, deletions, or re-sequence its content (Smith & Girod, 2003). However, teachers are called to "reinterpret the fundamental concepts and methods of the respective disciplines in accessible, engaging, and powerful ways for students" (ibid., p. 295). Other requirements are that science teachers should use constructivist ideas about teaching and learning, managing also the nature of scientific inquiry (Bencze & Hodson, 1999) while being able to challenge their students' ideas (Traianou, 2006). However, even though policy asks for those changes, it does not give the opportunity to implement them, so how is this resolved? Teachers are asked to find the solution, with it being requested of them to make the current aims of science education possible without having – or having very little – influence in what is asked. In that sense, curriculum innovation in science education is brought to schools in a top-down way, resulting in little change in classrooms (Couso, 2016). Bencze and Hodson (1999) advocated a participatory approach to curriculum development based on action research because the curriculum "should be regarded as problematic and open to scrutiny, critical appraisal, and revision" (p. 525). Their approach attempted to create a *common curriculum* where teachers who know their students, school environment and conditions work collaboratively on issues related to the design and implementation of teaching and learning experiences. An important argument to use action research as a methodology is related to teachers developing skills – which later they would ask from their students – such as critical thinking, problem solving or questioning by problematization. In this way, collaboration between teachers is seen as the best hope for school improvement (DuFour, 2007). Albashiry, Voogt and Pieters (2015) explored experiences of collaborative curricular development

between students, teachers, and employers to develop a shared vision about the educational programme and how it should be developed and implemented, thus shifting the position of teachers as information providers or executors of others' ideas (Van Driel et al., 2001), challenging a current dilemma between "'knowledge production' and its implementation or 'knowledge consumption'" (Couso, 2016, p. 55). So, I pose the question: how do teachers respond to curricular changes, having participated in them or not?

2.2.1.3 How do teachers respond to curricular changes?

Regarding curricular development, usually teachers are treated as implementers, executers, information providers, and less so as curriculum developers; in each of those positions, teachers might respond differently. An example of seeing teachers as implementers is made evident by an experience in South Africa which examined the subjective experience of teachers in advance of curricular change (Bantwini, 2010). Teachers had their own ideas about how changes should proceed and how to act on them. For some teachers, the reform meant only overwork and was time-consuming when time is already an issue in schools; others saw the change as modifying their routine in the classroom to adopt methods that were unfamiliar to them, like the use of inquiry-based learning and the constructivist approach. Some teachers commented that their salaries did not reflect the changes asked and the way that the reform was discussed was allowing only a short amount of time to comprehend those changes. Bantwini (2010) finished his article by advising that teachers must be involved during different stages of the developmental process and suggesting that CPD should be designed and delivered to support the implementation of the changes. However, the responsibility is put on the teachers to look for a way to participate in the changes rather on the way that the curricular development in conducted.

In Turkey, one study looked at an experience of curriculum evaluation where teachers – as information providers – were asked to fill in forms with their insights; however, their "views [were] not taken into consideration, and the forms [were] not evaluated" (Saracaloğlu et al., 2010, p. 2430). These authors reported that teachers felt 'dissatisfaction', 'despair' and 'disappointment' once they knew that their opinions were not taken into consideration. The curriculum development was described as managed by the central authorities with some participation of teachers in curricular development committees, but still teachers felt that the efforts of the "Ministry about curriculum development and evaluation [were] not sincere" (ibid., p. 2432), with the authors concluding that the teachers' role is understood as unimportant even though Ministry people think that their participation should be active.

A different example of curriculum development can be found in Australia where teachers – more as curriculum developers – felt more active in curricular changes, in relation to having the opportunity to exercise their agency in their workplace (Jenkins, 2020). Jenkins concluded that "teachers who enacted proactive agency were personally motivated to make the changes and were supported by contextual factors such as administrative support, positive collegial environments and good quality professional development" (ibid., p. 176). In this example,

when teachers occupy a curriculum developers' role, they describe that they can control what happened in their classrooms opposed to what happens when the change is mandated.

In the UK, Ryder and Banner (2013) posed the question: "how do secondary science teachers experience the curriculum reform?" (p. 506). The new curriculum at that time had an emphasis on teaching socio-scientific issues and the nature of science. These authors concluded that the teachers did not reject the reform, but their responses were varied, where some were comfortable with it, others were neutral, and others felt threatened by implementing the reform in their classrooms. That difference is explained by the teachers' conditions; a supportive context facilitates change while tensions are barriers to change. Ryder and Banner (ibid.) concluded that curriculum developers should recognise the multiple identities and science education aims of the teachers and their schools, for example, when teachers think that what is designed/decided may not be helpful to their students.

In Chile, regarding curricular changes, teachers are mostly considered curriculum implementers (González, 2015). However, according to Contreras (2016) even though teachers are treated as implementers they do not implement current curricular reforms in their classrooms. The Chilean teacher workforce's response to the most recent curricular change in the science curriculum was a national mobilization in 2019 asking to invalidate the current reform, amongst other working conditions' requirements (Acuña, 2020). Even though the proposed changes were in line with the current focus of science education and many teachers agreed with it in principle, the 'usual' way to make curricular reforms without teachers' participation resulted in a massive rejection of them (Torres, Avilés & León, 2019). In Chile, the new curriculum and the new law that has created the system of teachers' professional development have as a declared aim of boosting the autonomy of teachers. Potentially, such teacher autonomy could create the space for science teachers to engage in the reinterpretation and their own organisation of the curriculum. Chile's and other cases' experiences are similar in that teachers are providers of information, or implementers of the curriculum designed by others; in this way teachers become excluded from the curricular developmental process. At this point it is worth asking, in the case of Chile and more broadly: Do science teachers have the power and conditions to change/create a curriculum based on their students, knowledge, and school context? Whose knowledge is considered in the development of a curriculum? This kind of power-sensitive questioning can elucidate the instantiation of a particular curriculum and its relationship to the sociopolitical call.

2.2.2 Curriculum design, the sociopolitical questioning, and my positionality

There are two key strands in research on curriculum design that are particularly relevant to my study. The first of these foregrounds the way teachers have been excluded from processes of curriculum development (e.g. Bencze & Hodson, 1999) related to a sense of ownership of the curriculum (Ogborn, 2002). The second key strand goes further; rather than just noting this exclusion, it attempts to explain it using the concepts of 'cultural myths' (Tobin & McRobbie, 1996) and decolonisation (Gandolfi, 2021).

In Pietrocola's (2017) understanding of the curriculum, the exclusion of the teachers in the changes can no longer exist because "the science curriculum, more than any other field of knowledge, was burdened by social and political pressure to change in order to adapt to modern challenges and needs" (p. 2). I would argue, however, than more than considering that pressure just as a burden to change, the sociopolitical influence needs to be unpacked towards understanding the origin/context in which the curriculum is changed. As previously pointed out (*2.2.1.2 How is the curriculum developed?* and *2.2.1.3 How do teachers respond to curricular changes?*), schoolteachers are positioned as implementers, information providers or executers, and less as curriculum developers themselves. Related to this and drawing on the sociopolitical approach, there are some power-sensitive questions that can be posed in relation to curricular development, such as: Who made the changes to the curriculum? Whose practice and knowledge is legitimised in that development? And in turn, whose knowledge is not legitimised?

According to Bencze and Hodson (1999), the development of a curriculum is managed by Ministry people/policymakers who review what will be included to make recommendations for teacher to implement. In that sense, the changes are made by others instead of being informed by the practice of the teachers (Saracaloğlu et al., 2010). Sokolwska et al. (2013) carried out an analysis of science curricula in ten EU member states, acknowledging the affective component in the intended, implemented, and attained curricula levels, and concluding that what is happening in classrooms is rarely "detected in legal documents" (p. 10). Ogborn (2002, p. 146) argues that "teachers are the true owners of a curriculum" and in that sense its implementation could be a success, when teachers become curriculum-makers and not just implementers (cf. Bencze & Hodson, 1999). Ogborn (2010) underlines how academic researchers need to have a sense of modesty in regards to the extent to which research informs curriculum development, as do curriculum developers, in terms of what their contribution could be, while also respecting the experience of teachers' practice as equally valuable. In the same line, Giroux (1990) pointed out the typically reduced role of schoolteachers when thinking on curricular development and changes where they are positioned as implementers:

> What is evident in this traditional approach [of curricular development] is that it organises school life around experts in curriculum, instruction and assessment, who are in fact assigned the task of thinking, while teachers are reduced to the category of *simple* executers of those thoughts. (p. 175)

Within this perspective, curricular developers are positioned as the thinkers – mostly outside the school – who 'wish' to improve the quality of science learning in schools with their ideas, while schoolteachers are *simple* implementers/doers of those thoughts in a very traditional understanding of teachers' practices. This understanding obliviates, on the one hand, teachers' ownership of the curriculum and their agency as reflexive intellectuals (Giroux, 1990) and, on the other hand, the sociocultural and political setting where teachers enact their professional lives (Tobin & McRobbie, 1996; 1997), in doing so obliviating the institutional factors surrounding their practice (Benson, 1989). In front of this dismissal of the role of teachers,

others have wondered if science curriculum policy documents consider, in a broader sense, the social-institutional dimensions of science at all (Erduran & Dagher, 2014).

In their exploration of the perceptions of teachers regarding the incorporation of socio-scientific issues (SSI) in the Korean science curriculum, Lee, Abd-El-Khalick, and Choi (2006) concluded that even though the teachers gave value to the incorporation of the SSI aspects within their secondary lessons, the lack of time available and the cultural pressure to prepare the students' entry to higher education institutions constrains the possibility to develop the SSI curricular requirements. Thus, there is a clash between the policy requirement and the institutional culture, making it impossible for teachers to implement or for students to make sense of what is asked in the curriculum (cf. Sikorski & Hammer, 2017 on students as seekers of coherence; see also Golding, 2019 on a coherent curriculum for school mathematics).

Influenced by Tobin and McRobbie (1996), who posed the idea of cultural myths[15] around the chemistry classroom, a question worth asking under the sociopolitical approach is: Which are the cultural assumptions – e.g. assumed asymmetrical relations – between policymakers and schoolteachers regarding the curriculum's plan and enactment? Notably, it would be productive to explore how potential cultural myths could be constraining the science classroom with assumed power distribution rendering teachers and students powerless, where one is positioned as transmitter and the other one as receiver; such a state would echo what Freire described as the banking model of education. Tobin and McRobbie finished their study stating that "[t]he science curriculum is embedded in a sociocultural matrix and it is likely that reform can only be initiated and sustained if the shared beliefs throughout a community support recommended changes" (p. 239), that is, if the changes make sense to the ones who live in that context, namely, teachers and students. Such claims open the space to collaborative curriculum development, towards embracing an effort of decolonising the curriculum. This would allow a rethinking of how a curriculum engages with the context and diversity, disrupting colonial and universalised assumptions of what needs to be taught (Gandolfi, 2021). Decolonising curriculum and pedagogy is a movement so far more closely related to higher education (Shahjahan et al., 2021). However, it can be applied to secondary education within the secondary science curriculum (Gandolfi, 2021). Decolonising the curriculum emerges from the recognition that the curriculum is legitimising, validating or settling particular systems of knowledge production, e.g. western science (Gandolfi, 2021), while others become marginalised, e.g. indigenous knowledge in the science curriculum (Calsado, 2020; McKinley & Stewart, 2012; O'Hern & Nozaki, 2014). The meaning of decolonising cannot be related to abstract and universal efforts; according to Mignolo and Walsh (2018), it should gaze back at "who is doing it, where, why and how" (p. 108) as power-sensitive *'W'* questions that are important to ask to the curriculum development. In this sense, the decolonising is contextual, with political and epistemological consequences in terms of geographical, disciplinary, institutional, and stakeholder settings (Shahjahan et al., 2021).

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[15] These authors concluded that cultural myths "associated with the enactment of the curriculum might be thought of in terms of interacting sets of referents related to the nature of knowledge and the distribution of power through an educational system" (p. 238).

As previously stated, 'decolonialism' emerged from the Latin American context to protest against colonisation and occidental modernisation (Walsh, 2013), which I connect to the sociopolitical approach as a way to critically ask those 'W' power-sensitive questions (see *2.1.3* on *Theoretical approach to the turn and theorising from Latin America*). Thus, this decolonial questioning becomes important in the context of my research as a Latin-American researcher doing a PhD in the UK. In relation to this, I aimed to develop my work adopting an *inward-facing*[16] perspective, looking for alternatives to think differently my(our) role as teacher educator from the university and the ways the curriculum is developed.

In this section, I have focused on discussing a sociopolitical stance related to curricular development. However, there is another aspect that is worth paying attention to, which is bringing to the spotlight present-day curricular changes, in order to identify the relationship to the sociopolitical approach that this thesis attempts to do. There is a current change in the science curriculum – in Chile and a number of other countries worldwide – which aims to overcome some of the problems within science education, such as the disconnection between primary and secondary education; the volume of content expected to be taught in one school year, and the fixed understanding of particular conceptualisations of science, which have also been described as fragmented. This current change is the 'big ideas of science education', which I examine in the following section alongside a discussion on the overall notion of 'big', also relevant to the approach of 'big questions'.

2.2.3 Big questions and big ideas of science education

2.2.3.1 What are the big questions and how do they relate to science education?

Some questions are considered 'big questions' because they occupy most people's minds at some point during their lives with issues related to the nature of reality and human personhood (Billingsley et al., 2013; 2018). Lawson et al. (2020) referred to these kinds of questions as "big philosophical questions" (p. 62), while other authors have pointed out as their salient features being fundamental and profound questions about the cosmos, nature and culture in a changing world (Stavinschi, 2009). Expressly in biology, others have stated that these are the "big (metaphysical) questions of the nature of life as the most fundamental questions in biology" (Ingram, 2020, p. 40). Considering that these conceptualisations of big questions refer to essential, fundamental, and profound human personhood issues, it is stated that they can enter the school context where students can gain a deeper and wholehearted understanding of real-world questions and problems (Billingsley, 2020; Stavinschi, 2009).

According to Billinsgley (2020), the notion of 'big' also highlights that these kinds of questions are of considerable importance; hence, they cannot be answered by a single discipline. Specifically, these big questions and complex real-world problems can rarely be addressed through science alone (Billingsley & Hazeldine, 2020). In turn, science and science education need to connect and cooperate with other disciplines to "help many students to gain a richer

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[16] Inward-facing and outward-facing are concepts posed by Shahjahan et al. (2021) to differentiate the possible alternatives of action from within or from outside researched institutions.

and deeper understanding of the nature of science" (Billingsley, 2020, p. 16) by using questions, methods, and ways of thought of other bodies of knowledge. In so doing, addressing the big questions in a 'multi-, trans-, and inter-disciplinary' way can be more engaging to students (Lawson et al., 2020).

There are a number of common substantive themes on big questions. For instance, some big questions are: *Why does the universe exist? Does it have a purpose? Do people have free will?*, questions that are attempting to connect ideas in science and religion (Billingsley et al., 2018, p. 1117); *Is there life on other planets? Are we alone in the universe? Does the universe have a beginning? If so, what does it mean?*, questions seeking to connect astronomy, philosophy, sociology, and religion (Stavinschi, 2009, p. 1); *What is the connection between knowledge and experience? How are organisms 'being and becoming'?*, questions that are attempting to connect philosophy and biology (Ingram, 2020, p. 43); *Can a robot think for itself?*, a question related to human and electronic personhood in biology, engineering, and technology (Billingsley & Nassaji, 2020); and *What is personhood?*, a question that tries to generate an interdisciplinary discussion drawing on computer science, biology, philosophy, and politics (Lawson et al., 2020, p. 59). In a similar endeavour in the social sciences, Doyle (n.d.) brought history, geography, and modern studies into the school context through a new curriculum. In Doyle's suggestion, the curriculum should address big questions such as: *Where did humans come from?* and *Have humans always lived together?*, so as to enable students to develop a deeper understanding of the human and its place in the world regarding "the universe, human development and impact, and the future of civilisation and the planet" (Doyle, n.d., p. 27). Likewise, Gamoran (2016) considered big questions as a 'puzzle' starting from smaller questions "in ways that add up, over time, to answer the larger issues" (p. 90), pointing out also the idea that a big question cannot be answered in just one field; in this case, there is a shift from "sociological puzzles (for example, why do some students learn more than others?) to educational policy concerns (for example, "how can we reduce inequality in student learning?)" (p. 90), attempting to connect sociological and policy studies.

Due to the impossibility of answering big questions considering only science as a field of knowledge, big questions allow a greater understanding of the limits of science (Erduran & Kaya, 2018). In relation to this, collaborating between science and humanities could make it possible to share the responsibility to address those big questions "without placing the burden for delivery solely on the science department" (Lawson et al., 2020, p. 60). Stavinschi (2009) suggested the potentiality of big questions as a way to model the interdisciplinarity of research where "philosophers, physicists, cosmologists, mathematicians, theologians" (p. 3) can work together to tackle what science cannot solve alone. In that light, a multi-, inter- and transdisciplinary approach can be at the same time amongst, across, and beyond disciplines, trying to answer these big questions as concerns of humankind today (ibid). Besides, an interdisciplinary perspective might contribute to the enhancement of both teachers' and students' interest in science, and characterise and embody the nature of science due to considering "diverse disciplinary lens" with social, cultural, historical or economic issues (Erduran, 2014, p. 107).

As stated by Billinsgley (2020), by addressing big questions, students can gain a deeper understanding of the nature of science through real-world contexts and problems; for teachers, teaching based on those problems can be transformative of their practice (Allchin, 2013; Billingsley & Nassaji, 2018; Billingsley et al., 2018; Lawson et al., 2020). Regarding the nature of science, this approach – amongst, across, and beyond disciplines – might also disrupt a view that science is always right or the so-called 'uncritical scientism' (Billingsley & Nassaji, 2019), because of "appreciating the power and limitations of the natural sciences and their methods" (Billingsley & Hazeldine, 2020, s. p.). Uncritical scientism is a term used in the context of education which is related to considering the scientific view as the only one that can legitimately understand the variety of phenomena in the world (Billingsley et al., 2018). Thus, exploring the nature of science in real-world contexts/problems and in relation to big questions can "build students' epistemic insight" (Billingsley & Hazeldine, 2020, para. 6), drawing on a variety of arguments produced by different scholars in different bodies of knowledge.

Big Questions in Classrooms (BQiC) is a funded initiative in England which attempts to elicit teachers' and students' curiosity about knowledge in search for meaning, purpose, and truth as a human universal questioning. Billingsley et al. (2018) asked *How can the English education system open its classrooms to big questions? What can it do to help young people access a range of ways to think about integration of knowledge across disciplines?*, thus seeking both to bring big questions to the science classroom and to help students to understand the value of incorporating different kinds of knowledge and explanatory frameworks. Billingsley and her colleagues refer to engaging with 'epistemic insight' as a way to answer the above-mentioned questions. Epistemic insight is defined as the 'knowledge about knowledge', which is related to understanding different bodies of knowledge and how they interact and relate. According to Billingsley et al., the term 'epistemic insight' could be broader than the notion of 'nature of science', while it is an invitation to teachers and students to explore across subjects and not only within science (Billingsley et al., 2018, p. 1117), thus, recognising as valid other ways to produce knowledge, different from the ways of thinking that are characteristic of science, and disrupting rigid borders within science classrooms, where there is a supposition that science is a core subject while others are not (Billingsley et al., 2018).

Billingsley and her colleagues point out that students are interested in big questions about the universe, nature, and our place in it, yet such interest is reduced during school education because of various pressures and barriers in the science classroom (such as so-called 'recipe' or 'cookbook' investigations[17]), narrowing down the production of scientific knowledge. In that sense, engaging with epistemic insight is a call to *re*appreciate those big questions and the borders of different ways of knowing (Billingsley et al., 2018), at the same time as recognising *disciplinary knowledge* (knowledge about a discipline) and not only *substantive knowledge* (conceptual knowledge) (Billingsley & Hazeldine, 2020). Throughout the development of the epistemic insight of the students in relation to big questions, the often neglected students' epistemological understanding is also developed. In doing so, students "can evaluate, for themselves, what the contributions and limitations of science might be" (Erduran & Kaya, 2018, p. 1147).

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[17] Recipe or cookbook investigations are related to methods that are shown as a list of steps to follow where there is little time to discuss epistemology or whether it is the best way to undertake the research (Abrahams, 2017).

Another notion that also considers the potential of 'big' issues in the science classrooms is the 'big ideas in science education' approach. In what follows, there is a description of what the big ideas approach means. Then, I close this section by connecting big questions and big ideas in the context of developing the sociopolitical call. The relationship between the sociopolitical call and the recent incorporation of the big ideas of science education into the science curriculum in Chile is one of the foci of my study.

2.2.3.2 What are big ideas and how do they relate to science education?

The term 'big idea' was coined by a group of science educators, teachers, and scientists from seven different countries under the leadership of Wynne Harlen, who developed a set of key ideas with the intention to promote in students an understanding of the natural world. The group produced two books: *Principles and Big Ideas of Science Education* (Harlen, 2010) and *Working with Big Ideas of Science Education* (Harlen, 2015b). This work has the purpose, amongst others, of addressing both the fragmentation of scientific knowledge in the science curriculum (Harlen, 2010, 2015a, 2015b), where the rigid distinction between biology, physics, and chemistry is not so relevant, and the problem of decreasing student interest in science because of the missing link between the experiences of the students and scientific knowledge (Harlen, 2010). Other problems that this approach could help to address are the overcrowded character of the science curriculum, a view of school science as unequivocal, abstract, and theoretical, and the disconnection between concepts in the science curriculum (Sikorski, & Hammer, 2017), which is typically not context-based (Eleftheria et al., 2016; Osborne, 2011; Osborne et al., 2003).

The definition of the big ideas approach takes different conceptualisations and forms in the literature. There are some definitions of big ideas connecting different disciplines in science (integrating biology, physics, and chemistry), such as Mitchell et al. (2017)'s conceptualisation, they defined big ideas as *"a unifying principle that connects and organises a number of smaller ideas or concepts and multiple experiences"* (p. 3, italics in the original). Furthermore, these kinds of ideas are pedagogically powerful because they give a direction to teaching and learning while being expressed as sentences with a verb (not as topic headings)[18] and reflect one or more of the purposes of its use (Mitchell et al., 2017, p. 13). Hume and Berry (2011, p. 352) refer to big ideas as "full standalone statements, which give a sense of enduring understandings that students need to develop". Similarly, Whiteley (2012, p. 42) states that big ideas "can be thought of as the meaningful patterns that enable one to connect the dots of otherwise fragmented knowledge", while Ross and Duggan-Haas (2010) refer to big ideas as "the most essential consensus understandings" (para. 4). In the USA, the *Framework for K–12 Science Education* tries to address the problem of coverage and depth formulating transversal core ideas in the curriculum (Chalmers et al., 2017; Metz, 2012) and as per the *Next Generation Science Standards* (NGSS) released in 2013 and related to the third part of the Framework for

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[18] An example of big ideas as a topic heading could be: *'bacteria and micro-organisms'*. Conversely, a big idea expressed as a verb phrase could be: *'not all bacteria are harmful'*, (Mitchell et al., 2017), addressing a common misconception on bacteria.

K-12 Science education, it states practices, crosscutting concepts and core ideas (Bybee, 2014) between scientific disciplines. For others, the definition of big ideas is bound to each specific discipline. Cooper, Posey and Underwood (2017) have pointed out that big ideas in chemistry are central to the discipline, providing support to teach different concepts while also trying to address the fragmentation of the curriculum within the discipline. In here, a big idea is not as simple as just part of the field; it needs to make connections within the subject and be generative for students, allowing them to create new relationships between contents of the discipline (Olson, 2008; Smith & Girod, 2003). Similarly, Bang et al. (2013) defined big ideas as the "overarching principles that help students to build a holistic understanding of domain specific knowledge and assimilate individual facts and theories" (p. 1041), where the focus is within the subject using as big ideas – conversely to Mitchell et al.'s formulation – the topics of diversity, structure, interaction, and change. One thing that these different definitions (across and/or within disciplines) of big ideas have in common is that they may overcome the problem of the fragmented curriculum by allowing scientific content to be taught in a way that could make more sense to the students.

There are some intended student-centred benefits of using big ideas. For instance, big ideas are meant to allow students to make connections between scientific concepts and facts (Metz, 2012); when these ideas are connected it should be easier for students to use them in new scenarios, rather than using unconnected ones (Harlen, 2015a). Also, big ideas might help students to see the relationships between different scientific ideas and phenomena observed and encountered in daily life, motivating them to develop this new way of understanding (Harlen, 2015a) towards an epistemic understanding echoing the big questions. Students may be able to build connections and recognise patterns in different phenomena (Chalmers et al., 2017) and be capable of developing a more sophisticated level of understanding (Plummer & Krajcik, 2010). Moreover, big ideas can serve as an incentive to use certain scientific contents in an integrated way between disciplines (Cartier & Pellathy, 2009; Winarno et al., 2020). Ultimately, big ideas could act as a compass for students to understand the significance of what they are learning at school (Eleftheria et al., 2016).

There are numerous different examples of big ideas in science education in the literature. As previously outlined, Harlen and her colleagues posed a set of ten big ideas *of* science – theories, models, and principles that explain the natural world – and four big ideas *about* science – how those scientific ideas have been developed (Harlen, 2010). Other examples are big ideas about content, learning, and domain (Mitchell et al., 2017); big ideas related to some content such as homeostasis, evolution, information, interactions, and emergent properties (Cooper, 2015); about astronomy in terms of the Earth–Sun–Moon system (Lelliott & Rollnick, 2010; Plummer & Krajcik, 2010); about mathematical thinking, representation, generalisation, pattern, and proportionality (Lord & Kindle, 2016); and about the Nature of Science (Osborne et al., 2003). A recent example of these ideas in the Chilean context is the big idea of living being (González & Bravo, 2018) developed with undergraduate students of pedagogy at the university level.

The selection of the big ideas is an important aspect of defining how to teach them. Issues that need to be considered are size (how 'big' the idea is going to be), progression, pedagogy, and assessment (Harlen, 2015a). As per Cartier and Pellathy (2009), it is important to ponder how we select both the big idea and the phenomena to teach that big idea. In terms of the challenges set by the creation of big ideas, Mitchell (2017) states that teachers need support because "deciding on pedagogically powerful big ideas about content and how to phrase these for students is a complex and multifaceted undertaking" (p. 6). One way to overcome this difficulty is to understand the big idea as placed in a continuum related to a sense of progression between both the scientific content and levels of schooling (Harlen, 2010).

Moreover, there is a consensus regarding teaching big ideas in relation to the framework of learning progressions (Corcoran et al., 2009; Duncan & Rivet, 2013; Duschl, Maeng & Sezen, 2011; Gunckel et al., 2012; Plummer et al., 2015; Yin et al., 2014). Much of the research about learning progression can be termed 'hypothetical', as not all students progress in their learning in the same way; progression depends on teachers' practice and their understanding of their students (Plummer & Krajcik, 2010). Thus, hypothetical learning progressions need to be empirically 'tested' with students (Plummer et al., 2015). Learning progressions could be developed for a big idea over quite long periods of time (across different levels of schooling) or over short periods of time (among units in the same subject and level), giving contextuality to the learning (Jin et al., 2019). The development of a learning progression starts by 'unpacking' the big idea and analysing the ideas that students have about the concept in question; this hypothetical learning progression can be developed cross-age or in the context of instruction (Plummer et al., 2015). There are two ways of building learning progressions; one is evidence-based and draws on students' learning assessments, and the other is related to teachers' experience and analysis of the content domains (Duschl, Maeng & Sezen, 2011). It is more common to inform the building of a learning progression by the assessment of students or the analysis of the discipline rather than considering teachers' experience. The literature contains extensive examples of how to construct learning progressions, such as Plummer et al. (2015) who at the beginning of their study worked with information directly from students about their knowledge of the solar system. With this information, they created (in the second year of their study) a week-long professional development programme about the formation of the solar system. Finally, Plummer and colleagues created construct maps of the hypothetical learning progression to be used by schoolteachers.

In recent research validating learning progressions at schools, Jin et al. (2019) proposed a framework of validation in five stages; the last stage was the use of the learning progression at the school with teachers in a professional development programme; that is, at the end of their study they considered how the teachers work with this research product.

A similar situation happened with big ideas where researchers worked directly with students bypassing the schoolteachers. An example of the latter is a study that had proposed working with students' understanding of the operon model (in gene regulation) and its relation to big ideas (Cooper, 2015) to help them to use models of complex systems to understand broader

themes such as homeostasis. Conversely, an example can be found of a teacher who uses big ideas to teach in her classroom offering suggestions of how to use the approach in a way that is not too difficult to implement (Alleman, Knighton & Brophy, 2010). In this example, the schoolteacher, who appeared as the first author in the publication of this study, and the researchers worked collaboratively concluding that the big ideas are "the heart of the instruction" (ibid., p. 29). In an attempt to engage in a similar collaboration, I have explored the creation and conceptualisation of three schoolteachers teaching with big ideas in mind in their classrooms (see Bravo et al., 2019). In the format of a metalogue, we co-authored a research article in which we presented the teachers' experiences of teaching big ideas and my experience of researching their practice. However, the question about teachers' sense of ownership regarding this curricular change – schoolteachers creating their own big ideas – and a more in-depth exploration of how they work with this in their classrooms remains.

2.2.3.3 How have big ideas been used worldwide?

The approach of big ideas has become widely used and has been recently incorporated in many science curricula around the world. A new framework for scientific literacy was created in South Korea, where one of its dimensions was related to content knowledge in the shape of big ideas (Choi et al., 2011) towards a reconceptualisation of scientific literacy for the 21st Century, in the context of human life expanding from personal to global understandings. In their conceptual work, Choi et al. pointed out the importance of a new perspective on scientific literacy by stressing an integrated understanding of big ideas which includes values, metacognition, and global citizenship as knowledge needed for twenty-first century citizens. This new perspective, arising from the integration of big ideas, could envision an image of citizens who "could appreciate diversity of cultures and values, participate in construction of social values through collaboration and communication with others" (p. 680). However, when Choi et al. conducted a survey with teachers, asking them about the importance of these aspects of scientific literacy, they found that teachers lacked understanding of the importance of big ideas and of integrated views of teaching science. An important aspect of Choi et al.'s conceptualisation of big ideas is that they considered specifically big ideas that explain a scientific phenomenon using 'core' science content; yet they declared that this content should help students to think within and across disciplines: "big ideas also cut across traditional disciplinary boundaries (Millar, 2006; Tyler, 2007). This is a critical point because to solve challenging problems that occur in a global society requires integration of ideas that cross-disciplinary boundaries" (p. 683). This conceptualisation could resonate to a definition of big questions amongst, across, and beyond disciplines; however, in this case, big ideas are related to content knowledge – substantive knowledge in Billingsley and Hazeldine's terminology, or knowledge 'of' science in Harlen's understanding – rather than to the nature of the scientific content and other disciplines: disciplinary knowledge in Billingsley and Hazeldine's terminology, or knowledge 'about' science in Harlen's understanding.

A different understanding is provided by the work of Mitchell et al. (2017) in Australia. The Australian educational system has also recently applied a new approach to the science curriculum, focused on big ideas and their underlying principles (Mitchell et al., 2017). In their theoretical proposal, which draws on their previous experience with teachers, Mitchell et al. attempted to explore big ideas from a conceptual stance related to generating reflections on pedagogical issues, such as students' learning and engagement as well as content knowledge. In doing so, they proposed three kinds of big ideas: big ideas about content, big ideas about learning, and big ideas about the domain[19], where, according to these authors, the last two sets of big ideas entailed particular teachers' agendas in terms of epistemic understandings. Big ideas can be "pedagogically powerful in that they offer direction for teachers to make learning for students more connected" (ibid, p. 3); however, as seen in Mitchell et al.'s research, similarly to the South Korean case, when asked about these changes, teachers recognised that they have more understanding of disciplinary ideas than of big ideas in the field. Moreover, developing big ideas is not simple; it is "intellectually demanding and time-consuming for teachers" (Mitchell et al., 2017, p. 7), which is a dilemma that needs more research and, more importantly, it requires providing the teachers who are constructing and reworking big ideas with the necessary conditions to do it. It is especially necessary to explore, for instance, how schoolteachers conceptualise big ideas, how they reflect on the pedagogical opportunities they offer, and what they actually do with big ideas. The above-mentioned has implications in teacher education, especially in relation to teachers' professional development with big ideas, a focus of this thesis.

In Sweden, there is also a new curriculum focused on demonstrating achieved skills where, according to Mutvei and Mattsson (2015), every item of content can be related to a big idea, trying to address new ways of assessment and the achieved skills expected to be developed. Similarly to the South Korean case, the understanding of big ideas in this proposal is restricted to content knowledge, expressed as the 'core' content to be taught and separated by subjects (biology, chemistry, physics, and technology). However, an interesting aspect of this empirical work is that even though the use of big ideas is focused on content, the conclusions Mutvei and Mattsson draw from their experience with pre-service teachers is that it was possible to acknowledge not only the use of content knowledge, but also the relationship between teachers and students and how they visualise their own process of learning during the course.

In South Africa, there is recent experience of using big ideas of science related to electrical cells and circuits as two topics that have shown a number of misconceptions in chemistry and physics education (Bradley & Moodie, 2021). In their empirical work with pre-service teachers, Bradley and Moodie connected the South African science curriculum in grade 7 with Harlen and collaborators' big ideas of "all matter in the Universe is made of very small particles" and "the total amount of energy in the universe is always the same but can be transferred from

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[19] An example of big ideas about the domain is "There is no single scientific method and many important discoveries have been made without a neatly designed experiment that maps onto aim, method, results, conclusion" (Mitchell et al., 2017, p. 10).

one energy store to another during an event" (Harlen, 2010). Bradley and Moodie attempted to overcome common misconceptions through a 'systemic approach' that connects cells and circuits even though chemistry and physics education are typically taught separately and in sequence. The systemic approach, in Bradley and Moodie's (2017) words, is related to studying chemistry concepts through interacted systems with a clear relation between those concepts.

In USA with the NGSS released in 2013 and aligned with the Framework for K-12 Science education, there are three big ideas that aim to support the understanding and implementation of the proposed standards (Houseal & Ellsworth, 2014): (1) "There is more to science than I thought: A new, broader definition" (p. 65); (2) "Students learn science by actively engaging in the practices of science" (p. 65); and (3) "Piaget reconsidered: Students are capable of learning more at a younger age" (p. 66). It is noteworthy that these big ideas are related to the big ideas *about* science in Harlen's words and to Mitchell's big ideas about learning and the domain. Another example of the use of Harlen's proposal of big ideas along with using the K-12 curriculum is related to big ideas in computer science (Bell, Tymann & Yehudai, 2018). In their proposal, Bell et al. advance 10 big ideas that connect topics of computer science[20] in order to appreciate a bigger picture capturing "the essence of the discipline" (para. 4).

The research of Eleftheria et al. (2016), carried out in a number of European countries, explored how a group of teachers and teacher educators understood the big ideas of science, drawing on the work of Harlen (2010), considering 10 big ideas without the big ideas 'about' science. In their work, Eleftheria et al. made use of Harlen's report as a tool to organise the science content using also the framework of Go-Lab[21] repository, aiming to explore the conceptualisation and usefulness of the approach using questionnaires and workshops. In their study, 352 science teachers (the majority) and teacher educators from Austria, Belgium, Bulgaria, Croatia, Cyprus, Estonia, Germany, Greece, Hungary, Italy, The Netherlands, Portugal, Romania, Spain, and the UK participated in those workshops and completed the questionnaires. The authors show that most participants were not familiar with the notion of big ideas; however, they seemed to relate to a definition of big ideas similar to Harlen's and expressed the belief that it is important to make "connections between science subjects taught in different grades and connections between what students learn at school with everyday life" (p. 81). These results are very similar to a recent experience in the context of Chile (see Bravo & Reiss, 2021) where, even though the schoolteachers who answered a questionnaire did not know the notion before, they found it to be the natural way to teach in science.

In Chile as well, the new approach of the science curriculum is focused on big ideas of science education (Mineduc, 2012; 2015; 2019). When Harlen's big ideas report was translated into Spanish, it was rapidly incorporated into the Chilean science curriculum. In 2012, a Spanish language version of the big ideas report was launched, and that same year the big ideas' notion

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[20] For example: big idea (1) Information is represented in digital form; big idea (6) Digital systems are designed by humans to serve human needs.
[21] Global Online Science Labs for Inquiry Learning at School.

was incorporated to levels 1 to 6 of schooling. In 2015 it was expanded to levels 7 to 10, and in 2019 it was included in levels 11 and 12. By 2019, the approach was therefore incorporated into every level of schooling except pre-primary education. Even though the approach was incorporated into the Chilean science curriculum, as seen, since 2012, the question of how teachers conceptualise and use the approach in their classrooms still remains. In relation to this, in recent years I have participated in experiences with schoolteachers and other teacher educators in an attempt to develop big ideas (Bravo, 2018; González & Bravo, 2017), and mapped different conceptualisations and examples of big ideas by science schoolteachers (Bravo & Reiss, 2021; Bravo et al., 2019; González & Bravo, 2021).

Even though there are multiple conceptualisations of what the big ideas are and it is possible to draw some commonalities amongst them, the way that the big ideas are understood in this thesis is related to Harlen's approach[22], mostly because this is the framework used in the new science curriculum in Chile. I will also draw on Mitchell et al.'s conceptualisation of big ideas as pedagogically powerful guidelines offering the possibility to reflect on broader aspects of science education rather than just content knowledge. My positionality regarding the big ideas approach entails a critical exploration of the way in which the science curriculum in Chile incorporated the notion, how this is treated in a CPD programme focused on big ideas, and how two schoolteachers understand and teach big ideas where different discourses (policy, university, and school) are at play. My research also aimed to provide schoolteachers with a space to develop and create big ideas by themselves in the context of the CPD programme, while also offering a map of different conceptualisations of the big ideas approach (as observed in the national curriculum, the CPD programme, and from the practice of two schoolteachers). Thus, I will provide evidence of the use of Harlen's big ideas and the way they shift, ultimately contributing with more context-based conceptualisations of them.

2.2.3.4 Are there critiques to the big ideas approach?

Some authors have challenged the big ideas approach. Boxer (2019)[23] disputed the entire framework, arguing that while the big ideas maintain that they are presented as generating questioning, they actually give just answers. Perhaps related to this concern, Mcleod (2018) took Harlen's set of big ideas to build a map in which the biology component of the English National Curriculum was transformed into five big questions of biology, and from that map a learning progression was posed with a specific description of the content associated with those questions.

What does it mean to be big? Cooper et al., (2017) ask themselves this question, attempting to resolve the problem of determining the size of big ideas which may inadvertently lead to a fragmentation of knowledge. The original framework of big ideas was developed in relation to

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[22] See Chapter 3 on Methodology and Methods and the section *'3.2.1 A fortunate opportunity to work with big ideas in a CPD'* for a detailed explanation.

[23] Adam Boxer, a London-based chemistry teacher, wrote in his blog – A Chemical Orthodoxy – on issues regarding science education from his experience at his school. There is an entry related to big ideas which is called 'What's the Big Idea?' (May 15, 2019) in: https://achemicalorthodoxy.wordpress.com/2019/05/15/whats-the-big-idea/

scientific inquiry as strategy (Harlen, 2010); however, a problem of scientific inquiry is that it could lead to a distorted understanding of how to do science with several myths such as "science starts with observation; science proceeds via induction; experiments are decisive; science comprises discrete, generic processes; scientific inquiry is a simple, algorithmic procedure; science is a value-free activity" (Bencze & Hodson, 1999, p. 522). Another myth concerns seeing scientists as authorities who follow a scientific method characterised by guaranteed validity and universality.

A further issue regarding the use of big ideas is that a significant change in the curriculum like this, as with other curricular changes, could be felt as an imposition upon teachers who are positioned by others – as developed in *2.2.1.3 How do teachers respond to curricular change?* – as implementers, information providers or executers and less as developers. In that light, the question of how the National Curriculum understands and expresses the big ideas approach is also part of the focus of this thesis.

2.2.3.5 How do big questions and big ideas relate and interact?

The moment when big questions and big ideas meet is in the understanding of 'big'. As per the literature revised, big means: integration instead of fragmentation; systemic instead of linear; comprehensive instead of small questions / topic headings; broad instead of narrow; an overall picture instead of separate pieces of a puzzle. Moreover, big also means addressing fundamental issues incorporating different disciplines, because the issue is too big to be answered with just a single way/body of knowledge/discipline. In that light, the notion of big could be seen within one subject in a more classical sense (e.g. Bradley & Moodie, 2017 with big ideas in chemistry), across subjects (e. g. Harlen, 2010; Mitchell et al., 2017 with big ideas of/about science and about the domain), or amongst, across, and beyond disciplines (e.g. Billingsley et al., 2018, 2013; Stavinschi, 2009 with big questions). The notion of big might also signify connecting and organising smaller issues towards integrating overarching phenomena/questions (Mitchell et al., 2017; Gamoran, 2016).

While the framework of big questions is mostly used in the UK following the work of Billingsley and others attempting to bring together science, religion, and other humanities, big questions and big ideas can be broadly used to address similar problems in science classrooms and in the science curriculum. For instance, the way that scientific knowledge is fragmented into separate subjects – biology, chemistry, and physics – and into topics within each subject could hide their "epistemological distinctiveness" in such a way that methods and questions become homogenised (Billingsley et al., 2018, p. 1119). Such is the case with observation where observing can be common to different disciplines: "no one specific characteristic per se can be used to define a domain as scientific or to demarcate it from other disciplines" (Erduran, Kaya & Dagher, 2018, p. 6). Besides, in many countries including Chile, science in secondary education is taught separately from other subjects which obscures its limitations and potentialities. This, in turn, limits the understanding of how science interacts and relates to other ways of knowledge, and of how science can be questioned, as those other ways of knowledge might be blocked out (Bernstein, 2000; Billingsley et al. 2013, 2018). In doing so, big questions and big ideas are calling to integrate and to generate an epistemic insight related

to considering other ways of knowing. Specifically, in the case of big ideas, there is also an attempt to bring together the different scientific disciplines because, as proposed in Harlen's big ideas, the separation – and different use of language – between biology, chemistry and physics no longer applies. This is similar to the big questions when they are used within, across, and beyond disciplines (Stavinschi, 2009).

Big questions and big ideas can also meet when there is the necessity of a new understanding of how school subjects are framed and organised in a holistic sense (Billingsley, 2016). Big questions can "bridge science, religion and the wider humanities" (Billingsley et al., 2018, p. 1117) in a similar attempt of using the big ideas to connect knowledge that is otherwise fragmented in school science (Whiteley, 2012). In both notions there is an epistemological attempt to move across different fields of knowledge and subjects to gain epistemic insight, opening opportunities to see how science interacts with other ways of knowing (Osborne et al., 2003) and exercising, for example, how to think like a mathematician, historian or scientist (Billingsley & Hazeldine, 2020).

There are some examples in the literature that explicitly connect big questions and big ideas. Such is the case of Billingsley and her collaborators' work, bringing together some big questions and the big ideas in science proposed by Harlen (2010). In turn, Billingsley and colleagues bring insights to Harlen's understanding, using her progression as a starting point (Billingsley et al., 2018). For instance, Harlen (2010) states that in primary education students begin with small scientific ideas with the support of the teacher; the additional insight that Billingsley and collaborators are offering states that "students talk about the nature of science and what makes science distinctive compared with other ways of knowing that they learn about in school" (p. 1123).

Another example of the relationship between big questions and big ideas can be seen in the work of Ingram (2020) with the big question of *How is life interconnected?* This is related to ecology and can be connected to Harlen's big idea of 'organisms require a supply of energy and materials for which they are dependent or in competition with other organisms'. Ingram's question can also be related to evolution, using Harlen's big idea of 'the diversity of organisms, living and extinct, is the result of the evolution'. In doing so, the big question posed by Ingram can be answered by building on Harlen's big ideas. The work of Doyle (n.d.) designing a new curriculum to work across social subjects at the school is another attempt to bring together big questions and big ideas. Doyle stated that they were aware of the work of Harlen on big ideas in science, and using the notion of 'big' they were able to organise a course around big questions. This organisation of the teaching could also be related to Mitchell et al.'s (2017) take on big ideas, where big ideas as a principle can be pedagogically powerful as they offer guidance in teaching planning. The work of Ross and Duggan-Haas (2010) developed another direct link between "Big Ideas and Overarching Questions for Earth Science" (p. 4) by understanding 'How do we know what we know? How does what we know inform our decision-making?' as big questions. According to Ross and Duggan-Haas (ibid), big ideas allowed them to have an understandable inquiry-based framework, and to integrate Earth Science disciplines by encompassing geology, meteorology, oceanography, and astronomy.

Epistemologically, big questions and big ideas also meet as there is a distinction between content knowledge and the process of how that knowledge is produced. In the approach of big questions there is a separation between substantive knowledge (conceptual knowledge) and disciplinary knowledge (knowledge about a discipline) (Billingsley & Hazeldine, 2020; Lawson et al., 2020). This is similar to Harlen's distinction between big ideas *of* and *about* science, or the distinction in Mitchell et al. (2017) between big ideas *about content*, *learning*, and the *domain*. Specifically, Harlen demonstrates this epistemic insight in her four big ideas *about* science, concerned with how the big ideas *of* science have been developed (Harlen, 2010). It is noteworthy that when that intertwined understanding between the content and the process of how that content is produced is missed and the balance only leans towards the scientific content, there is also a missed opportunity to compare and understand how different disciplines address those big issues as well as how they relate and interact (Billingsley & Hazeldine, 2020).

2.2.3.6 My positionality regarding the notion of 'big'

At this point, my proposal is that the approach of 'big' (questions and ideas) meets the sociopolitical call because in both the focus is to build bridges amongst disciplines and to understand how knowledge is produced in those different disciplines. The approach of 'big' may trouble the hermeticism in science education (Bazzul, 2012) – which has avoided seeing itself under the lens of social, critical, or philosophical theories – by transgressing boundaries between fields (Kayumova, 2015). Troubling the hermeticism means recognising other ways of knowing as valid and disrupting rigid borders on the science classroom where there is a supposition that science is a core subject while others are not (Billingsley et al., 2018) as well as the idea that science as a body of knowledge is unquestioned and unequivocal (Eleftheria et al., 2016). In here, my position (and perhaps my wish as well) is related to this interconnectedness between the notion of 'big' and the sociopolitical call which I explore in a CPD programme. The CPD course can be read, as an experience, in a multidisciplinary way by adding other ways of producing knowledge, other questions and other methods.

Regarding either big questions or big ideas, many of the authors reviewed here finalise their work wondering how these frameworks are meaningful for teachers who have the ultimate responsibility for using them in their classrooms (Bell et al., 2018; Bradley & Moodie, 2017; Bravo et al., 2019; Houseal & Ellsworth, 2014; Mitchell et al., 2017). I would add a further power-sensitive questioning related to the curriculum: how are the changes in the curriculum – like the incorporation of big ideas – addressed by the schoolteachers in their classrooms? How do schoolteachers undertake these changes? The answer to these questions is usually sought in CPD programmes or other instances of work between teacher educators and teachers in service with the supposed aim of 'updating' the latter in the current trends of science education. Specifically, in relation to curriculum development and the role of CPD, the role of teacher educators is conceptualised as giving schoolteachers the necessary support to guarantee that the curriculum and its changes are "implemented adequately" (Couso, 2016, p.

49). According to Ryder and Banner (2013), a very common policy concerning curricular changes consists in using professional development instances to develop the teachers' knowledge of the reform and how to implement it (cf. Erduran & Msimanga, 2014 who proposed recommendations to professional development on argumentation as a response to a change in the South African curriculum). Though this approach is widely used, Ryder and Banner (ibid) concluded that, even with a high-quality CPD course, the implementation of the reform as designed cannot be guaranteed. In what follows, I develop a critical revision of CPD programmes in general and in science education, and the role of university and teacher educators on them.

2.3 Continuous Professional Development (CPD)

In general terms, CPD is described as a training that goes beyond the initial formation to be a teacher. CPD is sometimes seen a way to guarantee that changes in the curriculum are implemented as designed by developing the knowledge of the teachers on the curricular reform (Ryder & Banner, 2013); that is to say, curricular reforms need CPD programmes (Uçan, 2016), yet it is also argued that for teachers CPD programmes are needed when a new curriculum is introduced (Phasha, Bipath, & Beckmann, 2016; Subitha, 2018).

CPD is singled out as essential in teachers' practice for maintaining or improving some standards in education and society in the light of factors such as increasing globalisation (Mitchell, 2013). In that vein, is not surprising to see the OECD (Organisation for Economic Co-operation and Development) stating that "[e]ffective teaching is at the heart of a successful education system and there is a growing recognition that supporting teachers' professional learning from the beginning to the end of their career is critical to improve student outcomes" in what they called a strand of 'continuing professional learning'. Followed by recognising that CPD have growing importance "to respond to a fast-changing world and its challenges"[24]. In the first quotation is possible to read an aim oriented towards effectiveness – effective, successful, improvement – which could be associated to the problematic 'best practice' mindset that closes down the critical understanding of the complex and diverse task of teaching and learning (Lefstein & Snell, 2013). The second quotation directly addresses the world as just one place, obliviating variability and assuming that is rapidly changing, both features associated to the neoliberal agenda (Mitchell, 2013) which privileges economic growth and productivity, amongst other features.

Contested voices to this understanding of CPD include what Clarke and Hollingsworth (2002) saw as the aim of professional development of teachers by recognising their unique and individual learning and their practice, not in a linear fashion but rather as a model of growth anticipating its multiple and variable shapes. Similarly, Mitchell (2013) posed his definition, acknowledging the individuality of professional development as "the process whereby an individual acquires or enhances the skills, knowledge and/or attitudes for improved practice"

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[24] Both quotes were taken from the OECD webpage: http://www.oecd.org/education/teachers-professional-learning-study/continuing-professional-learning/ which appeared right away at the beginning of the site.

(p. 390). In Mitchell's definition is embedded the understanding of professionalism reflected in the word practice which necessarily has to do with one's day-to-day work.

CPD is associated with professionalism in a contested way. When the CPD is not understood as continuous and the aim of the professionalism is misunderstood just as training rather than being developmental (Núñez, Arévalos & Ávalos, 2012), the relationship between CPD and professionalism is missed. Professional development could be a continuous lifelong learning process between the initial and continuous training (Ávalos, 2002); however, initial and continuous training are both tackled in very different ways in terms of laws, standards and aims (Day, 1999). Usually there is a narrowed understanding of professional development as training, manual, course, workshop, methods, techniques, recipe books, formulae (Suárez & Metzdorff, 2018) which also bring into question the use of the word learning or development in how to name the process. The concept of 'professional development' is in relation to others (Henderson, 2015), whilst 'professional learning' could be related to an individual's process.

There is a close relationship between CPD and universities as the latter are one of the most common institutions to conduct those programmes (Ryder & Banner, 2013). In so doing, there is also a closeness between universities and schools. However, neither schools' nor universities' organisational conditions are usually considered in the research pertaining to teachers' professional development, nor is the role of teacher educators within those spaces (van Driel et al., 2012). Before delving into that relationship, in the following section I briefly examine features of CPD programmes, introduce a discussion on whether the process should be termed 'learning' or 'development', and review some experiences of CPD programmes in science education.

2.3.1 Professional development's conceptualisations

2.3.1.1 Professional development's features and aims: development or learning?

There are diverse approaches to understanding CPD programmes. For some, CPD is an essential process if teachers want to have their curricular knowledge up to date, being 'wise' with respect to how they select and use what is written (Day, 1999, p. 221). In this understanding, the curriculum is central and if teachers *want* to pursue – or are asked to participate in – a CPD programme, it is assumed that is just to be updated on what they do not know about the curriculum (Geldenhuys & Oosthuizen, 2015; Luneta, 2012), alongside aligning teachers' practices and policies and improve teachers' performance (Day & Sachs, 2004). In this sense, educational change can be seen as an imposition initiated by external factors rather than self-initiated due to teachers' recognition of a problem or dissatisfaction (Bell & Gilbert, 2005; Fullan, 2016; Uçan, 2016). A different understanding – in line with the self-initiation of a CPD programme – argues that professional learning exists to improve teaching and learning of the teachers' own practice (Guskey, 2003), integrated at the level of personal practice (Vaillant & Cardozo, 2016) and taking into account schools' socio-cultural settings (Day & Sachs, 2004; Uçan, 2016) as well as understanding that CPD is "a process rather than an event" (Subitha,

2018, p. 76). This understanding is in line with a reconceptualisation of what professional development means (Subitha, 2018), incorporating reflection and communities of practice to build shared sense-making and collaborative engagement (McArdle & Coutts, 2010).

When the aim of the CPD is to update schoolteachers to change their practice, there might be hierarchical recognition that there is another who oversees what teachers should know, rather than being determined by themselves. A problem that Vaillant and Cardozo (2016) reported is that usually professional development is undertaken *on* teachers, so that they change their practices, and not *with* them. Additionally, Vaillant and Cardozo stated that CPD courses are brief and are not situated within the broader context of teachers' experience. Subitha (2018), talking about the situation in India regarding CPD, and the conclusions arguably apply worldwide, stated that the quality of CPD is "far from satisfactory" (p. 77), where there is also a distance between the providers of CPD – usually centres of higher education and policymakers – and the daily practices and needs of schoolteachers in service or the needs of beginner teachers who receive little attention in teacher development (cf. Golding, 2015 with an example of Initial Teacher Education in England). In here, schoolteachers are positioned, ultimately, as "implementers of curricular and reform directives" (Subitha, 2018, p. 77), constituting a problematic position of simultaneously being "the subject and the agent of change" (Uçan, 2016, p. 38).

Vaillant (2016) pointed out that there is a large body of research on professional development but there is a break between that research and the practice because, according to her, what is clearer is that professional development has neither "satisfactory nor sustainable results" (p. 6). Similarly, Mitchell (2013) pointed out that despite the research on professional development, there is a lack of understanding of how the professional development actually happened in these programmes. In this vein, when thinking on how and under what conditions a teacher changes their practice, it is stated that the professional development is conducted in a vertical way where there are policymakers who design the reform and a school which receives the reform without the teachers' participation (Muñoz & Vanni, 2008), reflection or collaboration as professionals (González et al. 2014). That assumed teacher positionality resonates with both Giroux's duality of thinker/doer on curricular development (see *2.2.2 Curriculum design, the sociopolitical questioning, and my positionality*) and also a positivist view of science where knowledge is accumulative and new knowledge must be proven through empiricist scientific methods (González et al., 2014; Mellado, 2001).

Lieberman (1996) pointed out three types of professional development: a type that is 'direct learning' which is short-term, delivered through conferences or workshops focused on resolving an issue (e.g. Lessing & De Witt, 2007, conducting an evaluating of a workshop on inclusive classroom); a second type that involves interventions inside the educational institution; and a third type outside the institution in collaboration with universities or other tertiary organisations. According to Freire (2002), the type of short intervention outside the school is oblivious to the necessities of the local community; besides, it may not generate any knowledge or 'epistemological curiosity' opposed to the purposeful praxis towards a process

of 'conscientisation' (Freire, 1970). Other authors have also pointed out the fallacies of so-called 'one-shot' interventions (Day, 1999; Clarke & Hollingsworth, 2002) because of their emphasis on what schoolteachers supposedly are lacking. Related to the third type of intervention outside the school in collaboration with universities the problem could be a lack of communication and an absence of expectations by those providing the CPD as to what teachers are capable of (Núñez, Arevalos & Ávalos, 2012); thus, the process of learning is obstructed. In that light, some have argued that professional development needs an intensive "long-term collaboration between researchers and practitioners" (Couso, 2016, p. 56). Cavieres and Apple (2016) posed the question of how the professional development occurs globally by disputing what the OECD understands as development when stating that professional development emphasises the autonomy and reflection of teachers (OECD, 2005); however, as pointed out in the introduction of this section, the interest is to be under a marketization logic where teachers' work is individualistic and there is competition between peers (Cavieres & Apple, 2016). Similarly, in this understanding schoolteachers lack some updated knowledge to conduct so-called effective lessons, which is not necessarily related to the process of teachers' own learning.

The relationship between professional development and effectiveness is widely mentioned in CPD programmes (e.g. Luneta, 2012; Valdmann, Holbrook & Rannikme, 2017), alongside the idea of effective/excellent teachers (Luneta, 2012) or effective schools (Jovanova-Mitkovska, 2010), as in the above-mentioned OECD strand on continuing professional learning. The issue of effectiveness is associated with the question of how CPD should be evaluated. Amponsah, Ampadu and Thomas (2021) point out that the aim of CPD is the "successful implementation of effective classroom instruction" (p. 1). Similarly, Valdman, Holbrook and Rannikmae (2017), even though they declared that their intention is to conduct an 'authentic' CPD based on identifying teachers' needs by also developing a sense of self-efficacy, stated that CPD aims to develop "a teacher to function effectively in the classroom" (p. 577). In 1996, Loucks-Horsley, Styles, and Hewson stated some principles for effective professional development of science and mathematics teachers which is widely cited (Chval et al., 2008). One of these principles was the professional development must be guided by a "clear, well-defined image of an effective classroom" (p. 3). The use of the notion of effectiveness in these examples is noteworthy because one could ask: Who is defining that image? This understanding of CPD as developing effective classroom instruction or functioning effectively under an idealisation of an effective image could be associated with the problematic notion of a single 'best practice' which dismisses the complexity and particularities of the teaching and learning in each experience (Lefstein & Snell, 2013).

Following this discussion of effectiveness, there is a 'naming' discussion regarding how to call the teachers' process in CPD, namely, the question of calling it 'learning' or 'development' (Nilsson, 2014). Research has focused on how to develop some knowledge in relation to effectiveness, posing the issue on the other, as other person, (Vaillant & Cardozo, 2016), rather than assuming a personal role in that process. Conversely, hooks (1996) put the emphasis on 'how we learn', trying to add one's own responsibility on the process at the same time as positioning the actors. Clarke and Hollingsworth (2002) go further, talking about professional growth associated with a continuing process of learning which is crucial to understand

teachers' change from a passive position to a complex process of learning (Subitha, 2018). Clarke and Hollingsworth developed the 'Interconnected Model of Professional Growth' (IMPTG), suggesting that the model could shift the perspective of change as done *to* teachers to "a complex process that involves learning", when teachers are situated as learners in a process of professional learning (Clarke & Hollingsworth, 2002, p. 948). The model proposes a movement amongst different domains: personal, practice, consequence, and external domains that are intertwined: change in one domain can have an effect on another by enaction and reflection (Golding, 2019). In that sense, I argue that the word 'development' is related to effectiveness towards some standard/image defined by others, while 'learning' is related to one's own process, based on the position of teachers as learners from their own daily practice (Ávalos, 2002).

The positionality of teachers as learners has been explored in several studies (Beavers, 2009; González et al., 2014; Postholm, 2012; Shulman & Sherin, 2004; Wallace & Loughran, 2003) and in the case of science teachers, the concept of teacher as learner has also been used (e.g. Loughran, 2007; 2014; Smith & Loughran, 2017). In Loughran's understanding, the notion of teachers as learners is associated with an attitude of durable learning which involves collecting and analysing evidence about one's own practice and the response that this has on one's students. The position of teacher as learner should be framed from the initial formation to be a teacher and the continuous process of training, and it could also be applicable to teacher educators in CPD programmes (Loughran & Menter, 2019; Loughran 2014).

Learning is social and situated: we learn in mutual interaction from others and with others (Couso, 2016; Postholm 2012). In that vein, collaboration is a crucial factor of learning (Fullan, 2016). Learning in collaboration with others could shape what we do, how that is interpreted and who we are in that interaction (Lieberman, 2007) as opposed to the *culture of individualism* related to teachers working in isolation (Brookfield, 1995; Day & Sachs, 2004).

Learning communities – as social learning systems (Wenger, 2000) – are spaces of professional learning because they enable collaboration and shared meanings towards a sense of belonging, enabling new ways of being (Lieberman, 2007), and because the focus is on collaboration that might become a sustainable model for teacher development (Golding, 2018). The conceptualisation of community has been widely explored in relation to teacher professional learning (Couso, 2016). When the practice of teachers engages with their community, they participate fully in working towards improved practice because of the skills, attitude, and knowledge developed in that community (Mitchell, 2013) influencing classroom and school change. A community of teachers engaged with their professional learning can reflect on their own practice and share it with their colleagues (Nilsson, 2014). As per Kafyulilo (2013), teachers' collaboration is reported as influencing the students and the school.

There are different notions in the literature of how to understand and put into practice that sense of community. For example, Wenger (1998), following the idea that learning is a social process and should not be understood in isolation, proposed the concept of a community of practice, conceptualising learning as a "lived experience of participating in the world" (p. 3); another notion is professional learning communities (Hargreaves, 2002; Hargreaves & O'Connor, 2018; Stoll et al., 2006), which are understood as people sharing and reflecting

critically on their practice as a collective aim (Stoll & Louis, 2007), in doing so, benefiting teachers due to being part of one and improving students' learning (Golding, 2015). These kinds of communities are expected to be functioning inside every school (Stoll & Louis, 2007); however, as Stoll recognises, "when collaboration is sometimes mandated — or feels as if it is — making it repelling rather than compelling" (Stoll, 2020, p. 423), meaning that collaboration inside the school does not always work.

Even though the importance of communities of practice is highly recognised, there are few examples in the literature of long-term communities of science teachers where this kind of experience is reported. One example of a community of practice in science education is the group named PEEL (Project for Enhancing Effective Learning) in Australia which in 2008 reported 34 years of working together, sharing concerns about the prevalence of "passive, unreflective, dependent student learning, even in apparently successful lessons" (Mitchell & Mitchell, 2008, p. 50). Another long-term community of science teachers is the group PRETeC (Teachers Reflecting on a Transformative Education in Science) in Chile which as of 2021 has 11 years of sharing their practice in science education, discussing some aspects such as the image of the science teacher and the importance of science in their own lives and the lives of their students (Acuña et al., 2016; PRETeC, 2018; Torres & Bravo, 2021). Tippings, Nichols and Tobin (1993) pointed out the importance of communities of learners to reconstruct science teacher education. They stated that these communities not only aim to (re)signify the importance of collaboration and collegiality, but also highlight learning as a "life-long endeavour" (ibid., p. 69) which affects all participants of the community.

In what follows I examine other experiences of professional development in science education.

2.3.1.2 Proposals and experiences of CPD programmes in science education

There are three strands on professional development that are notably related to my study. The first brings attention to a type of professional development based on personal, professional, and social domains to review teachers' own practice (e.g. Bell & Gilbert, 2005), which is closer to my own experience of providing CPD programmes. A second strand analyses critically the way CPD programmes are usually evaluated and described as bypassing what is deeply happening with teachers' learning (e.g. Aldahmash et al., 2019). A final strand elaborates topics addressed in professional development in science education and strategies mostly based on a sense of community and collaboration between participants.

In 1996, Bell and Gilbert proposed a model of professional development based on a three-year study conducted in New Zealand. According to them, a group of science teachers changed their practice from a transmissive approach to an approach that helped students build their own knowledge by questioning their previous ideas based on reflection on their learning (Simon & Campbell, 2012). Bell and Gilbert's model proposes three intertwined domains: *personal* (involving feelings, motivation, availability, and commitment); *professional* (referring to knowledge, conceptions and visualization of the response of the practice in students); and *social* (related to the value of the collaborative work and the context). Bell and Gilbert's understanding of professional development – arguably more in line with the idea of professional learning – as an interplay between the personal, professional, and social

dimensions of the teachers' practice involves the revision of one's own practice which is necessarily associated with a process of deep reconstruction of the understanding of what it means to be a science teacher (Simon & Campbell, 2012). According to Bell (1998), this reconstruction occurs in interaction with others, where the reconceptualisation of the meaning of teaching science becomes the first step to changing one's practice.

After Bell and Gilbert's model, a group in Chile mentioned in the introduction of this document, called PRETeC, proposed in 2014 a set of five principles of professional development created *by* and *for* science teachers (González et al., 2014), echoing Vaillant and Cardozo's (2016) distinction of CPD usually conducted *on* teachers and not *with* them. This proposal emerged as a collaborative effort including the self-revision of the teachers' practice. As a result of PRETeC's analysis, the first principle is related to the importance of building a common vision about what to teach in science, singling out the aim of scientific literacy of the society and the aim of a science education that serves for the transformation and improvement of the local community; the second principle is related to researching one's own practice based on the particularities of the context while taking action for its improvement; a third principle is related to a stance of constant individual and collective reflection on the practice in an environment of respect, trust, and mutual support; the fourth principle is related to valuing the authority of the teachers' experience and practice as a source of professional learning; and the final principle is related to promoting and valuing the participation of teachers from a diversity of contexts and levels in which they teach (González, et al., 2014). I have been participating in PRETeC since its origin in 2010; thus, I participated in the creation of these principles before providing CPD programmes. In doing so, I uphold these principles and I have attempted to put them in practice in my current work as teacher educator.

In a recent literature review on science teacher professional development, Aldahmash et al. (2019) pointed out that most of the literature is focused on describing and evaluating CPD programmes in the format of descriptive articles. According to Aldahmash et al. (ibid), this kind of descriptive evaluation of CPD programmes is typically conducted with instruments such as surveys (e.g. Coffie, 2019), which makes sense because to understand more deeply changes in teachers' practice and learning needs more time and other in-depth methods which are not always available or of interest to researchers. Nevertheless, according to Aldahmash and collaborators, it is also possible to describe the kind of professional development that makes the most difference for science teachers, such as ones that are school- and classroom-based, consider the needs of schoolteachers, facilitate collaborative work between peers and are supported by the school leadership over time (echoing Golding 2018). Aldahmash et al. (2019) concluded that the people involved in CPD programmes also should have their needs of support and training covered, so as to be able to evaluate in a deep manner the effects of the programme.

Studies on CPD programmes on science education have addressed specific themes within science education (Aldahmash et al., 2019), such as scientific inquiry (Kapanadze et al., 2015, inquiry-based science education (IBSE) and learning outside the classroom (Martins-Loução et al., 2020). Other examples include a CPD model focused on inquiry-based learning (IBL) in

science education which contemplated teachers conducting lessons based on the students' own questions while analysing them as part of a CPD course (Kurtén & Henriksson, 2021), and an inquiry approach in a chemistry laboratory which also incorporated teachers delivering a lesson with inquiry-type experiments to be analysed across the whole group who participated in the course, contributing to their professional development (Taitelbaum et al., 2008). These kinds of CPD programmes based on inquiry are related to my own experience of conducting a CPD programme for this research where the CPD course had as one of its main foci scientific inquiry as an aim of the current Chilean science curriculum.

Aldahmash et al. also pointed out that CPD programmes based on communities of practice, action research and teachers' research have the most attention as types of professional development amongst researchers. For instance, action research is largely applied in science education supporting CPD (Eilks & Markic, 2011; González-Weil et al., 2014; Mena, Bravo & Pérez, 2017) and curricular change (e.g. Bencze & Hodson) in the format of Participatory Action Research (e. g. Eilks & Markic, 2011) or action research that is collaborative (e.g. Chou, 2011; Herbert & Rainford, 2014). Eilks and Markic (2011) proposed a long-term (six years) cooperation between science educators and science teachers, connecting their results with the IMPTG model of Clarke and Hollingsworth (2002). In their conclusions, Eilks and Markic pointed out that the participation of both science educators and science teachers has an important impact on the relationship between schools and universities. Similarly, Herbert and Rainford (2014), in an action research project on the experiences of two teacher educators and an in-service science teacher, pointed out the importance of the generated 'third space', to reconceptualise teacher education mediated by action research, and the school-based collaboration which also allowed collaboration in multiple settings (combining university and school). In this line, what seems a relevant aspect of the way that CPD is conducted is the need for involvement of all who are participating in the programme, namely, teacher educators and schoolteachers.

Van Driel et al. (2012) conducted a review regarding professional development of science teachers and concluded that something is missing is the relationship between the role of the teacher educators/facilitators and the outcomes of professional development. In that same vein, Lumpe (2007) made an explicit call to science educators to "[s]top facilitating one-shot workshops. Work closely with schools to foster professional learning communities. Get to know school systems and staff members. Become part of a learning community yourself" (p. 127). Here it is worth asking who are the teacher educators in the professional development programmes? Whose professional practice is developed? And in what institutional conditions does professional development occur? These questions are addressed in the following section.

2.3.2 Relationship between professional development and universities

2.3.2.1 University-school relationships

There is a contested approach on how the university-school relationship is conducted. On the one hand, even though, as pointed out by Tippings, Nichols and Tobin (1993) and then Lumpe (2007), collaboration between the university and the school is conducive to learning for both

parties, what is happening in CPD programmes is shaped by power relationships and assumed unquestioned roles of teacher (the facilitator) and learner (the schoolteacher), resulting in no real intention to engage in mutual learning (Day, 1999). Besides, as Day (1999) pointed out, most of the writing regarding professional development is done by researchers within academia which suggests that schoolteachers have limited access to the research on CPD programmes. An example of that imbalanced relationship can be found in Thody (2008) who – in an unproblematised manner – asked how the academy can 'persuade' teachers to adopt the theories produced at the university, followed by an exploration of the challenges for academics expecting to see their ideas translated into the teachers' practice at their schools. Thody (2008, p. 415) concluded that one problem could be that the information is not 'ready' to be used by 'downloading' it and goes further by proposing as a solution to change the style of writing to a 'newspeak' manner. In this example, the knowledge of the academy is not questioned and, what is more, the issue of applying the research to practice is imposed upon the schoolteachers. On the other hand, in a partnership model it is assumed that the academics and schoolteachers worked collaboratively because the knowledge produced in academia should not only be transmitted to the schoolteachers to implement (Cochran-Smith & Lytle, 1999). Research-practice partnership is a type of long-term collaborative work between researchers and schoolteachers attempting to contribute theory and practice to the educational setting when the teacher is positioned as researcher as well (Guerrero & Reiss, 2020), shaping their own professional development.

In a relationship, the individuals are considered distinct but connected which leads us to ask about the complexities of the relationship regarding social aspects such as cultural discourses, interests or economic positions (Fenwick, 2009), which could be asymmetric. In that sense, in the university-school relationship when conducting research-based professional development, science educators have turned to ask how factors such as the school context or teachers' beliefs influence their views of professional development (Lumpe, 2007). Tsui and Law (2007) stated that because the CPD is focused on resolving contradictions situated at the borders between academia and the school, the relationship shifted from understanding that only the schoolteacher learnt in the process into learning for all participants. However, those boundaries between the researchers and practitioners are persistent and untouched (Bakx, Bakker, Koopman & Beijaard, 2016).

In Latin America there is growing concern about the university-school relationship (Vaillant, 2019), mostly related to the professional development of teachers. Vaillant (ibid) goes further, arguing that the universities have little contact with schools which makes difficult the relationship between theory and practice. In Chile, the relationship between the university and the school is posed in institutional discourses or national documents as a desirable goal of professional development but still the importance is less recognised in practice (Tenorio et al., 2020) which also leaves the question of who are the teacher educators from the universities involved in the CPD programmes. As developed in *2.1.1.2 Subjectivity from sociological perspectives applied to teachers' subjectivity*, the subjectivity of teacher educators in higher education is less explored in the teacher education literature (da Silva & Neto, 2016). As a result, teacher educators have been self-made through mostly self-study research (Cochran-Smith et al., 2019).

In the space of professional development, the learning of the teacher educator is important; however, it is neglected (Van der Klink et al., 2017). In Latin America, Vaillant (2019) posed the same call regarding teacher educators who should ask themselves about their theoretical frameworks as well as their practice because they are as important as schoolteachers in professional development, although that reflection is not solely the responsibility of the teacher educator; rather, there is also an institutional responsibility, even though teacher educators as a group are raising awareness on becoming life-long learners (Darling-Hammond, 2017; Van der Klink et al., 2017). A recent exploration on teacher educators' learning, not specifically in science, can be found in Vanderlinde et al. (2021), who stated that since 2013 there has been an increasing interest across Europe in the professional development of teacher educators. Even though the teacher educator that is the focus on this book and in the quotation from the European Commission is a teacher who teaches mostly to pre-service teachers, the missing support for education and professional development can be applied to teacher educators in CPD programmes to in-service teachers as well. Vanderline et al. (2021) proposed that there is a problem of definition as to who this teacher educator is because the term is "blurred, multidimensional and often context dependent" (p. 3), which also highlights the need to unpack the institutional conditions – the authors refer to understanding the omitted workplace learning – and further issues related to the sociopolitical dimensions associated with diverse contexts around the need to understand who the teacher educator is which becomes my interest in this study.

Parejas and Margalef (2013) pointed out some other dilemmas exploring the possibilities of reflection by teacher educators. While engaging in collaboration, teacher educators presented intra- and interpersonal, as well as external, dilemmas such as the time needed for reflection. Personal beliefs surrounding teaching and learning, as well as the beliefs of others and intrapersonal dilemmas such as the frustration to incorporate new strategies of teaching, are among those matters requiring adequate time for reflection. Parejas and Margalef (2013) concluded that these kinds of tensions can lead to avoidance of any collaboration at all or even stop innovation in teachers developing and improving practices. One issue that is common in this lack of research-based knowledge regarding the teacher educators' role is an increasing number of tasks in their workplace, namely, the university. Some of the factors that could be constraining professional development are time, workload or lack of both resources and management support (Van der Klink et al., 2017). Teacher educators are asked to respond to institutional requirements, many of which are related to becoming more competitive in comparison to other scholars and institutions, especially the requirement for publication which might have an impact on their contract or promotion chances (ibid.). In this sense, there is a responsibility from the educational institutions towards the professional development of the teacher educators (Smith, 2003). Then it bears asking, how does that educational institution function?

2.3.2.2 The neoliberal university

The university as well as other institutions has been permeated by a neoliberal business-like logic (Amigot & Martínez, 2013) with managerial understandings related to production and dissemination of knowledge. Cannizzo (2018), quoting Stephen Ball, pointed out that the

transformation of public education to a market-oriented mindset has three main policy technologies: "the market, managerialism and performativity" (p. 215). The privatisation of the university is positioning students as consumers while academic staff have seen their remuneration decreasing as well as their working conditions deteriorating. Besides, the increasing of casualisation as way of employment is transforming the university to a 'fast' academia (Gill, 2009; Robertson, 2008). All the above-mentioned could mean negative reverberations in activities where the university is involved, such as CPD programmes.

Blackmore and Kandiko (2011) pointed out that as a result of privatisation, many academic activities are not paid at all or poorly paid; this also has to do with fast academia because there is a sense of "always on" availability to respond to the increasing requirements (Gill, 2009, p. 9). In that sense, university workers felt more pressure, to the point of feeling that their working environment is toxic (Cannizzo, 2018). In Chile too the neoliberal model is experienced at the university level with rankings, productivity indices and the promotion of competition amongst colleagues (Fardella, 2020). As developed in the section on subjectivity, this marketization of the universities as well is producing a subject that is hyper productive – hyper agentic academic who is minimising their institutional context while maximising their agency (Fardella, 2020).

In Chile since the time of the dictatorship (1973-1990), universities, as well as other institutions and settings, have experienced a progressive neoliberalisation (Fardella, Sisto & Jimenez, 2017), which, for example, has imposed a sense of competition and individualism on how to conduct academic work. Besides, a high percentage of academic staff in Chilean higher education, nearly 60%, suffer the casualisation of their employment with "unstable part-time contracts with little institutional support" (Montenegro, 2016, p. 528), mostly in private institutions rather than public ones. In this scenario, the role of the teacher educators regarding their own professional development, in science education as well, is silenced by the conditions in the university (cf. Bazzul, 2016). Carter (2014), quoting Picower, stated that under the regime of neoliberalism the role of the teacher educator should not be less than activism, otherwise there would be little chance of changing the conditions.

2.3.3 CPD programmes and the sociopolitical questioning

In the literature there is an often repeated call for a reconceptualisation of professional development which means, from the perspective of schoolteachers: situating the learning to the experience (Wallace & Loughran, 2003); involvement of schoolteachers in the design of their own professional development (Geldenhuys & Oosthuizen, 2015; Luneta, 2012); adaptation of any CPD material to their local areas (e.g. Golding, 2018); consideration of social and cultural institutional settings of the particular schoolteachers' context (Aldahmash et al., 2019; Postholm, 2012; Subitha, 2018) that also reconceptualises teachers' reflections incorporating social and critical dimensions (McArfdle & Coutts, 2010); and promotion of a culture of collaboration amongst teachers (Bantwini, 2019), amongst others. From the perspective of teacher educators, this reconceptualisation means the consideration of their own professional development (Cochran-Smith et al., 2019; Montenegro, 2016; Vanderlinde et al., 2021), the promotion of reflection on their practices with the support of their institutions

(da Silva & Neto, 2016), and the involvement in collaborative and participatory action research projects (Eilks & Markic, 2011; Herbert & Rainford, 2014) or in the CPD in general, amongst others. In this context, I feel called to reconceptualise my own role in CPD courses as a teacher educator who is also occupying a researcher and PhD student role, as well as unpacking, for example, what does it mean to run a CPD programme funded by the ministry of Education in Chile since 2015 and with a special focus since 2016 in my own PhD study? What does it mean to my colleagues, facilitators/teachers or schoolteachers, who occupy the role of participants/students in the context of the CPD? In doing so, in my case, this reconceptualisation of the CPD programme means to also make explicit my positionality regarding professional development of schoolteachers and my own.

M positionality conducting CPD programmes meets the sociopolitical approach which could shape the reconceptualisation of CPD programmes because of incorporating power-sensitive questioning to: the way that the CPD was designed and conducted; the professional development of teacher educators less explored in science education literature; the critical lens on a recent incorporation within the science curriculum, such as the big ideas in science education; and a broader discussion on whether the process should be called 'learning' or 'development'. One can also ask: What does it mean to consider the power imbalance or asymmetries between university and schoolteachers or the position of teacher educators as learners in a neoliberal context? In that process, where both learn, who decides what is learnt? Who decides what is *effective* CPD? Why are CPD programmes called to update teachers into curricular changes, considering that CPD is usually conducted outside the school classroom? Why is the path to becoming a teacher educator less explored? What is the context in which teacher educators develop their practice? With these questions I feel called to attempt to undertake what Simon and Campbell (2012) identified as the deep reconstruction of what it means to be, in my case, a teacher educator, because of the revision of one's own practice. Having said this, in the following and last section of this chapter, I develop the potential contribution of my study.

2.4 Contribution

In this chapter, I have mapped some key approaches and debates in the literature on the sociopolitical turn as a way in which this critical lens might problematise the science curricular development and professional development programmes. Specifically, I have traced key notions of the turn such as subjectivity and the ways it has been addressed; curricular development and schoolteachers' participation in it; and the role of teacher educators and CPD programmes in science education. The main arguments of those sections are summarised as follows:

i. The sociopolitical turn is a call to break the impenetrability of science education by drawing on notions/questions/methods from other fields to question the science education field, thus transgressing its boundaries. This call has been mostly theoretically based with some empirical examples using the notion of subjectivity. A

conceptualisation of subjectivity useful to my study highlights the socially situated understanding of the term.

ii. The science curriculum has many aims that are often presumed to hold globally (scientific literacy is currently an aim in countries of Europe and Latin America), which raises the question of its situatedness and how, for example, it deals with issues of power and knowledge in different societies. In terms of curricular development, schoolteachers are usually treated as implementers, executors, or information providers, and only rarely as developers. There is a recent incorporation in Chile and in other countries of the big ideas in science education approach to the science curriculum which also brings attention to the notion of big (ideas and questions) as going amongst, across, and beyond disciplines which enable a greater understanding of the limits of science and how different bodies of knowledge interact and relate.

iii. A common policy concerning curricular changes consists of using professional development programmes delivered by universities, creating a noteworthy university-school relationship. Often the role of the teacher educator is conceptualised as giving schoolteachers the necessary support to guarantee that the curriculum and its changes are 'implemented appropriately'. The professional development of teacher educators is omitted because the focus is to develop the schoolteachers' knowledge. The university and the school as institutions are unquestioned in the CPD space.

Alongside the chapter, I have been providing traces[25] of the potential contribution of this work which is not by proposing solutions but rather generating a struggle (in curriculum development and teachers' professional development under a sociopolitical questioning). The exercise to imagine what is and is not there (the relentlessly rejected in Derridian terms) allows me think on how the mindset of presence – a dominant understanding of things like the neoliberal agenda or the idea of 'best practice' in education – closes down the possibilities of differed meanings. A trace "is not at the start of things, it is not the origin, because the idea of origins is complicit in the logic of presence" (Henderson, 2015, p. 45). That logic of presence makes a defensive barrier defending it in a way that is totalising (ibid.). If the way that the curriculum, the professional development, the practice of teachers is understood in the logic of presence – hegemonic understandings of certainty – what/who is not present is positioned outside that defensive barrier; therefore, it is/they are relentlessly rejected. That is what I wanted to explore, the subjectivity(ies) produced in the scenario in and around a CPD course focused on big ideas of science education by tracing what/who is relentlessly rejected. I feel especially called to stress not only the subjectivities of the schoolteachers participating in the CPD programme but also the question of the professional development of the university team's praxis and my own, inside and outside this space. Following Haraway (2016), I aim to stay with the trouble, imagining, in a provocative way, what *is and is not there* in a particular experience concerning the science education field.

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[25] 'Trace' is a Derridian notion associated to *différance*, which is defined as what we necessarily ignore that exceeds the alternative of presence and absence (Derrida, 1998; 1995). Trace is "the mark of the absence of a presence" (Spivak, 1976, p. xvii), which recognises the non-present and is expressing the absence of fullness. More on the notions of *différance* and trace are developed in Chapter 7 alongside dialogue as a possible future research area.

In practical terms, a potential contribution is related to the notion of subjectivity associated with the sociopolitical call. Subjectivity in this thesis will be understood as everyday relations that articulate how the experience is lived in relation to a specific institutional context; this highlights the socially situated understanding of subjectivity wherein the encounter with *other* (whether the social structure, language or an-other) could be what produces subjectivity. This thesis critically examines the production of schoolteachers' and teacher educators' subjectivities around a CPD programme in the current sociopolitical Chilean context. In here also lie my positionality in this thesis, because my interest is to unpack that encounter with others by understanding the institutional context – university and school – in which this encounter occurs. In relation to the sociopolitical turn – as an approach in which this thesis sits – I am positioned both by my role as a teacher educatory working in a university and by my use of the different theories of subjectivity I have outlined.

Another potential contribution is related to curricular development and professional development in science education, considering that big ideas is a recent change in the science curriculum. I want to explore the discourses of control and colonisation of curricular changes. Related to this and drawing on the sociopolitical approach, there are power-sensitive questions that can be posed such as: Who made the changes to the curriculum? Whose practice and knowledge are legitimised in that development? And in turn, whose knowledge is not legitimised? The potential contribution in this regard will be by mapping the different conceptualisations of big ideas while also making a critical exploration of the way that the Chilean science curriculum is incorporating changes, how these changes are addressed in CPD programmes, and how schoolteachers develop their practice, considering these kinds of changes where different discourses (policy, university, and school) are at play, attempting to understand the conditions within which the schoolteachers' practice is enacted. Thus, I will also provide evidence of the use of Harlen's big ideas and the way they shift, ultimately contributing with more context-based conceptualisations of them. The sociopolitical turn is a call to break the impenetrability of science education by drawing on concepts and approaches from other fields to question the science education field. I argue that the CPD programme that is part of my study can be read in a multidisciplinary way by adding other ways of producing knowledge, other questions, and other methods. Coming back to the relation to otherness in subjectivity, the learning process in CPD programmes could be related to a mutual interaction with others. In that sense, another potential contribution is related to unpacking the interaction between the participants of the CPD programme of this research, while attempting to understand what happens in the encounter with otherness and how subjectivities are produced.

The overall aim of this study is therefore to unpack and think critically about the subjectivities produced in and around a science CPD programme focused on big ideas, as this should allow me to explore hierarchical relationships between the university and the school, control and colonisations of curricular changes, the omitted professional development of teacher educators, and the influence of institutional context on the participants of the CPD programme. By asking after and looking back at the conditions of that subject formation, we – science teacher educators, myself, my colleagues – could keep questioning what is assumed to

be the state of things by asking social, political, and culturally important questions, situating these within the context of school science education.

2.5 Research questions

In this literature review I have articulated the main topics regarding curricular development, CPD programmes, and schoolteachers and teacher educators as participants of those spaces, all of it problematised under a sociopolitical lens. Here, I present the three research questions that frame this study.

This thesis sits within a body of sociopolitical questioning as a lens to explore the subjectivities produced in and around a CPD programme. I have argued that the question of subjectivity in science education is related to the recent 'call' to pay attention to the sociopolitical discourses rarely studied within the field. Therefore, my first research question (RQ1) is *'How are teacher educators' and schoolteachers' subjectivities produced in a CPD programme focused on big ideas of science education?'* which attempts to become a way to provide an empirical illustration of the turn that has been mostly theoretically based.

As previously stated, the big ideas in science education is a recent change of the science curriculum in Chile and in a number of other countries too. In this thesis I aim to make a critical reading of this incorporation into the science curriculum, as well as how the schoolteachers are developing their practice considering this approach when, as I have argued, they are mostly considered as implementers of curricular changes. This critical position entails an exploration of the way in which the science curriculum in Chile incorporated the notion, how this is treated in a CPD programme focused on big ideas, and how two schoolteachers understand and teach big ideas where different discourses (policy, university, and school) are at play, towards understanding the conditions under which the schoolteachers' practice is enacted. My second research question (RQ2) is therefore *'Under what conditions and institutional discourses do science schoolteachers develop their practice using big ideas of science education?'*.

In my study, I have the aim to provide schoolteachers with a space to develop and create big ideas by themselves, attempting also to build a map of different conceptualisations of the big ideas approach from the national curriculum, the CPD programme, and from the practice of two schoolteachers contributing with practice-based conceptualisations of the big ideas approach. My third research question (RQ3) is *'How do science schoolteachers participating in a CPD programme conceptualise and respond to the curricular change of big ideas in science education and the CPD programme?'*.

In summary, the three research questions leading this study are:

- RQ1: How are teacher educators' and schoolteachers' subjectivities produced in a CPD programme focused on big ideas of science education?
- RQ2: Under what conditions and institutional discourses do science schoolteachers develop their practice using big ideas of science education?

- RQ3: How do science schoolteachers participating in a CPD programme conceptualise and respond to the curricular change of big ideas in science education and the CPD programme?

Research Question 1 is addressed in Chapters 4 and 5 of this thesis, while Research Questions 2 and 3 are addressed in Chapter 6.

CHAPTER 3: Methodology and methods

Researching subjectivities in and around a CPD programme

This research aims to explore the production of Chilean science schoolteachers' and teacher educators' subjectivities in and around a CPD programme focused on the big ideas of science education. Drawing on my practice as a teacher educator working in a team providing CPD courses, I conducted an intervention to explore any gaps between how the curriculum is designed and how schoolteachers and teacher educators bring it to life. The CPD, called NIPDE (anonymised name for National Inquiry Professional Development Expounded), funded by the Chilean Ministry of Education, consisted of 11 whole-day sessions and was designed and led by a university team of 12 colleagues, of whom I was one, with a participant group of 21 science schoolteachers. I conducted classroom observations and interviews with two schoolteachers to further explore their conceptualisations and practice teaching the big ideas of science education. My analysis uses and develops a conception of dialogue to explore the different types of discourse that emerged around the CPD at the university and within the schools. In a broader sense, I am attempting to bring science education and its sociopolitical dimension to a point of intersection by illustrating and articulating a precise version of the turn that has been theory-based as it relates to the empirical experience in and around the CPD.

In this chapter, I justify my approach and how I came to analyse the data produced. I also explain how I began to appreciate a subjective change which shaped my research. I argue that this change was due to both the exploration of the sociopolitical turn and an openness to different areas or perspectives that resonated with my research, which led me to incorporate the notion of dialogue in the analysis. The chapter is organised to present different aspects of the research process, first by describing what I did between 2016 and 2017 preparing and conducting the fieldwork, the decisions that were taken and my position in that process. Secondly, I explore the reflections and conundrums that might explain the subjective change in the way I read my data from 2017 onwards. Then, I describe the process of preparing and analysing the data under this new position which was greatly influenced by my supervisors and a collaborative analysis group. The separation between what I did and how I came to analyse might be artificial because some reflections happened simultaneously; however, for this chapter, I separate them to explore the movement towards perspectives previously unfamiliar to me, such as the sociopolitical one. Due to incorporating these perspectives, my epistemological positionality while researching science education was (is) changing as well. For instance, at the beginning of the analysis, the focus was 'external', namely, what happened to the schoolteachers participating in NIPDE; then, it shifted to first questioning my own and then my colleagues' roles as teacher educators. What follows is a discussion of the methodology used in this study. First, I advance the ontological and epistemological position of this study. Secondly, I provide an overview of the methods – access, fieldwork, participants, and instruments. Thirdly, I explore my subjective change. In a fourth section I describe the analysis using dialogue, the issues on reliability/dependability in coding and interpretation, and the structure of the findings chapters. Finally, I provide a section that discusses the ethical issues and dilemmas that emerged in this process.

3.1 Ontology and epistemology

As researcher, I am "bound within a net of epistemological and ontological premises" (Denzin, & Lincoln, 2018, p. 56) which shaped this research. Ontologically, I agree with the proposition of multiple realities constructed by human beings who experience a phenomenon (Krauss, 2005). Besides, I consider that the multiple teacher educators' and schoolteachers' identities depend on the subject's perspectives and points of view regarding a particular setting, in this case a CPD programme at the university or the classroom at a school. This research is constructivist because I am "seeing knowledge as developing by a process of active construction and reconstruction of theory and practice by those involved" (Carr & Kemmis, 2003 p. 148). It is critical as well because the proposed study is not only about understanding the social world of CPD and those who are involved (schoolteachers and teacher educators) but also reflecting upon it and changing it, especially my own practice as teacher educator. I am interested in the movement between these two epistemic positions. This research is rooted in a qualitative methodology. In qualitative research, it is important that the literature review is related to what is known about the problem, which theories are used, what concepts, what theoretical and methodological debates exist in the field and what has not been studied (Flick, 2009). For me, it is important to have a similar discussion merging the experiences of academia, including science educators and curriculum developers, and the experiences of teachers.

The constructivist or interpretivist paradigm (Merriam & Tisdell, 2015; Robson, 2011) is the ontological position which asserts "that social actors are continually accomplishing social phenomena and their meanings. It implies that social phenomena and categories are not only produced through social interaction but they are in constant revision" (Bryman, 2004, p. 17). As well as the interpretation of understandings, meanings, and actions (Carr & Kemmis, 2004), Darlaston-Jones (2007) points out that social constructivism "views the individual as a sense maker in that each of us seeks to understand or make sense of our world as we see and experience it" (p. 2). To this extent, as one of my interests is the production of subjectivity of teacher educators and schoolteachers in the context of a CPD focused on big ideas in science education, I aim to understand the salient aspects shaping the professional identities of these subjects in Chile; therefore, there is an assumption which implies that reality and the social world are not necessarily fixed and also that they are constructed through these social actors, myself being one of them.

I am also interested in the depiction of the schoolteachers' practices in terms of big ideas, which will contain an interpretative element that is concerned with the description of their meaning of teaching (Carr & Kemmis, 2004). Trying to enhance the importance of the context in the interpretation, my view is also critical. My position is specifically related to Freire's view of the critical paradigm wherein "the goal is to critique and challenge, to transform and empower" (Merriam & Tisdell, 2015, p. 10), acknowledging the transformative and emancipatory character of education as the practice of freedom (Freire, 1982).

Epistemology is related to the "relationship between the inquirer and the known" (Denzin & Lincoln, 2018, p. 56). Interpretivism can be defined as the epistemological position which is usually presented as the alternative to positivist positions (Robson, 2011). In interpretivism,

the researcher is attempting to grasp the subjective meanings of social action (Bryman, 2004). I adopted the epistemological position of interpretivism because it fits my research question's nature, in that I problematise the way we think about teacher educators and schoolteachers, specifically, by exploring their subjectivities.

Louis and Calabrese-Barton (2002) pointed out as "knowledge claims are richer and more complex if there is a bridge between the personal experience of the participant and academic discourse" (p. 14); it is therefore important for me (as researcher and participant) to present a thorough explanation of my positionality. My positionality in this thesis is related to the sociopolitical call in science education which I connect with who I am (developed in the introductory chapter) and the context in which I have been advancing my practice as a teacher educator towards thinking differently. The sociopolitical approach might allow me to depict my own context, practice, and discourse, and those of my colleague teacher educators in CPD programmes in science education. In doing so, I felt specially called to unpack questions that were hidden to me by asking questions related to hierarchies, control, and asymmetries between the university – within it too – and the school. For instance: Whose knowledge is the one that is considered in CPD programmes? Whose practice is under the microscope? Who is privileged or marginalised in the knowledge production around CPD programmes? Who decides what knowledge is valid and why some categories of knowledge are universally accepted while others are not, for instance, in curricular changes? Or how might global norms about 'good' pedagogy reinscribe colonial hierarchies of knowledge and power? All of these are power-based questions – not necessarily answered in this thesis but contributing to the critical exploration of my study – attempting to both disrupt hegemonic discourses in science education (Carter, 2004) and "to challenge and w/ri(gh)t/e science education" (Carter, 2008, p. 171).

As above-mentioned, this thesis sits within a body of sociopolitical questioning as a lens to explore the schoolteachers' and teacher educators' subjectivities produced in the context of the CPD programme (related to the first research question) as a way to provide an empirical illustration of the turn that has been mostly theoretically based. Thus, I am positioned in relation to the sociopolitical turn both by my role as a teacher educator working in a university and by my use of subjectivity. Even though this illustration is regarding the Chilean context, the conclusions that I draw are applicable to a broader literature on science education.

In terms of my position regarding subjectivity, I argue that by gazing back into cultural particularities – e.g. who is the researcher and how they are (I am) socially situated – (following Harding's invitation), and by asking after (following Butler's questioning) the constitution of schoolteachers' and teacher educators' subjectivities, it may be possible to understand the political meaning (Bazzul, 2012) of the experience of my interest. In doing so, on the one hand, I aim to recognise the dismissed fact that schoolteachers and teacher educators are political subjects; on the other hand, I also attempt to advance a new scientific subjectivity (Lather, 2012), which calls to embrace the limits of our own knowing. It is noteworthy that this (or these) new scientific subjectivity(ies) may entail a subject production that does not mean

totality. That is, the subject emerges in the process of being repeatedly produced, as these relationships are fluid; the subject is fragmented and unfinished in their identifications and sense of self, shaped by ongoing activities and interactions. In this sense, my interest is also to start exploring the shifting subjectivities and the institutional context in which this occurs as an unending process of my practice. Besides, it may also contribute to opening a contingent space for new articulations of subjectivity, specifically as the case of my thesis, in a CPD programme in science education.

Considering the big ideas in science education as a recent curricular change worldwide, my positionality is also critical. The way that the big ideas are understood in this thesis is related to Harlen's approach, as it is incorporated in the new science curriculum in Chile at all levels except for pre-primary education (more on this in *3.2.1 A fortunate opportunity to work with big ideas in a CPD*). I will also draw on Mitchell et al.'s conceptualisation of big ideas as pedagogically powerful guidelines when they are related to learning and about the domain. My research also offers a map of different conceptualisations of the big ideas approach from the national curriculum, the CPD programme, and from the practice of two schoolteachers.

Regarding the CPD experience, at the beginning of this research I felt specially called to conduct a CPD programme as somewhere where teacher educators and schoolteachers produce their professional learning together, following the invitation of Lumpe (2007) to participate in a professional learning community rather than just be the facilitator of a CPD programme. The way that the CPD programme was conceptualised was related to creating a Hybrid Space of Learning (see *3.3.1 Putting into question the 'hybrid space of learning'* where I look critically at this very idea), where there was the intention to be a space for professional development of schoolteachers *and* teacher educators. In doing so, I attempted to build the CPD *with* the schoolteachers rather than *on* them (after Vaillant & Cardozo, 2016), as in my own experience developing PRETeC's principles of professional development, understanding that a CPD course is a process rather than an event (Subitha, 2018). In the context of this thesis, the aim was to build with the schoolteachers more than a CPD course to update the schoolteacher in a recent curricular change (Day, 1999); rather, it was to develop as a collaborative effort some conceptualisations of the big ideas approach considering the schoolteachers' context, knowledge, and system-wide issues on professional and curriculum development. However, all the above-mentioned desire of a reconceptualised CPD programme started by first unpacking through a sociopolitical lens my own assumptions of what was (and become) the CPD programme, my role, the role of my colleagues and the role occupied by the schoolteachers participating in it.

Finally, this study attempts to follow the invitation posed by Jackson and Mazzei (2013) to thinking with theory in the research project as an epistemological position. Jackson and Mazzei challenge us to use theory to think with their data – and "use data to think with theory" (p. 261) – as a way to shake their/our uncritical habit of reading, thinking, and seeing data as they/we always have. They encourage one to try to be audacious, to bring new themes and modes of thinking from other fields towards asking more questions rather than reaching conclusions. In their invitation they are using concepts from philosophers such as Gilles Deleuze, Felix Guattari, and Jacques Derrida to view the data in qualitative research from

diverse perspectives. I think this invitation resonates with my intention to view the data from this experience by using theory, and questions, from other fields/perspectives such as the use of subjectivity and some pieces of writing like the interludes developed after each findings chapter. Thus, in this thesis, by *re*examining, *re*thinking, and *re*conceptualising, I position myself by asking questions to open up the possibilities of new subjectivities (of schoolteachers and teacher educators) regarding curricular changes and CPD programmes on science education by incorporating the sociopolitical perspective. Special attention will be given to the subjectivity of teacher educators whose practice and professional development is less problematised in the science education literature.

In a practical sense, the exercise of unpacking and thinking critically through a dialogical analysis – a methodological stance developed in *3.4 Analysis of the data* – about the power relationships that are part of a cultural/institutional context might open the possibility to produce a textured account of the subjectivity of these actors in their contexts and in the field of science education. Thus, reconceptualising subjectivity in science while looking back on my own socially situated research project in all its cultural particularity and its relationships to other projects of my culture, and asking after the subjectivation processes through dialogue, can be productive to keep questioning what it is assumed as the state of things of the scientific subject formation, arguably little explored in the science education field. As subjectivities are ever-changing in a permanent resignification process (Butler, 1997), the question of their constitution in science education would be also an attempt to uncover what conditions and discourses are producing these subjectivities at the same time as opening a possibility for reworking them towards a new scientific subjectivity. This reflection is crucial for me in this study, yet it is also a reflection that I want/hope to keep exploring.

What follows is an overview of the methods of this study describing the access, fieldwork, participants, and instruments used.

3.2 Overview of methods

3.2.1 A fortunate opportunity to work with big ideas in a CPD

Three circumstances led me to work with big ideas in a CPD programme: the incorporation of big ideas into the Chilean science curriculum; a project with the Ministry of Education which considered CPD programmes; and one of my PhD supervisors is one of the creators of the big ideas' framework. These three influential factors did not coalesce at the same time; however, together they constituted a serendipitous opportunity to work with big ideas in my research.

As developed in Chapter 2, the big ideas approach is widely used to teach science. In Chile, the new approach to the science curriculum focuses on the big ideas of science education. In 2012, a Spanish version of the big ideas report was launched, and that same year the big ideas framework was incorporated into levels 1 to 6 of schooling. In 2015 it was expanded to levels 7 to 10, and in 2019 it was included for levels 11 and 12. By 2019, the approach was therefore incorporated into every level of schooling except pre-primary education. Thus, when I started this research in 2016 at the policy level, school science teachers were asked to teach with big ideas, which led me to consider the big ideas approach as a setting for this project.

Since 2015, I have been participating as a teacher educator in an ongoing project with the Ministry of Education in Chile. The project, named NIPD, has been running under a collaboration agreement updated every two years between the Ministry and 13 universities in different regions of Chile. The national project involves a series of CPD courses that have scientific inquiry as a main theme. As part of the project, there is a CPD version oriented to 'beginners' in scientific inquiry called NIPD; and there is a version pursuing to 'expounded' the knowledge of the scientific inquiry called NIPDE. NIPD and NIPDE are consecutive. Every university should conduct both versions more than once; most schoolteachers who participated in NIPDE have already participated in NIPD with the same university, meaning that my colleagues and I knew the schoolteachers of NIPDE in advance and vice versa. In NIPD, the Ministry provides guidelines related to the content and general organisation while every university oversees the specific implementation of it. Conversely, NIPDE is less structured by the Ministry, so each university oversees the content, its design, and its implementation. I had the opportunity to lead the first NIPDE in a university (Uni1 as pseudonym) in 2017, becoming part of my research where I propose the teaching of big ideas as one of the main foci of the course.

In 2016 I came to work with one of the creators of the big ideas approach. When I applied to be supervised by Michael Reiss, as a teacher educator I was anticipating that I would be undertaking a CPD programme in my research proposal but at that time, I imagined the CPD would focus on scientific inquiry and Pedagogical Content Knowledge (PCK). After a few months, I realised that the big ideas framework was part of the Chilean science curriculum and considering Michael's experience, I shifted to explore the intentions and practices in relation to the big ideas of science education by science schoolteachers in Chile, which was my aim after the first year of my PhD studies. In 2017 the fieldwork took place which is explained in detail in the following section.

3.2.2 Fieldwork

My initial position as researcher was centred on the schoolteachers' voice, and in the notion of a 'lack' towards incorporating this in the big ideas approach. I thought that because the approach was already part of the science curriculum, my aim was to make visible the 'hidden' schoolteachers' voice within it. I identified three gaps: i) lack of practical knowledge (of teachers' practice) in academia in relation to the use of big ideas; ii) lack of knowledge among the teacher educators of CPD programmes focused on big ideas; and iii) lack of experience among teachers regarding theorising their practice. With that in mind and trying to gather as much information as possible from what I thought was the schoolteachers' perspective, I designed a fieldwork which allowed me to evaluate how the schoolteachers were understanding and putting into practice the big ideas' approach. I started the research as if the schoolteachers had prior (practical) knowledge of big ideas, the CPD was a good opportunity to explore that knowledge, and that theorisation from the practice was possible. In these assumptions the role of teacher educators was unified as 'academia', as one undistinguishable voice without unpacking it.

The fieldwork had three phases. Phases one and two aimed to explore what the schoolteachers knew and did in their practice with big ideas and the conditions at their schools to teach them, while phase three aimed to explore what can be learned and taught during the design and implementation of a CPD programme on big ideas. Table 3.1 provides a summary of the fieldwork.

Table 3.1: Participants, instruments, and time in each phase of the fieldwork.

	Instrument	Participants	Date/length
Phase one	Online questionnaire	63 schoolteachers	March 2017
	Questionnaire follow-up interview	Two schoolteachers	September 2017
	Five classroom observations	Two schoolteachers	October and November 2017
	Stimulated recall interview	Two schoolteachers	December 2017
Phase two	Interview	Two people of the leading team in each phase one school. Two local policymakers' deputies of the Ministry of Education.	October and November 2017
Phase three	Audio- and video-recording of design meetings and implementation of NIPDE. Researcher journal. 13 schoolteachers' journals.	12 university teachers 21 schoolteachers	Design: June 2017 - January 2018 Implementation: 11 whole-day sessions (10am to 5pm) between November 2017 and January 2018

3.2.2.1 Phase one

In phase one, as a preliminary part of my research, I conducted a web-based questionnaire (see Appendix 1[26]), aiming to reach a large group of schoolteachers and to explore their conceptualisations and practices using big ideas. I used the questionnaire to gather as much information as possible that could confirm or refute my initial assumption that the schoolteachers already have their own conceptualisation of what the big ideas are, despite the recent introduction of this approach into the curriculum. In the second section of the questionnaire, I started providing two definitions of the construct and an example of one big idea. To give the definitions beforehand was discussed with other science educators because it could be leading participants' answers; however, I chose to provide them to narrow down

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[26] The questionnaire was sent in Spanish to the schoolteachers. I produced the English version for the thesis.

the answers to what the curriculum was using as the big ideas' framework. Trying to explore their experience teaching big ideas, I asked '*Given these definitions, do you have experience in teaching with any big idea?*'; following this question I added '*Do you have your own definition of a big idea?*'. I was particularly interested in this second answer – the majority said 'yes' (35/38 who completed the questionnaire) – that could confirm schoolteachers often used the principle behind big ideas before knowing the name of the construct[27].

There are advantages and disadvantages on using questionnaires (Jones et al., 2008); one disadvantage is what Jackson and Mazzei (2013) referred as 'centring' the subject, meaning, the researcher asked for a supposedly coherent narrative that arises as truth in the answers which can be problematic when analysing the information. As I provided two big ideas' definitions I might have been 'centring' the subject/leading the answers; however, as preliminary exploration the questionnaire was useful to recognise and select the participants (criteria explained below) to complete phase one and participants who wanted to participate too in the CPD programme afterwards (phase three)[28]. In that sense, I did not reduce the information to the way conventional coding works with questionnaires (Jackson & Mazzei, 2013); rather, its use was related to selecting participants and to exploring my initial assumptions.

To send the questionnaire, I made use of my personal connection with two database sources: i) a group that have shown interest in activities organised for the master's in science education at the university that I work for; and ii) the group of teachers who had participated previously in NIPD since 2015. In early March 2017 I approached via email a list of 200 potential participants, providing basic information about the research and inviting them to complete the questionnaire. The participants received an information sheet with the consent form before filling in the questionnaire. Acknowledging the difficult task of receiving completed web-questionnaires (Jones et al., 2008), I explicitly made use of my connection to the potential participants. Thus, I started the email with the subject 'Request for help: big ideas questionnaire in mind' and I introduced myself by saying 'probably you remember me from (…)'. I received 63 answered questionnaires (38 of them filled completely and 25 partially).

Next, I chose teachers who answered the questionnaire to conduct interviews and classroom observations to engage more closely with their practice, and, in so doing, attempting to disrupt the centred subject resulting from the questionnaire. Interviews also present the limitation of centring the subject as a fixed subject. However, acknowledging that the information could be 'incomplete', as long as there is a process of retelling and remembering the practice (Jackson & Mazzei, 2013), I also conducted classroom observations and a subsequent interview that stimulated the recall of the observed classroom practices.

I selected four schoolteachers; the selection criteria were: i) showing interest in participating in the CPD; ii) having experience working with big ideas; iii) availability for interviews and classroom observations; iv) availability for interviewing the headteachers and/or the head of

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[27] A common answer was that many schoolteachers did not know about the construct; however, after reading the definitions they stated that big ideas was the 'natural way' to teach science. Many of the schoolteachers had their own definition of big ideas. More on this can be seen in Bravo and Reiss (2021).

[28] The last question was '*Would you like to participate in a CPD programme focused on big ideas?*'.

the science department of the school; v) at least one teacher at each level of schooling (pre-school, primary and secondary education); and vi) two females and two males. Dora, Ricardo, Pamela, and Julio[29] met those criteria; however, only Dora and Ricardo in the end participated in phase three. Dora is a primary teacher who has been participating in activities organised by the University since 2010[30]. She was invited to the CPD as a facilitator to oversee the reflection dimension of the schoolteachers, meaning, that she was part of the university team. Ricardo is a primary teacher in a public school, and he was invited to participate in the course as a student; he participated in the beginner's version of the course (NIPD) in 2015.

I conducted interviews with both Dora and Ricardo before both the classroom observations and NIPDE. This first interview attempted to understand their conceptualisations of using big ideas to teach science, expanding on their answers from the questionnaire. Then I asked them if it would be possible to observe their lessons teaching big ideas. Dora invited me to three lessons and Ricardo to two, all of them near the beginning of the CPD. Most of the observations took place in Dora's and Ricardo's classrooms but one of Dora's lessons was in a nearby wetland. The lessons were video-recorded with authorisation and informed written consent of the school's headteacher, each teacher and students' parents, plus oral consent from the students. The second interview was held after the classroom observations using the stimulated recall interview (SRI) method (Dempsey, 2010). I showed Dora and Ricardo extracts of their lessons, aiming to stimulate their reflections (Nilsson, 2014), trying to depict their subjectivity teaching big ideas. The SRI considered the answers from the first interview and the extracts of the video-recorded lessons (see Appendix 2). The interviews were audio-recorded, transcribed, and translated into English when necessary.

3.2.2.2 Phase two

Phase two aimed to explore the conditions and context of the schoolteachers to teach big ideas at their schools and at the policy level. First, I conducted interviews with staff from the leading[31]'s teams in Dora's and Ricardo's schools. In Dora's case, although the headteacher gave his permission for me to be in the school and to record lessons, he declined to be interviewed for the purposes of this study. He led me to the person who oversaw the pedagogical issues of the school instead. That person had a role like a deputy headteacher in the UK. In Chile, this role is known as UTP (acronym in Spanish meaning Techno-Pedagogical Unit). I was not allowed to audio-record the interview with the UTP, meaning that I only have the notes I took. Conversely, in Ricardo's school, I interviewed the headteacher and the UTP and both interviews were audio-recorded. Secondly, I conducted interviews with local representatives from the Ministry of Education[32]: Ramiro, a biology teacher, who was the local

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[29] With Pamela, a pre-primary teacher, I conducted both interviews, classroom observations and the interviews to the headship team; unfortunately. she could not participate in the CPD. With Julio, a biology teacher, I only did the first interview, and he did not participate in the CPD course.

[30] Dora is a participant of a group of science teachers who have met since 2010 to share their practice. One of my university colleagues and I are also part of this group. Dora has been invited ever since to research projects involving science education and CPD led by my colleagues.

[31] In Chile, the leading team is formed by the headteacher and deputy headteachers or UTP.

[32] Chile is organised in 16 regions. Every region has a delegate department of the Ministry of Education and there is a central department in the capital of the country. Dora, Ricardo, Mario, and Ramiro worked in the same region.

Coordinator of Teachers' Professional Development; and Mario, a maths teacher, who was the local Coordinator of Science Education. Ramiro's role in professional development was new because of the recently enacted law of New Public Education in Chile (in October 2017). Mario had been working in the Local Department of the Ministry of Education for many years (see Appendix 3).

The information produced in phases one and two was the data used to explore how Dora and Ricardo's subjectivities regarding teaching big ideas are produced in a scenario where the discourses at both the policy and schools' levels are at play. This is discussed in Chapter 6.

3.2.2.3 Phase three

This phase aimed to explore the complexities of what can be learnt and taught during the design and implementation of a CPD programme focused on big ideas identified before as NIPDE (see Appendix 4). NIPDE had four main topics: (1) big ideas of science education, (2) contextualisation to the local territory, (3) community of learning, and (4) scientific inquiry. A version of NIPDE was held in Uni1, from its design (with meetings since June 2017) through to the implementation of 11 sessions (on Saturdays between 10am and 5pm; starting on November 2017). I was appointed as the coordinator of NIPDE because it was part of my research; however, the design and implementation were developed by a team of 12 colleagues including myself. The information produced in NIPDE is my researcher journal, video and audio record of the sessions of the course, the audio record of the design meetings, the designed syllabus of the course, the artefacts produced during the course and the reflective journals of the schoolteachers and the university team. I have written consent from the schoolteachers and my colleagues to use this information in my research. The following is a closer description of the participants of NIPDE.

3.2.3 NIPDE's participants

3.2.3.1 University teachers: different 'We'

The university team was formed by 12 professionals, including myself[33], from different areas related to science education. The university team has some features which allowed for our organisation 'as a non-unified *We'* with diverse experience and interests. Five of us (see Table 3.2) have a PhD and the two are PhD candidates; three are not schoolteachers, while 12 have the initial training as teacher; seven of us have a contract with the university; five of us do not have a contract with the university and have been hired just for the course.

There are other ways of grouping us in terms of contractual institutional conditions, qualifications, experience working at schools and the subject matter of the undergraduate. In that sense, seven out of twelve has a full contract with a university and the same number have a PhD or is studying for one. Eleven out of twelve are working/studying only at the university level while Dora is working at a school as well. Half of the group are either biology teachers or biologists, there are two primary teachers, and the remainder of the group has only one person

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[33] A brief commentary on my relationship with the university team and the role of reflexivity on this research is developed in the section on ethical considerations.

in each career. This information is important in Chapter 4 of the analysis when depicting the subjectivity of the university team. In Table 3.2 there is a short description of the university team.

Table 3.2: Short description of the university team in alphabetical order (pseudonyms except for me). This group was working directly in the design and implementation of NIPDE.

Pseudonym	Undergraduate Degree	Postgraduate situation	Current workplace and contractual situation
Alvaro	Teacher: History and geography	PhD in education	Full-time contract at Uni1
Amelia	Teacher: Physics	Master's in science education	Full-time contract at another university; hired only for this project.
Carlos	Teacher: Chemistry	PhD in science education	Full-time contract at Uni1
Cecilia	Teacher: Biology	PhD in education	Uni1 zero-hours contract; hired only for this project
Daniel	Teacher: Biology	PhD candidate	Full-time contract at another university; hired only for this project
Dora	Teacher: Primary	Master's in science education	Full-time contract in a school; Uni1 zero-hours contract; hired only for this project
Gabi	Teacher: Primary	Master's in science education	Full-time contract at Uni1
Javier	Psychologist	Master's in psychology	Uni1 zero-hours contract; hired only for this project
Juan	Biologist	PhD in ecology	Uni1 zero-hours contract; hired only for this project
Karen	Teacher: Biology	PhD in science education	Full-time contract at Uni1
Patricia	Teacher: Biology	Master's in science education	Full-time contract at Uni1
Paulina	Biologist	PhD candidate	Uni1 zero-hours contract; hired only for this project.

Another way to group us is regarding our role in the course as 'experts' in one of the four foci. Alvaro and Juan oversaw the focus of contextualisation to the local territory; Amelia, Carlos, Karen and I were in charge of the focus of big ideas of science education; Daniel and Patricia were in charge of the focus of scientific inquiry; Karen and Javier were in charge of the focus of community of learning. Dora oversaw the dimension of reflection; and Cecilia, Gabi and I were part of the administration team. Even though there was an attempt to have these foci intertwined, leading to having at least six of us present in every session, there were two foci that were central per day; that meant that at least two people oversaw the day while the other facilitators were helping/accompanying the development of the session's activities (see Appendix 4).

Within this group of university teachers, eleven design meetings were held. Four meetings before the course, six during the course, and one after the course. The first meeting was in the middle of June 2017, and the last was at the end of January 2018. The course was implemented between the 11th of November 2017 and 11th of January 2018. The average attendance at the design meetings was seven people; I was in every meeting as well as someone from the administration team (sometimes I had that role too). Dora began to participate in the design meetings when the course had already started. Two focus groups were held with the university team, one in the middle of the course and one after the course as an assessment of NIPDE (see Appendix 5).

The information produced in the design meetings was used to explore how the university teachers' subjectivities regarding the design of a CPD course are produced in the context of educational institutions such as the Ministry and the university. This subjectivity is analysed in Chapter 4 of this thesis.

3.2.3.2 Schoolteachers

Twenty-one schoolteachers from pre-primary to secondary education were participants in the NIPDE course. All of them had completed the first course (NIPD) which was the requirement to participate in this course. In Table 3.3 there is a description of the schoolteachers. Five schoolteachers participated in the 'initial' version of NIPD in 2015 at Uni1; nine schoolteachers participated in the same version of NIPD at Uni1 but in 2016. Seven schoolteachers participated in the second version of NIPD in 2016 but with another university within the same region, namely, Uni2.

Seventeen are primary teachers, two are secondary teachers, and two are pre-primary teachers. Pre-primary and primary teachers had some experience of science education without being specialists, while secondary teachers were biology or chemistry specialists. There were representatives of nine different districts within the same region. The schoolteachers sat together at round tables according to the version of the NIPD or zone. For example, all the schoolteachers from district D2 were at the same table as well as the ones from district D3. Usually, the teachers work in groups, the groups were the same as the tables. Nicia is the only one who did not finish the course which is discussed in Chapter 5.

Table 3.3: Short description of the schoolteachers' backgrounds in alphabetical order.

Pseudonym	Degree	District	Version of NIPD
Caro	Primary teacher	D1	Second cohort 2016 with Uni1
Cesar	Primary teacher	D1	Second cohort 2016 with Uni1
Consuelo	Pre-primary teacher	D2	Second cohort 2016 with Uni2
Clarita	Primary teacher	D2	Second cohort 2016 with Uni2
Eliseo	Primary teacher	D1	Second cohort 2016 with Uni1
Franco	Primary teacher	D3	First cohort 2015 with Uni1
Ivan	Chemistry teacher	D4	First cohort 2015 with Uni1
Javiera	Primary teacher	D5	First cohort 2015 with Uni1
Jacinta	Primary teacher	D2	Second cohort 2016 with Uni2
Jorge	Primary teacher	D6	Second cohort 2016 with Uni2

Karla	Primary teacher	D7	First cohort 2015 with Uni1
María	Primary teacher	D8	Second cohort 2016 with Uni2
Marita	Primary teacher	D1	Second cohort 2016 with Uni1
Mónica	Primary teacher	D9	Second cohort 2016 with Uni1
Nadia	Pre-primary teacher	D2	Second cohort 2016 with Uni2
Natalia	Primary teacher	D2	Second cohort 2016 with Uni2
Nicia	Primary teacher	D1	Second cohort 2016 with Uni1
Paloma	Primary teacher	D1	Second cohort 2016 with Uni1
Pedro	Biology teacher	D1	Second cohort 2016 with Uni1
Ricardo	Primary teacher	D7	First cohort 2015 with Uni1
Susi	Primary teacher	D9	Second cohort 2016 with Uni1

It bears noting that I did a follow-up question to the schoolteachers after one year of having participated in the course. I asked them through an email sent on the 9th of May 2019 – the last day of the course was the 11th of January 2018 – the following question: *"Thinking on the NIPDE course, do you have recollections of some content, topic or situation that feels more meaningful?"* I received 11 email answers.

The information produced in phase three is used to explore how the subjectivity of university teachers and schoolteachers are produced while designing, implementing, and participating in NIPDE. Those subjectivities are explored in Chapters 4 and 5.

To summarise, I produced information through schoolteachers' questionnaires (n=63), schoolteachers' interviews (2 teachers; 4.45 hours); classroom observations (2 teachers; 4.68 hours); leading team's and Ministry deputies' interviews (4 people; 4.53 hours); design meetings (11 meetings; 13.10 hours); and session of NIPDE (11 sessions; approx. 80 hours). All the data were audio-recorded, and the observations and sessions of NIPDE were video-recorded as well. I transcribed the schoolteachers' interviews while parts of the other interviews were transcribed by another person. I transcribed selected extracts of the classroom observations, some parts of the sessions of NIPDE and made notes of other parts from the audio recordings, creating a compiled document of approximately 500 pages of data analysed in the thesis.

3.3 My (subjective) change

3.3.1 Putting into question the 'hybrid space of learning'

In between the production of information and the analysis of it, I began to appreciate a subjective change which shifted the focus of my research – centred on the schoolteachers – towards problematising my own practice. This change started by questioning how I conceptualised the CPD before the fieldwork and how my conceptualisation changed during the analysis, for instance, problematising the way I aimed to 'evaluate' or 'confirm' my assumptions. I argue that this change was due to both the exploration of the meaning of the

sociopolitical turn within science education and the incorporation of what could resonate with my research from different areas or perspectives.

Initially, my research had the aim of exploring the intentions and practices of Chilean science teachers teaching the big ideas of science education which have recently been incorporated in the curriculum, and in particular examining whether the schoolteacher's voice was missed in that process. Furthermore, building on my experience as teacher educator, I suggested the design and implementation of a CPD programme focused mostly on big ideas. When designing the fieldwork in 2016, I named the CPD a 'hybrid space of learning'[34], as somewhere that schoolteachers and teacher educators could share their practice, developing a new understanding of how to teach big ideas. With that idealised image of 'hearing' the hidden voice and creating a 'hybrid', I conducted my fieldwork, exploring the schoolteachers' conceptualisations of big ideas and designing and implementing a CPD programme. The notion of 'hybrid' arose in a conversation with one of my colleagues trying to establish our position in the CPD programme. In the literature, some referred to the 'hybrid space' as a new space between physical and digital when students are not able to go to their schools due to illness or other issues (Trentin et al., 2015). Conversely, Moje et al. (2004) pointed out the concept of a 'hybrid (third) space' as a "blend of the discourse of the informal practice and of the formal one of the mathematics classrooms, dictating new forms of participation legitimized" (p. 127). Moje et al. (ibid.) suggest three views on what a hybrid space can provide: i) a supportive scaffold between 'marginalised' knowledge and 'accepted' discourse; (ii) negotiation between different discourse communities; and iii) an emerging discourse that could destabilise the 'official school discourse'. When I proposed the notion of hybridity to the CPD, I was attempting to bring together the practical knowledge of the schoolteachers with the theoretical knowledge of the university team to create a collaborative understanding of big ideas: in Moje's words the marginalised and the accepted. What I did not realise at that time was that I was taking my part on settling the knowledge of the schoolteachers as the marginalised/informal and the knowledge of the university as that which is formal/accepted. However, in doing this I was covering over the differences between these groups, trying to 'blend' in an unquestioned manner the interactions and relationships between them in a hybrid discourse.

By taking distance from the CPD programme – geographically coming back to the UK and in time because it was 2018 – reading literature of the sociopolitical turn, I came to observe closely my practice, questioning my assumptions such as the very notion of hybridity. One that especially resonates with my work was Roth (2008) who pointed out that since hybridity is inherent to forms of knowledge, science education should "specify the hybridity of practices within and across individuals and groups" (p. 918), instead of creating a 'new' hybrid unity which can hide the difference. Bazzul (2016) also refers to the notion of hybridity, acknowledging that it should be politicised "to promote multiple, 'other' becomings, or political recognition" (p. 8), which is a call to spend time on how individuals are constituted as

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[34] The word learning is related to the discussion elaborated in Chapter 2 on how to name the process in CPD programmes as development or leaning. I chose to include the word learning because the people involved in the space is treated as learners referring to their individual's process during the CPD.

subjects, namely, the question of subjectivation processes. Freire (1972) pointed out the importance of what he coined the 'epistemological distance' as the act to come closer, renaming the world and being able to *see* it from another referential system. Frequently, the 'world' of CPD programmes in science education is focused on the improvement of schoolteachers' practices (Kasi et al., 2020), placing on them the responsibility for its success or failure. However, as Smith (2003) asked herself, "what about the professional development of teacher educators?" (p. 202). I also started to question my own and my colleagues' notions of science, learning, and teaching as well as our/my assumptions of becoming hybrid – university-school – with unified discourses.

To illustrate this reflexion on the idealised image of the hybrid I´m going to use an extract of the first session of NIPDE[35]. Alvaro, positioned as expert in geography, was the person who oversaw the foci of contextualisation to the local territory. The first activity was for the schoolteachers to identify on a map of their local territory (the districts in Table 3.3) some socio-environmental issues and heritage aspects (traditional dances, national rails, old churches, or national parks). At the end of the activity, Alvaro and a schoolteacher, Ivan, had the following exchange:

> **Ivan:** It is difficult to locate ourselves {talking about the mapping} (.) as well as it is difficult to bring to the classroom this number of variables (.) there is a lot of valuable things in our *surroundings* that maybe we have not considered and that could be a contribution to what we are *supposed* to do.
>
> **Alvaro:** (…) We are closing the activity now (.) in session three we will give you more systematised information from different sources about these two things – heritage and socioenvironmental issues to use the local territory – (.) because what we did today was to raise and systematise the knowledge of every one of us but the knowledge of all, although rich and diverse, is not enough to explain why things happen and how we can teach them. We will provide more information to *enrich*, as the way we should do with our students; we should enrich what they already know.

According to my initial positionality designing the course, we were making the content as situated as possible using the local territory to teach science. However, at that moment I did not realise – we were not realising – that we were reproducing the discourse of informal/formal knowledge. There is a type of knowledge that is considered formal which appears as more important because it could *enrich* the activity and there is a knowledge that is not recognised as legitimate, even though the schoolteachers were bringing their district-based knowledge – yet I suspect they know their space better than us.

At that time, I took Alvaro's account as a complement of what was just said for other schoolteachers in the plenary; however, depicting our image of the hybrid I came to see that the word 'enrich' sounds as if the activity was lacking something; the result was *poor* and needed some other information to be complete. Reading about decoloniality[36], I came to the notion of 'epistemic racism' (Santos, 2014) where there is a colonial epistemology that does not take into serious consideration the production of knowledge of the zone of the

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[35] In the following section of data analysis, I will explain the key transcription convention used in the extracts and my use of dialogue as analytical tool. The extract used here is just to illustrate how I begun to question my assumption of the hybrid.

[36] Related to what was explored in Chapter 2 in the section on the decolonial question.

other/excluded. In this case, the implicit assumption of those of us running the CPD course was that the situated production of knowledge by the schoolteachers was not enough and it should be enriched with the formal understanding of the well-known regional problems which, according to Alvaro, is a chain that is replicated with students. Paradoxically the use of the territory to make the teaching situated was central in NIPDE; however at the same time, the knowledge about the territory was not enough. Another aspect that is highlighted in this extract is that the vocabulary and ideas introduced by the schoolteachers are not explored or put into dialogue in the plenary (for example, surroundings changed to local territory). In that light, the 'hybrid space of learning' was kind of far from bringing together the supposedly practical knowledge of the schoolteachers with the supposedly theoretical knowledge of the university team as egalitarian contributors of a new understanding of how to teach big ideas.

This questioning was influenced by the reading of the sociopolitical. I am understanding the sociopolitical turn as opening questions that were not previously included in the science education field, such as the question of subjectivity or decolonial questioning. In this case, that question made me turn my first position as centred only on the schoolteachers' practice to look also at my own practice – and the ones of my colleagues from the university – attempting to unpack the teacher educators' role.

Another aspect that also influenced the subjective change was the incorporation of what could resonate to my research from different areas or perspectives which is developed as follows.

3.3.2 Aliveness or from homogenization to difference

During my initial training as a biology undergraduate, I studied a course on morphology and physiology where we were asked to open a cockroach to understand its structures and functions, which was a very common strategy. The tricky (creepy as well) part was that we should be able to keep the cockroach alive while opening it and then taking its parts out to look closely with a magnifying glass. I bring this up because sometimes analysing NIPDE I felt it to be like a cockroach – metaphorically – being opened, although in my case, being luckier than the insect. The sense of aliveness, opposed to what I experienced opening the cockroach, was related to being the person who is dissecting by analysing NIPDE while also being the subject dissected, meaning, my own practice in NIPDE. As above-mentioned, I am explaining the subjective change in relation to the incorporation to what could resonate with my research from other areas or perspectives, as well as questions that I did not think before. In that sense, I am trying to understand the structure – meaning the participants of NIPDE – and the functions – interactions that happened during the course – but without just 'opening' it to take its parts out, rather, incorporating other perspectives by thinking with them. Those different perspectives were related to the discussions during the supervision sessions and my participation in a collaborative analysis group with two friends also doing their PhDs.

3.3.2.1 With the supervisors

A moment when I think the change materialises is when discussing with my supervisors, Professor Michael J. Reiss and Professor Claudia Lapping, resulting in my epistemological position developed here. That materialisation might cover what Carter (2011) suggests as

engaging with other disciplines to (re)consider new politico-ethical directions in science education. For me, to explore the sociopolitical dimension of science education, it has been crucial to have the space provided by my two PhD supervisors, (re)naming my own subjectivity around CPD programmes. With both, the monthly conversation turned to questioning, for example, my initial assumptions around CPD programmes and the ethical dilemma of researching my friends and current colleagues in Chile.

An example of incorporating a political question related to institutional knowledge and positionalities happened in one supervision session. I remember the meeting was held when I came back to the UK after the fieldwork trip during early 2018, and I was explaining the 'hybrid space of learning'. I said that in the hybrid space the schoolteachers and teacher educators share their practice developing a new understanding of how to teach big ideas. Then I added, the aim was to *homogenise* what we understood by big ideas. At that moment, one of the supervisors reacted by asking me, *"why do you want to homogenise?"*. I did not realise that maybe I was understanding the hybrid as a consensus without considering the difference between conceptualisations while erasing the contested to have a common, unique definition of big ideas until that question was posed. Coming back to the example provided on pages 66-67 with the dialogue between Ivan and Alvaro, after that question of why I want to homogenise, I was able to re-read that the *enrichment* – uttered by Alvaro – of the situated knowledge of the schoolteachers was an issue worthy of attention when analysing the interaction between university and schoolteachers, especially regarding how we think knowledge is built. In so doing, questioning, for example, how we may be reproducing that there is knowledge that is accepted as legitimate and there is other knowledge that is considered as illegitimate.

Something similar happened in the common definition of big ideas, when in the same dialogue between Ivan and Alvaro, the vocabulary and ideas introduced by the schoolteachers were not explored or put into dialogue in the plenary. In that light, how is the definition going to be common if it is considering just one kind of vocabulary and excluding another? These kinds of questions led me to think that a single definition of big ideas could be something that does not exist, something that is elusive. Reflecting on the elusiveness of that definition, the notion of 'empty signifier' was pointed out by one of my supervisors, which helped me to problematise the understanding of the big ideas in the curriculum, by the schoolteachers, and in NIPDE in Chapter 6 of this thesis.

In another supervision around August 2018, the ethical dilemma of researching my friends and current colleagues in Chile was discussed. We talked about how I could depict the practice of my colleagues who at the same time are my friends. How can I address that situation when there is a history of friendship, for example with Karen, with whom I have been working since 2008? How can I comment on my colleagues these reflections on shifting to analyse our practice in NIPDE designing it and implementing it? In that sense, we discussed the ethical dilemma of researching from 'inside' – echoing the idea of the dissected cockroach – and then leaving the field, writing about the analysis, and disseminating it. At that moment we also talked about how the analysis of the thesis might be received by the participants within it; I explained that I was hesitant to show my analysis to some of my colleagues because I did not

know how they might react (this reflection is developed in the final ethics section). One important issue that arose at that moment was the understanding that I was not researching them personally, rather it was the subjectivity produced in the context of the university during NIPDE. Another thing that I realised during this ongoing conversation of researching as 'insider' was that it could be easier to talk about my own practice rather than the practice of my colleagues; to myself was easier to be 'critical', unpacking what I said, how or to whom I was talking during the design and implementation of the CPD programme. For that reason, when explaining what changed my focus of the research, I started posing questions first of my own practice and then of my colleagues/friends.

3.3.2.2 With *Juego, Mito y Excusa* (Play, Myth, and Excuse)

A similar methodological point on working across disciplines, raised previously with my supervisors, occurred with a collaborative analysis group with two friends who were also studying for their PhDs. With Coca and Felipe (real names), we created a group of analysis of our data which benefited from our different backgrounds – the experience of Coca in psychology and psychoanalysis, Felipe's experience in anthropology and sociology of education and my experience in biology and science education. The three of us were working on our PhDs, we are Chileans, and we share an interest in Chilean teachers' subjectivities and how these are produced: Coca, regarding the subjectivation process of pre-primary teachers, Felipe regarding the subjectivation process of dissident teachers, and myself regarding the subjectivation process of science teachers teaching big ideas, all of us in the Chilean context. We met once per week from June 2018 to December 2019 to discuss our data and reflect together.

At the beginning we named the group as Play, Myth and Excuse (*Juego, Mito y Excusa*), where the word 'play' was used because of Coca's initial focus on the role of playing in pre-primary education with children, 'myth' because of Felipe's desire to make an intersection between Greek mythology and the dissident teachers, and 'excuse' (as an excuse to meet) because in the first meeting I said that the big ideas approach allowed one to have a very different group of people working together in the same place. During the year and a half that we met at the University in London, we were influencing each other's analysis, that is for example, how at some point we changed our name to 'Group, Forest and Dialogue' ('*Grupo, Bosque, Diálogo*'). As we were analysing together, our foci on the research changed as well; for Coca and for me 'group' and 'dialogue' become the analytical tools we used to read our data, while for Felipe the word 'forest' resonated to his conclusion. My participation in this group was crucial to engaging with my data, selecting key episodes, and unpacking my position as teacher educator/friend/colleague.

The usual strategy was that in every meeting one of us was presenting his/her selected items of data, then the whole group discussed freely for about two hours around what was shown. Even though every one of us was familiarised with our own data, the fresh eyes of the other two during the meetings offered new and surprising perspectives and give rest to what could be an exhausting task of reading again and again your own data. It was within the setting of this group that I came to give the specific shape to the key moments I used in each chapter.

For example, in one of the meetings I showed an episode around an activity of NIPDE where the schoolteachers were creating research questions. At that time, I was seduced by the relevance that the creation of research questions took in the CPD; however, with Coca and Felipe we came to specify that the notion of *chaos* while creating the questions was a crucial moment of the course (more on this is presented in Chapter 5). Their specific background – Felipe in sociology and Coca in psychology and psychoanalysis – was another feature of the contribution of this group. For instance, we spend many hours discussing the sociological aspect of hierarchies and power relationships between the university and the school. Similarly, Coca's understanding of the notion of signifier and signified allowed as to depict big ideas as a polysemy and how it can be an empty signifier in which every definition fits (developed in Chapter 5).

My participation in this group allowed me to read my data in a critical and refreshing way to the point at which it was possible to look from some distance at the data with which I was so deeply familiarised. The environment of care and trust generated with these two greatly admired friends helped me to unpack my practice in a safe space while at the same time being deeply questioned by myself and my peers; the exercise of 'undressing' my practice every three weeks for a year and a half allowed me to understand my own subjectivation process being them part of it as well, and, I assume, myself being part of their subjectivities researching for their own theses.

Having described what I mean by my subjective change, I will now move on to discuss how I have analysed the data produced.

3.4 Analysis of the data

This study is a piece of qualitative research shaped within a sociopolitical perspective. My analysis of the data produced uses and develops a conception of dialogue to explore the different types of discourse that emerged in and around the CPD programme and it attempts to depict the subjectivity of those participating on it.

From a linguistic perspective, there is agreement that dialogue can go beyond the stereotypical view of two or more people talking (Burbules & Bruce, 2001). According to Lefstein and Snell (2013) dialogue is the act of "talking through an issue that serves particular purposes" (p. 14). When one adds to the definition 'who' is talking in the dialogue it became a social and political issue that involves deeper interpretations of communication and social relations, such as power and cultural traditions. Any particular instance of dialogical relation will depend on the specific language/words people use, which is as important as the context where they meet or the gestures they use in the interaction. In that sense, dialogue as discursive practice has a certain element of materiality which is worth paying attention to when trying to understand the circumstances in which it occurs. Dialogical analysis has been described as providing tools to depict subjectivity produced in qualitative research (Sullivan, 2011). As such, drawing on linguistic aspects, dialogic analysis allows one to unpack tensions between different voices, implicit or explicit elements or how individuals are permeated by social or institutional discourses (Gillespie & Cornish, 2010).

In my analysis, dialogue is used in different ways, from a traditional linguistic sense of conversations to how different voices moved around a theme. Before moving on to the methodological implications of those conceptualisations, the practical process of how I dealt with the data, and then the process by which I selected key moments for detailed analysis and interpretation, I will discuss important issues of data preparation, such as the process of translation and how transcription was undertaken. I will finish this section with the structure of the final shape of the findings chapters.

3.4.1 Data preparation

The data were in Spanish, so the translation to English was a challenging and relevant task in my research as I became interested in the detailed exploration of linguistic aspects such as words uttered by those participating in NIPDE. The analysis was undertaken in Spanish and after I selected the key episodes for inclusion as extracts in this thesis, I translated them into English. To translate the episodes, I mostly used the UK dictionary Lexico, powered by Oxford University Press, the Linguee dictionary, and the Word Reference webpage. The process of translation was first from scratch, and then using Google Translate until I was satisfied with the result, using the platforms mentioned. I also asked other PhD students who were in the same position of translating from Spanish to English and I checked forums when insecure on my translation of some idioms.

An example of what was challenging was the translation of gendered words regarding an ongoing discussion of inclusive language which in Chile has resurfaced from 2018 (Meneses, 2020). In Spanish when referring to a person such as a student or a teacher, the phrases are usually not neutral but gendered, with the most general use of *he* (in Spanish *él* or *ellos* as masculine plural) as a default. In most of the occasions during the sessions of NIPDE or in the design meetings the use of the masculine pronoun was used to refer either in singular as he/him or as *ellos* to the whole group of students or teachers even though there were not just males in those groups. As a complementary example, as there is a raised awareness of language that excludes based on gender, there were also moments during the design and sessions of NIPDE – less often but still existent – where the use of ways to alternate the use of *he* and *she* or other ways to avoid identifying gender at all. For instance, there is an increasing use of the words *las, los* and *les* (*les* is less used) where *las* refers in plural to women, *los* refers in plural to men and *les* with the incorporation of the letter 'e' as a non-binary understanding of gender. In both cases, either the use of the masculine generalisation of *he – ellos* in plural – to refer to the whole group or the use of *las* and *los* I translated as the plural 'they' in the episodes or neutral words that in English do not imply gender. Furthermore, I decided to not dig into that discussion of inclusive language (its non-appearance in many cases) in my analysis even though I recognise its political importance as issues to do with language inclusivity are not core to my focus.

Another example of challenges encountered in translation were Chilean idioms which might lose part of their significance when translated into English. That is the case for the expression *la moví'a de piso*, translated as 'sweep-you off-your-feet', uttered by a schoolteacher which I used in a key episode in Chapter 5. I did not find a direct translation to the phrase; the way I

translated it was trying to respect the character of a common phrase uttered by the schoolteacher while trying to use an English expression. However, there are some issues that make the translation less accurate. On the one hand, the meaning in English seems to be related to falling in love very quickly and unexpectedly to someone (which may be related to uninhibited dance). What the schoolteacher intended to explain was how an activity in the course was destabilising what he understood by a specific scientific notion which might have been unexpected to him, but I presume it did not mean to fall in love to the notion! On the other hand, the colloquial tone of the expression could have been lost in translation. The literal translation of the phrase *la moví'a de piso* could be 'the moved (in feminine) off the floor' where the word *moví'a/movida* (moved) is omitting the letter 'd'. Usually in Chile, this kind of omission is related to a relaxed, informal way of talking which might be not completely expressed in the 'sweep-you off-your-feet' translation; even though the phrase in English is informal, phonetically it is not the same.

A final example of the translation process was a word that I did not translate, and it is presented in Spanish as *Lazarillo*. *Lazarillo* was the name of an activity during the course which meant that in pairs (either university or schoolteacher members) one person was blindfolded and the other one was asked not to speak while they walked around the university. The purpose of the activity was to guide and be guided in the pair (more on this in Chapter 5). When I searched how to translate this word the closest options were 'seeing-eye dog' or 'guide dog' (in Linguee) which made me think that the word does not exist in English. A noteworthy aspect of this example is that the word *Lazarillo* is very familiar in the Chilean context because there is a mandatory book in the curriculum which is called 'El Lazarillo de Tormes' (1554) by an anonymous author from Spain which is well known in our educational system to this day. Currently, this book is expected to be read in the 9th year of schooling. When the activity was presented in the session, every person might have had a slight idea of what the aim of the activity was because of the connexion to the Spanish book. In Chapter 5 I explained more what the activity was; however, in the NIPDE session, that kind of explanation was not necessary because the word *Lazarillo* triggered a collective recollection connected to one's own school life.

Another important aspect of the preparation of the data was the transcription of the key episodes. After selecting the episodes (process explained below), I used a standard key transcription convention to show verbatim the dialogues, representing them as closely as possible to how they occurred. This key transcription convention was adapted from Lefstein and Sneill (2014) and, as displayed in the exchange on pages 66-67, there are ways to show pauses in the speech, emphasised words, and transcriber comments. These conventions constituted an important limit of the interpretations of the analysis through dialogue:

{text}	Transcriber comment
(xxxxxxx)	indistinguishable speech
(.)	Brief pause (under one second)
(1)	Longer pause (number indicates length to nearest whole second)
(( ))	Description of prosody or non-verbal activity
[	Overlapping talk or action
te:xt	Stretched sounds

sh-	Word cut off
Text	Emphasising
TEXT	Shouting
(.hhh)	Audible inhalation

The way that I presented the selected key episodes is also worth commenting on. As I used episodes of verbatim extended quotes, the episodes are separated into parts as part of the analysis. In each part of the episodes, there are individual words or whole phrases underlined (as illustrated in the short extracts on page 76) which are the ones that are particularly relevant to my interpretations. In the findings chapters, before and after each part of a key episode the time is shown, and the context of the episode is provided.

A final data preparation was the use of comic strips as visual representations of selected key episodes. In Chapters 5 and 6 I used comic strips as a form of transcription that I created, choosing frames of video records. These comic strips were produced showing a vignette that was capturing verbatim parts of the video record from NIPDE (Chapter 5) and from Dora's and Ricardo's lessons (Chapter 6). The benefit of the comic strip is that it captures both the words spoken and the setting of the classroom and some gestures of the participants. It is a way of showing nonverbal issues in the episode via a form of transcription. The process of creating these comic strips was guided by selecting screenshots from the video record of what I wanted to show. I subsequently modified these screenshots in Photoshop to create the cartoonish appearance. Then in a Word document I located the modified pictures to be read as a comic strip and added the dialogue verbatim from those moments.

3.4.2 Data analysis

In what follows, I discuss the ongoing analytical process undertaken in this thesis from the practical procedure of how I dealt with the data to the way I used and developed a conception of dialogue with examples of my process.

A first step was the organisation of the data produced. I put together a compiled document of the 11 sessions of NIPDE using the video and audio records, and a document with notes and verbatim transcription of the design meetings' audio record; besides, I also organised the transcription of the interviews and classroom observations made in phases one and two. My first approach to the data was to code them openly per fieldwork phase; that is to say, I analysed the data separately, in three sets as the data were produced in corresponding phases: interviews and classroom observations of teachers' experiences teaching with big ideas (from phase one); interviews from schools' and policy's conditions to teach big ideas (from phase two); and the information produced during both design and implementation of NIPDE (from phase three). The following section explains in detail the process of coding, the selection of key moments, and the way I undertook the dialogical analysis.

3.4.2.1 Coding, selecting key moments, and conducting a dialogical analysis

My first approach to the data was to code them openly per fieldwork phase. That is to say, I coded the (1) information from phase one: interviews and classroom observations of teachers' experiences teaching with big ideas; (2) information from phase two: interviews from schools'

and policy's conditions to teach big ideas; and (3) information from phase three: data produced during both the design and the implementation of NIPDE. It is worth noting that the final findings chapters are not organised in this way (see *3.4.2.3 Final shape of findings chapters*); however, this first approach led me to identify critical issues from the data.

Doing my own translation of the dataset (see *3.4.1 Data preparation*) gave me a very good opportunity to familiarise myself with the data. Similarly, coding openly the interviews of phase one (two per schoolteachers; six in total) was a great way to familiarise myself with the interviews and with the classroom observations. With the information produced in phase one, I attempted to explore the schoolteachers'[37] conceptualisations of big ideas. I analysed their talk, seeking within the data answers to the following questions: What is their definition of a big idea? How does she/he teach it? Why is important for them to teach big ideas? What are the results in terms of the students or her/his own learning? And how was the CPD as a space to develop big ideas?

Conducting these first explorations informed my decision to focus on different conceptualisations of big ideas to then move on to exploring not only the schoolteachers' ones but also mapping and problematising how the National Curriculum and the CPD programme conceptualised the notion. This first exploration was crucial to the shape of the third chapter of findings, namely, Chapter 6. Table 3.4 shows an example of the questions that led this first analysis of the fieldwork's phase one.

Table 3.4: Example of codes organised in the questions.

Question	Initial code	Quote example
What is the definition of big idea?	Conceptualisation of big ideas	"something that changes the world, it has a relationship with it, it is something that makes things different, it is something that in theory makes us good as a society, it does us good because in the case of the port, for example, it generates jobs for people. Besides, it is a protected environment for other animals, and, I feel that a big idea is something that has the power to change both people and environment, that's why they [the big ideas] got so much attention, a big idea will never go unnoticed, it should be striking, I think."
How does she/he teach it?	Role of questions	"Then, when we came back [from the recreational trip], we started talking with my colleague next door and we said why don't we make a project? And we put the two courses together 45 minutes and we let them ask questions, many questions."

With this first exploration of the conceptualisation of big ideas, the schoolteachers and myself co-authored a research article, in the format of a metalogue, in which we presented the

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[37] At this point, in the middle of 2018, I analysed the experiences of Dora, Ricardo, and Pamela; however, Dora and Ricardo were the only ones that participated in NIPDE and at the end I decided that was a key criterion to the final shape of the findings chapters.

teachers' experiences of teaching big ideas and my experience researching their practice (see Bravo, Astudillo, Cisternas & Flores, 2019).

Regarding phase two, the interviews from schools' and policy's conditions to teach big ideas were also coded manually and openly, resulting in 19 codes. This first exploration of the policy and school conditions contributed to Chapter 6. Table 3.5 shows an example of the codes that led this first analysis of the fieldwork's phase two.

Table 3.5: Initial coding conditions to teach big ideas in science education. Example with two codes.

Initial code	Quote example
Incorporating big ideas into de curriculum	"According to what I read of the curriculum, it has to do a little with the vision of literature that the ministry was coining (…) Of course, the same as in mathematics and in other disciplines, you can see how the literature influenced the changes, that is, who were the consultants or those who worked in it said, this is the line that prevails today worldwide. It is common that we commissioned an international study of the curriculum of, let's say, twelve top countries seeking for common factors and in those common factors, you determine, this is the literature that today takes it, then if we have perhaps the best at the national level, I'm going to say something silly, but you have a hundred big ideas, we came up with eighty that are the most common."
Understanding of the policy	"On the one hand, you have a good law that reaches the schools, which will depend on the push that is put into it for this issue to be installed, but on the other hand, you have deficient teams at all levels, from the central level people who do not understand the real meaning of the law, even people in the provincial departments of education who do things that seem relevant to them. There is a colleague, for example, a supervisor who only focuses on *convivencia* [school wellbeing] because it is his subject of research, because he publishes about that, because they teach in school the topic of *convivencia*, and for him the whole problem of the educational system is a problem of school *Convivencia.*"

Some of the initial codes proved to be somewhat redundant, or to provide distinctions that were not particularly relevant to my analysis; thus they were merged. One of these inclusive codes was 'Curricular changes externally informed' (see *6.2.1.1.1 Curricular changes externally informed*) which has connections with the literature regarding the curriculum in science education, how it is developed, and how schoolteachers responded to it which is discussed in Chapter 6, alongside the problematisation of big ideas in science education at the policy level, the CPD programme, and the experience of two schoolteachers in their classroom and school context.

Finally, a first exploration of NIPDE (including design and implementation of the CPD programme which is the information produced in phase three) was also an iterative process to engage and familiarise myself with the data.

Regarding the implementation of NIPDE, the openly coded process was conducted trough NVivo (Figure 3.1) of the compiled document including the 11 sessions of the course. In this first exploration of NIPDE, 66 codes were obtained (see Appendix 6). Some quotes had more than one associated code, and many of the codes repeated through the text. Most codes were extracted within an explicit level, while some of them can be traced to an interpretive level. In Appendix 6, it is possible to see an example of the quotes of one code named 'frustration-tension' which was especially relevant to a finding depicted in Chapter 5 (see *5.2.3.1.2.3 Involvement: frustrated and challenged* and *5.2.4.1 Unwillingness: frustrated and limping*).
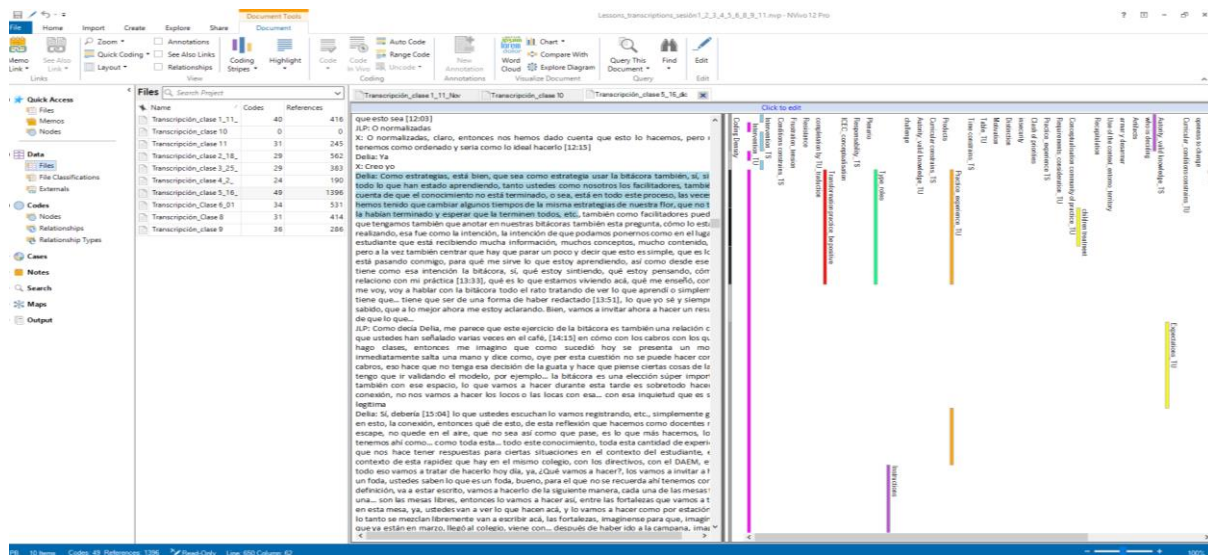
Figure 3.1: Screenshot of the NVivo programme with the first exploration of NIPDE's implementation coding openly.

As shown in Appendix 6, I counted the number of utterances made by the university teachers (UT) and the number made by the schoolteachers (ST) per session of NIPDE. This information allowed me to make inferences related to the interactional form of dialogue (Lefstein & Snell, 2013), such as who speaks and how often? (see Figure 3.2).
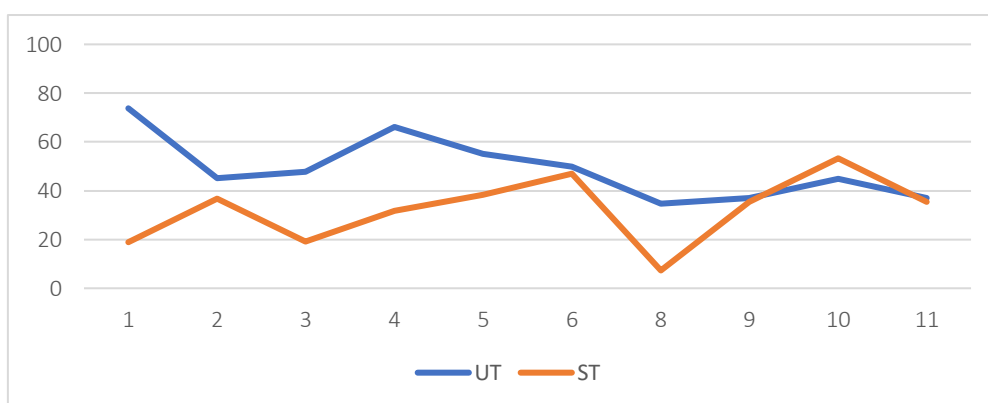
Figure 3.2: The number of utterances (%) by university teachers (UT) or schoolteachers (ST) per session.

Even though this quantitative information was not directly used in the findings, it enabled a first interpretation of participation which can be traced back to the design meetings amongst

university teachers, allowing some interpretations related to the relationship between university teachers and schoolteachers (see Chapter 4).

Regarding the design meetings (fieldwork's phase three), even though I coded the data openly as per the previous material, a first approach included the engagement with some notions from literature that attracted me at that time following the invitation of Jackson and Mazzei (2013) to think with theory in the research. In this case, the notion of border[38] in the context of the relationship between academia and school, and especially within academia, led me to put special focus on the interactions among the university team during the design meetings. In that light, I explored the design meetings, thinking, for instance, about the role of our institutional positionings and our conceptions of knowledge structures. A similar iterative process was conducted in relation to the implementation of NIPDE, noticing the interactions between schoolteachers and university teachers in terms of power relationships and institutional or teacher-student positionings.

As I became more receptive to some details in the interaction among those participating in a conversation either between university teachers or between schoolteachers and university teachers, I started to think that analysing the dialogue could be generative to my analysis focusing on different aspects of language[39]. Then I came across a linguistic approach to analysing dialogue (e.g., Lefstein & Snell, 2013; Burbules & Bruce, 2001). Lefstein and Snell (2013) pointed out that to narrow a definition of dialogue in terms of linguistic form misses important aspects of culture/power relations; therefore, dialogue is inseparable from its materiality which enables the reconceptualization of the interaction between subjects as broader than speech acts. As such, I explored the interaction between those participants in both the design meetings and the implementation of NIPDE, noting especially their speech, words uttered, silences, emphases, overlapped exchanges, or contextual elements to depict their discourses, also considering the institutional settings in which these interactions occurred. In so doing, dialogue became my analytical tool where my process involved an in-depth review of key episodes using verbatim extended quotes. In what follows I will provide some examples[40] of how I used and articulated dialogue in the analysis and how I selected the key episodes used in every chapter.

In a broader sense, one could understand dialogue used in different layers in my research. On the one hand, a dialogue contributing to my subjective change, such as between the discourses of science education and the sociopolitical dimension, between my supervisors and myself, and between the collaborative analysis group and myself (see *3.3 My (subjective) change*) . On

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[38] Related to border I positioned the idea of hybridisation explored before. I was considering the 'worlds' of academia and the school as figured worlds that can have a border between them as potential site of resistance. This reflection was influenced by readings of postcolonial thinking where hybridisation rather than the mixed result of the two worlds could be the space for collaboration and resistance of the unbalanced power relationship. Then I expanded on this reflection, reading about decoloniality which is more precise to the Latin-American context as developed in Chapter 2.

[39] Drawing on this methodological point of working across disciplines developed in the section 'my subjective change', it was similarly useful to consider that from a Deleuzian perspective, language constitutes the transcendental space where words and things meet and differentiate (Lagos-Serrano, 2021). Thus, it is important to pay attention to aspects that transcend language such as the body and the material in general.

[40] These extracts are analysed in the findings chapters.

the other hand, dialogue can be considered as a tool for my analysis by paying attention to episodes of utterances between the participants of the CPD programme. The first of these two layers of dialogue was crucial to how I selected the key episodes and, ultimately, the different ways in which I used dialogue in the thesis.

It has been argued that dialogical analysis is based on 'key moments' (Sullivan, 2012). Sullivan pointed out that familiarisation with the entire data set is crucial, which is related to what I have described before considering each fieldwork phase coded openly; however, "reduction is necessary for an interpretation and analysis to take place" (p. 8). In the case of this thesis, conducting a dialogical analysis is related to focusing on 'key moments' or 'key extracts' as a way to achieve that data reduction. This point was crucial in my analytical process due to the amount of data that I had produced (a compiled document of 500 pages). Sullivan (ibid) maintained that "an utterance is a significant unit of meaning, different from the sentence or the line and is defined by its readiness for a reply/reaction. As a unit of meaning, it can be of variable length" (p. 8). In that light, my use of dialogue was based on selecting these key moments/episodes showing verbatim the extended quotes of interaction representing them as closely as possible to how they occurred.

Using Sullivan's understanding of key moments had methodological implications for this analysis. As a result, three findings chapters emerged, organised around 'key moments/episodes' of the interaction between those participating in the CPD programme. After going through the entire data set, familiarising myself with the implementation and design meetings of NIPDE, I reduced/selected key moments in an iterative way, meaning, that I first selected a variety of extracts drawing both on what was interesting and what was apparently most significant for my research questions. Then, the key moments that were only of marginal relevance to my research focus were excluded, leaving the moments that later on I used in the findings chapters. In what follows, the relationship between the key moments selected and the findings chapters is shown alongside examples of the particular criteria for the selection of each of them.

As key moments involved capturing significant aspects of the interaction, sometimes I put special attention on words uttered, other times I was focusing on how different voices moved around a theme, and sometimes I depicted how different voices were at play within one person's speech. An example of focusing on words uttered is depicted in Chapter 4. Many design meetings were centred around the question of how much we know about, for example, the knowledge of scientific inquiry that the schoolteachers have prior to the course. Before the course started, we used the expression of *levelling up* as shown in the following exchange between facilitators:

> **Paulina**: (…) about how much they know about scientific inquiry
> **Karen**: [Yes
> **Paulina**: And the previous training they had either with us {in Uni1} or with Uni2 becau-
> **Amelia**: [To level them up later
> **Paulina**: [The group will be mixed

Daniel: Sure, because we can oversee the <u>levelling up</u> of the conceptual knowledge that the teachers will bring (.) since we are certain that everyone comes with a different idea {of scientific inquiry} even when they have been with us {in the previous training}

When I started to dig into the idea of *"level up"* or *"levelling up"* and the question of to what extent we knew the schoolteachers in advance, I started to recognise that our design meetings moved around the notion of 'knowing' not just the people who will attend to the course but also our own knowledge and the schoolteachers' knowledge of some science education concepts such as scientific inquiry. As I became intrigued by the notion of knowledge, I decided to explore in depth the design meetings, looking for 'key moments' when we talked about knowing the teachers or knowing the concepts. This resulted in the selection of three key episodes: one before the course started (the exchange showed above on this page is part of this episode), one before the fourth session of the course, and one key episode from the first focus group, aiming to evaluate the course in the middle of its implementation. That led me to depict our assumptions of what the schoolteachers bring to the course, our certainties of what we know about science education and our attempts to disrupt our own knowledge, which was greatly influenced by our institutional positionings (more on this in Chapter 4).

Another use of dialogue is made by examining how different voices moved around a theme. When reading the compiled document of the implementation of NIPDE I started to notice that the work around a series of activities and commentaries that involved the creation of research questions by the schoolteachers was crucial. I was attuned to the emergent character of these activities because during the course we ended up undertaking more activities than we had planned related to this. In that sense, I put special focus on key extracts of the implementation of NIPDE where the schoolteachers were commenting on this type of activities. During the fourth session of the course the following exchange occurred between schoolteachers Javiera, Ivan and Franco, and a facilitator from the university team, Daniel:

Javiera: So, it was a <u>chaos</u>
Ivan: A little mess
Daniel: Unstructured (.) thinking of what Ivan said, we can leave it like th-
Franco: [I think that the *sweep-you off-your-feet* feeling was because of the analysis of one's own process
Javiera: That is the problem that <u>we, teachers,</u> have (.) because we do not analyse as deeply as it should be to reach the research question (.) <u>we ask our children</u> to create a question and when they show us the result we say "Ok, that's fine" so we don't sit down with them to check if the question is ready, or something is missing

The theme of chaos was a prolific one. I started to realise that even though many schoolteachers talked about chaos, the meanings attributed to it were different which gave a clue to look as well into the positions as teachers and students. In one session of the collaborative analysis group – Play, Myth, and Excuse – I brought this extract where we discussed what Javiera pointed out as what *"we teachers"* did with the students regarding the creation of research questions. In that sense, the theme of creating research questions and the idea of chaos was gaining relevance in the analysis because it allowed me to discuss what I then came to call pedagogical and epistemological positionings. With this in mind, the selected key episodes moved around the notions of the positions of teachers and students and

what it means to create research questions pedagogically and epistemologically in science education. Then, the selected key extracts were three: two episodes from the third session of NIPDE, one in the morning session where there was a motivational activity called *Lazarillo* – mentioned above in *3.4.1 Data preparation* – and one at the end of the day in a plenary, and one episode from the fourth session – the exchange shown at the bottom of page 112 is part of this episode – where a plenary around chaos was conducted (more on this in Chapter 5).

To illustrate the use of dialogue as how different voices can be at play when one person is speaking, I will use the case of Dora. Dora was the only person within the university team who was also working in a school as a primary teacher. The following is an exchange in one design meeting between facilitators:

> **Carlos**: But there is a decision making that is not made by you as a schoolteacher
> **Alvaro**: Yes, however, it's what is part of the experience of making your own curriculum (.) in the sense that it has your own decisions that are conscious, autonomous, and reflected?
> **Dora**: I think here, the issue with the curriculum is (.) is showed to the teachers like <u>having everything we need to teach</u> (.) is made like that (.hhh) but here {talking about this CPD} I think the difference is that <u>the teachers</u> have felt like part of the university team (.)

I knew that the case of Dora was a particular one because she straddled the *border* of this relationship between the sphere of academia and the school, being part of both worlds with her practice. Besides, Dora and Ricardo (Ricardo as a participant of NIPDE as a student) were the teachers I interviewed and observed in their classrooms teaching big ideas in phase one of the fieldwork. As shown in the exchange, Dora seems to be referring to herself as a teacher at the school *"having everything we need to teach"* and as a teacher in the CPD course when she refers to "*the teachers*" feeling part of the university team. As I became more attuned to the multiple voices in her speech, I started to realise that Dora and Ricardo (as both a student in NIPDE and a teacher in his school) were cases to which it would be worth paying particular attention. As I commented in *3.4.2.1 Coding, selecting key moments, and conducting a dialogical analysis*, my first approach to the data analysis was per phase of fieldwork; that is, I analysed the big ideas' conceptualisations of Dora and Ricardo and considering their multiplicity of voices I decided to explore in depth Dora and Ricardo's subjectivities regarding teaching big ideas in their classrooms and how they are produced in a scenario where the discourses of the curriculum, NIPDE and their schools are at play. In so doing, the key episodes selected are from the classroom observations – shown as comic strips – while I also made use of national curricular documents and the interviews from schools' and policy's conditions (more on this in Chapter 6).

It bears noting that the different conceptualisations of dialogue associated with all three findings chapters are not restricted to just one chapter. Thus, I was focusing on some words uttered (e.g. the verb 'to guide' in Chapter 5), different meanings around one theme (e.g. contested understandings of 'big ideas of science education' in Chapter 6) and different voices in one person's talk (e.g. my position as PhD student and also as facilitator in NIPDE in Chapter 4). Having explained how I conducted the coding, selected key moments, and undertook the dialogical analysis, in what follows I discuss issues related to the trustworthiness of my research.

3.4.2.2 Reliability and dependability

An important aspect of my analysis process is related to data representation, since Eisenhart (2006) points out that the way the data are represented and used in research constitutes an argument that can provide research validity. Data themselves are not valid or invalid; rather, their validity is related to the inferences drawn from them (Maxwell, 2002). Eisenhart (2006) claims that it is important for a researcher to be able to describe all the decisions made in order to represent their data which, in my case, is what I attempted to do in the previous section. One of the most commonly used strategies to represent data is through providing participants' quotations. As in this case, they have the form of key moments of dialogue from the design meetings and implementation of NIPDE and quotes from the interviews conducted in phases one and two. As mentioned above, I selected the most significant utterances relevant to my research questions, the 'key moments' of dialogue in Sullivan's terms.

Regarding the different criteria for establishing rigour in the context of qualitative research, Guba and Lincoln (1985) proposed criteria of credibility, transferability, dependability, and confirmability (Denzin & Lincoln, 2018). Drawing on Guba and Lincoln, in the following paragraphs I describe these criteria for qualitative research and the different strategies that I have used to incorporate them in my study.

According to Denzin and Lincoln (2018), credibility is related to how well a researcher accurately describes the phenomena under study, which is related to the correspondence between what the researcher claims in the study and the participants' views. Techniques suggested by Lincoln and Guba (1985) to address credibility include spending a prolonged time in the field, data collection triangulation, and member checking. In terms of my research, regarding the time in the field, I spent approximately seven months doing my data generation from the first design meeting to the final session of the CPD programme. Besides, as I was involved in the field for several months and considering my experience working with the same group of teacher educators for years, it was possible for me to develop a trusting relationship. Regarding the use of multiple sources or triangulation, I did apply different methods of data production: questionnaire, interviews, stimulated recall interviews, classroom observation, video and audio records of the design meetings and implementation of NIPDE, and researcher's and schoolteachers' journal. As shown in the previous section, I combined these different methods to achieve a more in-depth interpretation and insight into the experiences in and around the CPD programme. According to Creswell (2013), the aim of triangulation is to corroborate the data provided, by gathering evidence from different individuals, types of data produced, and methods. An example of this triangulation is shown in Chapter 6 where I have problematised the conceptualisation of big ideas, considering the interviews with the people from the leading team or senior management team in each school, the interviews with the local policymakers' deputies of the Ministry of Education, and the National Science Curriculum of Chile, alongside my own observational field notes during NIPDE's implementation. Another way to ensure credibility is through the use of member checking (Robson, 2011). In my

research, member checking was conducted in different ways; for one thing, I discussed my findings regarding the design meetings (Chapter 4) with my colleagues (teacher educators), especially with Karen who was the project coordinator of NIPD. Similarly, I discussed my findings with the schoolteachers whom I observed in their classrooms; as a result, we ended up writing an article related to this process (see Bravo et al., 2019). I develop a more reflexive account of this issue in *3.5 Ethical considerations*.

Another aspect of research rigour is the salient transferability of the research findings. Transferability which is related to peer debriefing (Denzin & Lincoln, 2018) refers to how the researcher could 'apply' findings to alternative contexts (Given, 2008). Even though it has been said that it is impractical to make replications/generalisations in qualitative work (Ward Schofield, 2002), Lincoln and Guba (1985) argue that throughout thick descriptions, other researchers are able to judge whether or not those particular findings can be transferred to the sites or context under study. In my thesis I have attempted to provide a thoroughgoing description of the sessions of NIPDE in the findings chapters (see also Appendix 4) as well as the classroom observations with comic strips (see Chapter 6, specifically *6.2.2.1.1.1 Setting the scene: Dora's lesson* and *6.2.2.1.2.1 Setting the scene: Ricardo's lesson*). A more reflexive discussion on transferability, yet in the context of the findings (i.e. a discussion on transferring the NIPDE course to other universities), is depicted in *4.2.1.2 Assumption: level of trust, 4.2.2.1 Certainty: we are flexible*, and *4.2.2.2 Certainty: we are knowledgeable*.

The dependability of a study depends on the extent to which readers are able to examine how the entire research process has been conducted (Lincoln & Guba, 1985), while confirmability is related to the 'control' of researcher bias (Suter, 2012). Robson (2011) and Creswell (2013) recommend providing a rich account of the entire data production and analytical process (an audit trail). Specifically related to the latter, I have attempted to provide a comprehensive account of the research process. I have established my ontological and epistemological position; provided an overview of the methods; and explained how the fieldwork was conducted; then, I have described the participants of my research; I have provided an account of how the process of the research influenced my reflexivity as a researcher; finally, I have discussed the analysis of the data, including data preparation with a particular emphasis on the translation of quotations from Spanish to English and how the coding, selection of key moments, and dialogical analysis were undertaken. All these research stages and the way they were executed were discussed in depth with my supervisors. In sum, regarding the audit trail of my research, the present methodology and methods chapter had the aim of justifying my approach and how I came to analyse the data produced, describing the path I have followed to conduct my study. In what follows I describe the final shape of the findings chapters, considering what was previously developed.

3.4.2.3 Final shape of findings chapters

The final shape of the three findings chapters is related to who is participating in the interaction and the setting in which this occurs. The dialogical relation will depend on different aspects of language as well as aspects that transcend language, such as the body and other manifestations of the material. In so doing, the findings chapters are organised trying to uncover those aspects which permit me to unpack the subjectivity of those participating in and around the CPD programme in relation to the research questions. The chapters are arranged as indicated in Table 3.6.

Table 3.6: Summary and the structure of findings chapters linked to the research questions.

	Subjectivity	Selected key episodes	When (time)	Where (place)	Research questions (RQ)
Chapter 4 Design meetings: different trajectories around knowing	University teachers	Design meetings	Before and during NIPDE course	At the university	RQ1: How are teacher educators' and schoolteachers' subjectivities produced in a CPD programme focused on big ideas of science education?
Chapter 5 Inside the course: shifting positions in relation to activities on research questions generated by schoolteachers	University teachers and schoolteachers	Implementation of NIPDE	During NIPDE	At the university	
Chapter 6 Teachers' experiences of school science: problematising big ideas from policy to classroom	Dora and Ricardo, leading team, other school staff and policy makers	Dora's and Ricardo's lessons Quotes from interviews	During NIPDE; Dora's and Ricardo's teaching big ideas	At Dora's and Ricardo's schools	RQ2: Under what conditions and institutional discourses do science schoolteachers develop their practice using big ideas of science education? RQ3: How do science schoolteachers participating in a CPD programme conceptualise and respond to the curricular change of big

In the findings chapters the subjectivities are mapped with visual representations incorporated in each chapter. As part of my analytical process, I used a diagram to represent the subjectivities and differentiated meanings. As an example, Figure 3.3 shows the subjectivity of the university team as a starting point before the course started and then how it diverged along two trajectories which I attribute to the implementation of NIPDE. These visual tools are meant to, on the one hand, summarise my process of thought regarding the movements in the discourse of the participants' subjectivity and, on the other hand, have a pedagogical utility by providing a better representation of my reasoning as "representations can be useful tools in learning and understanding" (Erduran & Kaya, 2018, p. 1135). These diagrams can provide to the reader a sense of how the discourses progress or shift over time as a sort of concreteness to my interpretations that are rather complex and abstract ideas.

As visual representations of processes "can be tools for developing and monitoring understanding" (Erduran & Kaya, 2018, p. 1133), I made use of diagrams to show my own process of analysing the data; I decided to present these diagrams in my thesis to represent visually, at a high level, how the research developed.

Starting point: "We don't know them"   Trajectory I: "We won the Nobel Prize"

Trajectory II: "We don't know everything"
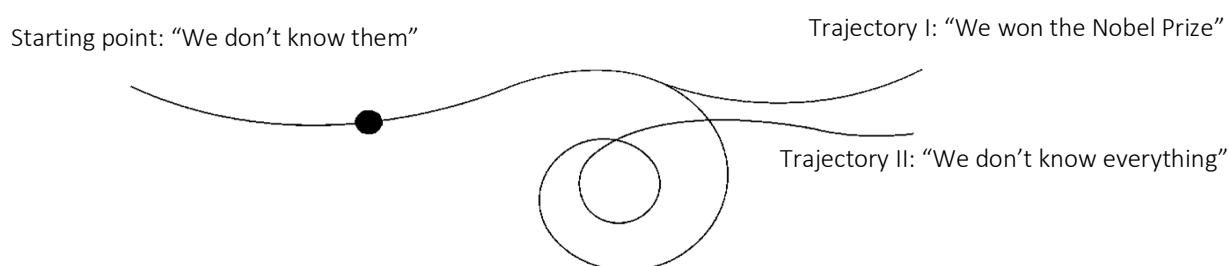
Figure 3.3: Diagram that illustrates the movement of the university team' subjectivity depicted in Chapter 4. The black dot indicates when NIPDE started.

The way Figure 3.3 should be read is from left to right, beginning with the starting point, going through the black dot that symbolises the beginning of the CPD course and then following the first separation of the central line into trajectory I and trajectory II. Alongside the analysis, this diagram increased in complexity by incorporating new starting points (for example, schoolteachers' subjectivity). The final version of the diagram is presented in Chapter 6.

Each chapter tries to unpack the subjectivities of my own and my colleagues' role in NIPDE (Chapter 4), the schoolteachers' shifting positionings regarding the reflections on the work around research questions during NIPDE (Chapter 5), and how the experiences of two schoolteachers teaching big ideas are produced within discourses of the policy, university, and schools' levels at play (Chapter 6). The completed diagram is showed at the end of Chapter 6.

After each chapter of findings there is an appendix of what I came to call an *Interlude*. An Interlude, as in a play, is a short pause; here I use the Interludes to show an iterative process

of thinking with theory (Jackson & Mazzei, 2013). I present the Interludes written in a different style (with different font size and margin) which is related to the way some diverse and unfamiliar perspectives became a background to what I was analysing, like a ghost at my back (but without any creepy sense). That is, while analysing the data I 'brought' with me some literature, and when reading some literature, I brought with me the data. As such, the Interlude after Chapter 4 provides notions of vertical, horizontal discourses (Basil Bernstein) and 'knowing how we know' (Humberto Maturana and Francisco Varela); the Interlude after Chapter 5 is about the pedagogy of the question and generative themes (Paulo Freire) and subjectivity and positionality (Judith Butler); and after Chapter 6 it focuses on policy implementation/enactment (mostly by Stephen Ball). It bears noting that I did not invoke the Interludes as specific unique analytical frameworks that I then employed during the analysis of the data; rather, I was playing with some ideas produced by certain authors that resonated with my data. In this sense, the ideas were productive because they made me think about new ways of reading the data, opening my mind to new interpretations.

3.5 Ethical considerations

Ethical practices for this research are aligned with the BERA (2018) guidelines. Ethical approval from UCL Institute of Education was obtained for my research. Before fieldwork began, I obtained informed consent for each method used in this study: the questionnaire, interviews, stimulated recall interviews, classroom observations, audio and video sessions of NIPDE and the design meetings between teacher educators, and the schoolteachers' reflexive journals. Throughout this study, all data were stored on a secure server at UCL Institute of Education and were not available to any person other than me, my supervisors and the collaborative analysis group in an anonymised manner. During the analysis and writing up of my study, the real names of the participants were not included in the draft documents or final versions, with the exception of my own name. As part of the consent form, the participants were asked if their pseudonymised data could be used for this research. It tried to made clear there were no implications for their practice or professional relationships. All of them agreed to take part in my research, having also the right to withdraw from the research at any time.

Ethical dilemmas arose in particular because my practice and the practices of my colleagues were also the focus of my interpretation. As my friends', colleagues' and my own practice are involved I kept wondering if during the analysis I was privileging some analysis that resonated with my own opinion or argument over other possible interpretations. This question could resonate with what Lapping (2008) captured as 'ethics of interpretation' towards an ethical engagement with the research. In so doing, I attempted to face some feelings that emerged during this process of analysis, such as self-importance or condescension. I experienced an affective response when facing the dissemination of my analysis to my friends/colleagues. In the question of dissemination, I was hesitant to show my analysis to some of my colleagues who had participated in the research because I did not know how they might react. I was assuming that this could be difficult as I thought my colleagues might be angry. Why did I think that? I think a possible explanation has to do with the unasked/uncalled critical lens applied to

my/our practice as teacher educators. Even though my colleagues agreed to be part of my research, the usual way to research interventions such as CPD programmes is related to analysing the practice of the schoolteachers not the teacher educators' role, which, as explained in the section on my subjective change, was also surprising to me. Having said that, I have had very good experiences talking about my thesis with my colleagues, especially with Karen with whom I shared the findings chapters and she responded very positively and said that they challenged her. From that moment we have been discussing our role as teacher educators in very diverse ways because we continue to work together on CPD programmes. Now I think that I was projecting my own fears on my colleagues. Perhaps, part of the issue of disseminating my analysis was towards myself, namely, from Paulina as researcher giving back the analysis to Paulina as teacher educator which made me aware of my multiple positionalities in the process.

I placed myself in the research in multiple positions. I started working on the NIPD project in 2015, occupying an administrative role (taking care of budget, locations, enrolment, and so on) and also involved in academic decisions (syllabus of the course, activities, materials), but when my PhD started, I placed the study in NIPDE (part of NIPD project) where the university team and I delivered the sessions. So, I was occupying administrative, researcher and teacher educator roles at the same time. This led to multiple positions also in front of my colleagues. Karen, the project leader, was (is) my boss, colleague, and friend, but she also then became one of the researched in my research. I have been working with Karen since 2008 when I also was her student in some courses on pedagogy in biology; in 2014-2015 I did the master's degree where Karen was the programme leader and one of my supervisors. In 2010 with Karen I started to participate in a group of science teachers who meet to share their practice. Dora, part of the university team who was the teacher I observed in phase two, also participates in that group. With Dora, my colleague in the science teachers' group and NIPDE, while observing her lessons in this study I began to also occupy a researcher role. With Ricardo, in his role of student of NIPDE, while observing his lessons I also occupied a teacher educator and researcher role. With the university team who are colleagues and friends, as I had the opportunity to lead NIPDE, I began to also occupy a coordination role.

The multiplicity of my presence in this study enabled me, on the one hand, to resist fixed positions with some particular behaviour (of researcher, interviewer or observer) and instead permitted me to occupy somewhat opposed positions which influenced the analysis by coming back to those multiple positions and the context in which they were produced. On the other hand, this permitted me to look at my own practice – and the practice of my colleagues from the university – attempting to unpack the teacher educators' role and the subjectivity of schoolteachers in and around a CPD programme focused on big ideas.

My current struggle on this revision of my practice – being picky with myself – is that it generates a sense of insecurity in my thoughts and analysis of the thesis. I have not been released from that, but I do think I became hardened or more used to this exercise of unpacking critically what I did or said, meaning that I am more comfortable reflecting on and depicting my practice; perhaps that is also related to feeling with 'authority' to unpack other practices. How can I be aware of my fears for example of becoming self-satisfied with the critical lens

towards my practice? I am asking this because at some point I wrote in my diary *"it doesn't matter if you make mistakes and expose yourself"* as if it was easy to unpack one's practice. Those kinds of thoughts and questions remain in my mind as long as, coming back to the metaphor with the cockroach, I am the person who is dissecting by analysing NIPDE while also being the subject dissected, meaning my own practice in NIPDE.

Having discussed the methodology and methods of this thesis, I now turn to the three findings chapters with their corresponding Interludes.

CHAPTER 4

Design meetings: different trajectories around knowing

4.1 Introduction

As described in Chapter 2, this thesis sits within a body of sociopolitical questioning as a lens to explore the subjectivities produced in and around a CPD programme. I have argued that the question of subjectivity in science education is related to the recent 'call' to pay attention to the sociopolitical discourses rarely studied within the field which is addressed in this and the following findings chapter. In doing so, the research question that these two chapters are addressing is *'How are teacher educators' and schoolteachers' subjectivities produced in a CPD programme focused on big ideas of science education?'* where Chapter 4 considers particularly the production of subjectivity of teacher educators while Chapter 5 discusses the subjectivation process of schoolteachers. In addressing this research question, I venture to illustrate throughout the analysis what shaped this experience of teacher education in a CPD programme between teacher educators and science schoolteachers.

The purpose of this chapter is to explore the subjectivity of university teachers throughout a sub-set of the data, namely, the university team's design meetings. Part of my research involved meetings held by the university team and myself before, during, and after the CPD programme. In general terms, these meetings were held around the question of *how the course is going to be?* This implied not just the lesson planning of the course but also the emergence of our positionings and experiences. Why the design meetings? Because considering that we – the university team including myself – were a group of 12 people working together, it was possible to analyse the interactions around one aim which is the development and launch of a CPD programme to schoolteachers. Having this shared practice among that number of people brings to light different voices where our ideas and thoughts open possibilities for different interpretations of our emerging understandings and purposes. This challenged me to consider the complexity of this teaching moment.

Regarding the analysis, these meetings allowed me to use dialogue as a tool to read the interactions within the university team and about the schoolteachers. Throughout the analysis, I could map the different components of what I was focussing on when analysing dialogue, for example, by putting special attention on words uttered by members of the university team. In so doing, some of these components include social markers such as i) institutional context, positioning in relation to an institution and institutional practices, and ii) linguistic markers such as pronouns that constitute identifications between individuals (both present and not present in the sessions); and notions of agreement/antagonism between the university team.

The key moments selected allowed me to develop some interpretations of the subjectivity of the university team and how it is produced in relation to the schoolteachers, themselves, and the institutional context. The question around knowing the schoolteachers beforehand shaped the positionings that the university team had at the beginning of the course and then when the course started, its implementation led to a shift in that position. The above-mentioned is

illustrated with three key moments: one before the course started, one before the fourth session of the course, and one episode from the first focus group, aiming to evaluate the course in the middle of its implementation. That led me to depict our assumptions of what the schoolteachers bring to the course, our 'certainties' of what we (the university team and myself) knew about science education and our attempts to disrupt our own prior knowledge, which was greatly influenced by our institutional positionings.

Before moving onto the chosen key moments alongside the analysis, in what follows, I briefly explain a diagram used as visual representation of the subjectivities and differentiated meanings by the university team and some aspects of the context in which these key moments occurred.

4.1.1 The starting point and its trajectories: a diagram

The drawing – Figure 4.1 – illustrates the analysis of the design meetings around the question about knowing the schoolteachers beforehand, organised in a starting point called "*We don't know them*" and two trajectories emerging from it. One trajectory is called "*We won the Nobel Prize*" and the other one is called "*We don't know everything*". Every one of these phrases 'in vivo' is a quotation from one of the key moments selected to illustrate the movements in the discourse during the design meetings, that is, something that someone from the university team uttered. This diagram – and the equivalent ones that follow – attempts to show the increasing complexity of my analysis, presented as a visual representation of my process of thinking as well as the movement in the discourse of the participants' subjectivity.

Figure 4.1: University teachers' subjectivity. Starting point and trajectories. The black dot symbolises the start of NIPDE.
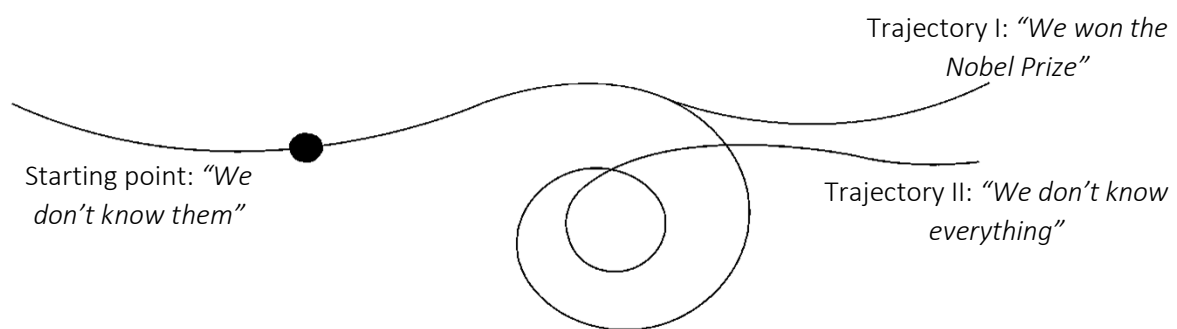
The way figure 4.1 should be read is from left to right. Beginning with the starting point named *"We don't know them"*, noting particularly that it is presented before the course started which is symbolised by the black dot. Then, our attention should follow the first separation of the central line into the trajectory I, titled *"We won the Nobel Prize"*; to, finally, come back to the separation of the central line to follow the sort of snail shape curvature or spiral to the trajectory II named *"We don't know everything"*. This organisation is important because is the way in which the findings are described, meaning that, I have begun discussing the starting point, then trajectory I and, finally, trajectory II. In what follows I will explain in detail what does

it mean each trajectory and the starting point building the diagram presented here in its parts constituting my analysis.

The starting point in Figure 4.1 and the trajectories illustrate how the university team was questioning its role as knowledgeable, while the different meanings of *knowing* in the group are presented in the analysis constituting the key moments. The starting point *"We don't know them"* is organised in two assumptions related to lack of knowledge of who the schoolteachers are and the level of trust on the schoolteacher's knowledge prior to NIPDE. After the course began, symbolised by the black dot in the diagram, the starting point is differentiated in two opposite trajectories. The first trajectory *"We won the Nobel Prize"* illustrates the positioning of the university team as experts with some certainties such as flexibility (designing the course), knowledgeability (regarding scientific inquiry), and horizontality (related to hierarchies in the relationship university teacher-schoolteacher). The second trajectory *"We don't know everything"* illustrates a differentiation from the first trajectory in the opposite direction, away from being omniscient experts. This trajectory is shaped by the attempt of destabilisation of our prior knowledge and an attempt to know who the schoolteachers are. A summary of the organisation of the chapter is presented in Table 4.1.

Table 4.1: Summary of the starting point and its two trajectories originated from quotes from the design meetings within the university team. In each moment, there are assumptions, certainties, and attempts.

Starting point: "We don't know them"	Trajectory I: "We won the Nobel Prize"	Trajectory II: "We don't know everything"
Assumption: lack of knowledge	Certainty: we are flexible	Attempt at destabilisation
Assumption: level of trust	Certainty: we are knowledgeable	Attempt to know the schoolteachers
	Certainty: we are horizontal	

It bears noting that in the starting point and in the first trajectory I am talking about 'assumptions' and 'certainties'. The different use I am attributing to these words is related to the focal point that is referred to. The term 'assumption' is used by the university team to refer to the schoolteachers, whilst the term 'certainty' is used by the university team to refer to themselves.

As part of the context of this study, I will refer to three universities involved in the same project. The first university is Uni1, where I am working and is the one responsible for conducting the CPD (NIPDE version) of interest to my research; Uni2 is another university in the same region of Chile as Uni1; and Uni3 is a university in another region. The relationship amongst these three universities is that in 2017 the Ministry of Education asked Uni1 and Uni3 to conduct a NIPDE version of the course in their respective regions, so Uni1 and Uni3 were designing the same course simultaneously. At that time, there was only one NIPDE version per region, therefore Uni1 received former students of Uni2 in the NIPDE course. Uni1 held a series of meetings to design the NIPDE course. The following paragraphs give an overview of the university team and the meetings involved in this chapter.

The university team was formed by 12 professionals, including myself, from different areas related to science education. The university team has some features which allowed for our organisation 'as a non-unified *We*' with diverse experience. Five of us have a PhD degree and two are PhD candidates; three are not teachers, while 12 have initial training as a teacher; seven of us have a contract with Uni1 while five of us do not and have been hired just to conduct NIPDE (see *3.2.3.1 University teachers: different 'We')*. The design meetings within the university team were held before, during, and after the course. The first meeting was in the middle of June 2017 and the last meeting was at the end of January 2018. The course was implemented between the 11th of November 2017 and 11th of January 2018. A complete overview of the design meetings can be seen in Appendix 5.

In this chapter, the first key moment presented is from the first meeting where the design of the course was discussed. The second key moment is from the first focus group as an instance of assessing the CPD programme to that point, right in the middle of the course. Finally, the third key moment is from a meeting right before the fifth session of the course amongst the people who would oversee the session the next day. A summary of the meetings used in this chapter is presented in Table 4.2.

Table 4.2: Summary of the design meetings as key moments involved in this chapter.

Date	Attendance/ (number of people) roles	Type of record	Short description
22nd September 2017	8: (1) administration team; (1) focus community of learning; (2) focus scientific inquiry; (3) focus of big ideas; (1) focus contextualization to the local territory	Audio record (time: 1.59.48)	First draft of the 11 sessions; products for every session and assessment
1st December 2017	6: (1) focus community of learning; (1) focus scientific inquiry; (2) focus of big ideas; (1) focus contextualization to the local territory; (1) reflection and coaching	Audio record (time: 1.00.03)	Final organisation of session following day
21st December 2017	9: (1) administration team; (3) focus community of learning; (1) focus scientific inquiry; (2) focus of big ideas; (2) focus contextualization to the local territory	Audio record (time: 1.41.55)	First focus group (After the fifth session)

As mentioned in Chapter 3, the key moment are separated into parts alongside the analysis. In every part of the episode, there are phrases or words underlined which are the ones that are particularly relevant for my interpretations. Before and after every part of the episode, the time is shown (see the key transcription conventions in *3.4.1 Data preparation*).

4.2 Analysis
4.2.1 Starting point: *"We don't know them"*
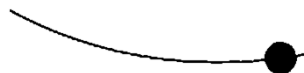
We don't know them is an in vivo quote which reflects the starting point from which the university team addresses the course. The uncertainty of not knowing who the future participants of the course were going to be took the shape of two assumptions: one to do with a lack of knowledge and one to do with the level of trust. The starting point with its two assumptions will be illustrated with an extract from one meeting.

This meeting, which took place 50 days before the actual start date of the course, was the third meeting held within the university team and the first meeting at which an attempt was made to draft the sessions of NIPDE. The meeting was held on the 22nd of September 2017 and eight people from the university team attended. At that time, the university team had little information except for two things about the future participants. First, all the future participants had already been on the NIPD version, and second, half of them would be former students from Uni2 and the other half would be former students at our university Uni1. That composition of former students from both universities in equal numbers was a prerequisite of the Ministry of Education.

In what follows, I present a key episode of 6:86 minutes in total (between minutes 21.10 to 32.12 in the recording) of the third design meeting separated in parts alongside the corresponding analysis. During the extract, the discussion was about the different expectations and knowledge that the schoolteachers would come with. The first assumption of lack of knowledge is presented as follows.

4.2.1.1 Assumption: lack of knowledge

The key episode unfolds a dialogue among Daniel, Amelia, Karen, Alvaro, and me (Paulina) discussing the possibility to make questions to be posed to the schoolteachers beforehand as a pre-test because the future participants were going to be former students from Uni1 and Uni2. Immediately before this key moment, Karen was explaining that the requirement for participation in this course – demanded by the Ministry – is to have support from the holder[41] of the school, providing schoolteachers with conditions to apply the learning from the course. Early in the extract, Daniel vocalised his worries around the expectations of the course that the schoolteachers would bring:

> **21:10**
> **Daniel**: The issue related to <u>teachers' expectations</u> seems critical to me
> **Karen**: [Mmm
> **Daniel**: Once a teacher overcomes the barrier related to <u>institutional support</u>
> **Karen**: [Yes

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[41] In the case of public schools, since the dictatorship the holder is the local government of the district. Currently, that is gradually changing to a Local Service of education separated from the Local government.

Daniel: He somehow sees in it {the course} either an opportunity (.) to be more knowledgeable in inquiry
Karen: [Yes
Daniel: And have more tools to make the community of learning
Karen: [Yes
Daniel: That he has put together thrive, and, and, and where he eventually included colleagues of his school who did not participate in the {previous} NIPD
Karen: [Yes
Daniel: And maintaining that leadership for good, versus the teacher who *as a first timer* (.) sees in this course the opportunity to gain tools
Karen: [Ah, sure
Daniel: To be able to create the community. Then we will be talking *simultaneously*
Karen: [Yes
Daniel: To teachers who have either one or the other expectation (.) I think that information is crucial for both the design
Karen: [Yes
Daniel: And in some way the type of accompaniment (.) the kind of expectation defines the first methodological basis, and it should be extraordinarily (.hhh) adjusted to the contexts of each one
Karen: [Yes
Daniel: Or of each group [that is key
Alvaro: [{to have a} diversity of language to cover the variety of expectations
Amelia: In the same vein, I do not know if an initial pre-test is considered?
22:16

In the extract Daniel seems to be talking about the uncertainty that teachers from Uni2 generate in him regarding their abilities to create a community of learning. In the scenario he is posing, the institutional support is resolved so the concern will be the *"teachers'* *expectations"* and, at some point, also the university team's expectations. The first situation he is raising – about which Karen emphatically agreed – is the expectations regarding the community of learning. It bears noting that a community of learning is a topic that was part of the guidelines provided by the Ministry to every university participating in the programme; in that sense, both Uni1 and Uni2 were asked to develop that topic in the initial version of the course. What Daniel is suggesting as a concern is the assumption that we can find two separated groups in terms of their expectations. One group of schoolteachers who already have the tools to create a community and will be expected to *"have more tools"* versus a group of teachers *"whom as a first timer"* will gain the tools to create a community. The former group is probably the one trained with us Uni1 while the second one is probably the group of teachers who were previously trained by Uni2 for which we do not know either the students or the way in which their training was conducted. That situation brings the unpredictability to the table which should be reduced as a priority according to Daniel. Karen with her repeatedly intervention *"yes"* during Daniel's point of view is gesturing her clear support of what Daniel is saying. It bears noting that Karen is the leader of the project.

The first assumption, that there would be two groups of schoolteachers in terms of their initial level, is one made without any prior knowledge whatsoever about creating a community of learning in their school (probably coming from Uni2) and another group who already have the

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tools and, maybe, an ongoing community with good leadership (probably the alumni of Uni1). According to Daniel, the crucial aspect of creating a community of learning is the tools that the schoolteacher has rather than the institutional support or more importantly the conditions, resources or understandings. For that reason, the adjustment and later the pre-test would be implemented to identify these two contested levels of initial knowledge (having or not having the tools) of creating a community among the teachers without taking into consideration the conditions such as the time to meet that the schoolteachers are required to develop that community.

Daniel, with Karen uttering approval, mentions that it is crucial to know what expectations the future teacher-participant may have, otherwise *"we will be talking simultaneously"* to schoolteachers that are positioned in both scenarios. That emphasised simultaneously creates a sense that having *"either one or the other expectation"* is a problem which we should consider in advance for both the design of the course and the accompaniment to the schoolteachers. That possible problem would be resolved if we design a course that is *"extraordinarily adjusted"* and with *"diversity of language",* according to Alvaro, trying to cover every possible expectation. In that scenario of uncertainties and demands on the university team in the design of the course that the same university team is making to themselves, is no surprise that Amelia asks if there is a *"pre-test considered"* because the message that is being created is that the university team should be prepared for every possible expectation.

Another expectation according to Daniel is "*to be more knowledgeable in inquiry"* which is introduced by me as well in the following part of the episode when answering Amelia's question:

> 22:25
> Paulina: In fact, <u>we had thought about that on different occasions</u>, and in other meetings, we also talk about that, about making a pre-test of these elements, as well as their expectations of asse:mble or their possibilities of creating a community
> Karen: [Yes, yes
> Paulina: Also, about how much they know about scientific inquiry
> Karen: [Yes
> Paulina: And the previous training they had <u>either with us {in Uni1} or with the Uni2</u> becau-
> Amelia: [To <u>level up them later</u>
> Paulina: [The group will be mixed
> Daniel: Sure, because we can oversee the <u>levelling up of the conceptual</u> knowledge that the teachers will bring (.) since we are certain that <u>everyone comes with a different idea</u> {of scientific inquiry} even when they have been with us {in the previous training}
> Karen: Yes
> Daniel: (.hhh) <u>I am sure that students who were with me (.) they did not manage to get rid of their own ideas at all</u>
> Karen: Mmm, yes
> Daniel: (xxxxxx) That is one thing (.hhh) we can deal with, but we cannot deal with levelling up in terms of the operationalisation they visualise {of creating a community}
> Karen: Mmm
> 23:22

In my intervention I said *"we had thought about that on different occasions"* but is not the same 'we' who are gathered in this meeting because I am referring to another meeting when the same topic was discussed, so there was a decision and Amelia was not there. My answer is to her avoiding revisiting that topic, rather making an affirmation without further discussion. After that clarification, I make explicit the assumption of different initial understandings of inquiry related to the original training with Uni1 or Uni2. Amelia then added the idea of *"levelling up later"* in the new training, the one we are designing. If Daniel was certain about the tools that we Uni1 gave in the previous training to the schoolteachers related to creating a community of learning, he is feeling the opposite in terms of schoolteachers' knowledge of scientific inquiry. Even though there is the acknowledgement of the diversity of understandings related to inquiry *"everyone comes with a different idea"*, these conceptualisations are presumably are not the same ones that were worked on in the previous training with us Uni1 because the teacher should have *"get rid of"* of them. Daniel is "*sure that students who were with me, they did not manage to get rid of their own ideas"*. Which is the idea of learning presumed here? On the one hand, it is associated with getting rid of previous knowledge that could be considered misconceptions which, with suitable training, must also be challenged. On the other hand, there is the idea of progression from a lower level to a higher level of understanding, which is posed as "*levelling up the conceptual"*. In that sense, it would be a conceptualisation of proper knowledge that is fixed and identifiable through a pre-test by Uni1 as experts.

Making a diagnostic test or the pre-test to see the starting point of knowledge of a group of students is a practice that is well-known as useful; one problem could be with the assumption that the outcome of that test will be used to 'level up', to jump from one level to another if the starting point is lower. According to this assumption of lack of knowledge, there is one thing that we, the university team, can be sure about and we can deal with, which is the level of scientific inquiry of us as experts in the topic, so the concern is not how we manage the scientific concept even though the teachers can bring misconceptions, the problem is again the schoolteachers having the tools to either create a community of learning or incorporate inquiry in their practice. In that sense, what Daniel said *"but we cannot deal with levelling up in terms of the operationalisation they visualise"* follows the idea of levelling up from a lower level. Amelia continues the conversation by saying that we can enrich the knowledge of the teachers bringing different experiences together. In this part of the key episode the phrase *"we don't know them"*, which gave the name to the starting point, is pointed out:

> 26:22
> **Paulina**: [But I believe that we are going to have this <u>diversity of commitments, expectations</u> and possibilities of assembly
> **Karen**: Yes
> **Amelia**: Maybe that will <u>enrich the experience</u>
> **Daniel**: How?
> **Amelia**: I believe that is going to be enriched, sure, because if a teacher comes with the expectation of saying "I would like to create a community" and sees how others do it
> **Karen**: [Of course, who does it
> **Amelia**: We will level <u>up for the better</u> (.)

Daniel: We are working on some assumptions (.) we can speculate with certainty about our teachers, especially about those <u>we have already had contact with</u>
Karen: [But I think that-
Daniel: In the case of half of them we just know their names, huh?, and their local district, right?
Paulina: Nope, we only know their district, <u>we do not know their names yet</u>
Daniel: (.hhh) <u>We don't know them</u> (.) s:o imagine we ask them "which level of building your community of practice are you at?" {talking as if is the teacher's answer} *say wh:at?*
Amelia: ((laughing))
Daniel: Sure huh, <u>I cannot start the first session and find out there</u>
Paulina: [No:o, indeed we cannot
Daniel: That for <u>half of the schoolteachers it is a surprise</u> that you must build a community, imagine they say that (.) we cann-
Karen: Also, we do not know how the Uni2 <u>gave them to understand</u> {the purpose of building a community} ... I mean from Uni2 <u>we do not know anything</u> (...)
28:47

The initial level of *"diversity of commitments, expectations"* became an important issue. Amelia's intervention is posing the 'enrichment of the experience', assuming either the diversity of the group would enrich the experience of the course or the starting point is a low level. It seems that the latter is Amelia's assumption because she continues saying that in this training the level might go *"up or go for the better"*. The difference between the training from Uni1 and Uni2 became more apparent with the feeling of positivity that Daniel posed as "*we can speculate with certainty*" regarding half of the future students or the ones *"we have already had contact with"*. That speculation which apparently has more conviction than supposition is related to two things: half of the students have the knowledge or maybe an ongoing community of learning while they did not get rid of their misconceptions of scientific inquiry. That is the group which had come for our previous training with us. The other half of the group (former students of Uni2) is a mystery but presumably they, at least, do not have the tools to create a community of learning. It bears noting that the 'enrichment of the knowledge' is also an idea that came up during the course while working through the first session with the topic of the contextualisation to the local territory which I used as an example to illustrate my Subjective Change in Chapter 3 (p. 65). In that sense, this starting point of feeling that the knowledge of the schoolteachers would require some additional input was also shown in the first session with them.

Coming back to the episode, the anonymity of the future students is yet more alarming and brings to the table explicitness of the zero-knowledge community-based assumptions of the former students of Uni2 phrased as *"we don't know them"*. The knowledge of the community of learning (creating one or as a topic) is seen as a surprise, even though the project with the Ministry had the contractual mandatory requirement to create one. That is, in the Ministry guidelines, communities of learning are stated as part of the content of the course as well as stipulating a requirement to create one.

The joke made by Daniel of "*say wh:at?*" revealed this assumption of having students for whom the creation of a community is less than well-developed, and rather is non-existent, which is an invitation to imagine the worst scenario: starting the first session with half of the students

being oblivious of the requirement of creating a community of learning in their schools. Then the fear is inevitable because we "*cannot start the first session and found out there* [that level]", and it is aggravated by the zero-knowledge whatsoever that we have of what Uni2 delivered in terms of training on the matter. The idea of learning that Karen posed could be related to having empty heads which are filled with what "[they] *gave them to understand*".

The assumption of a lack of knowledge of those running the course about the characteristics and knowledge of those taking the course is grounded in the fact that *we don't know the future students*. We can make suppositions of half of them – our alumni – but the other half have probably zero-knowledge about the community of learning and we also do not know how Uni2 made the training which brings more uncertainty. That assumption is creating a scenario where the first session of the course is alarming which means that it feels demanding for the university team to be prepared to do something that is becoming the 'worst' scenario. The following assumption of the level of trust is built on the level of knowledge that the schoolteachers will bring to the course.

4.2.1.2 Assumption: level of trust

In the following part of the key moment, a tension will be between Uni1 and Uni3, the latter being the university in another region that is designing the CPD (NIPDE version) at the same time. For the requirements of the Ministry, we should work together designing the course and as a result have a shared document of how to conduct the NIPDE version to later contribute to the transferability of the course to other universities participating in the project nationally.

> 29:54
> **Daniel**: But, going back to the conceptual issue, regarding the wording of this joint document with Uni3 (.) I actually agree that with that team – I know several of them – we agree in several points (.hhh) but I think the disagreement is <u>not related to understanding what scientific inquiry</u> means or what its levels are (.) I think it has to do with the <u>level of trust placed in the teachers</u> {regarding schoolteachers' knowledge in scientific inquiry}
> **Karen**: [Ahhhh
> **Daniel:** I mean, <u>in conversations while we have worked together on projects</u>, I have noticed something, I do not want to say *pessimism*, but they believe that an essential starting point is that the teacher (.hhh) is well trained in generating inquiry that he has never done (.) at first, surely is going to be structured inquiry and <u>may:be</u> just maybe in some cases for the *chosen one* (.hhh) they could have the chance to do a somehow more open inquiry (.) so I was thinking about how <u>we get to be respectful and at the same time coherent</u> with our convictions regarding the example you gave of this teacher {referring to the story that Karen told about one of our alumni who wanted to make a science fair} he will most likely be putting together a <u>science fair where the children are doing limited or confirmation inquiry</u>
> **Karen**: [<u>At best</u> ((laughing))
> **Daniel**: And, of course, he is <u>extraordinarily proud</u> of what he has generated
> **Karen**: [Mmm
> **Daniel**: Then we say to him "brilliant, but that is not the inquiry that we want you to achieve" ((laughs)) it is most likely that if <u>we spoke frankly</u> with that alumnus (.) he will decide that NIPD is not for him, huh?
> **Karen**: And he changes <u>his interest to arts</u>

Daniel: What he has achieved is not being valued

Paulina: [And <u>he becomes demoralised</u>

Daniel: Because there are <u>gaps and gaps</u> and we have talked about it many times. There is a gap with respect to the teacher who did not even know that it {science} could be taught otherwise; the teacher that has just started teaching science; and the teacher who had already done many things, that has gone through <u>a catharsis of failure</u> when realising that his practice itself did not make any difference {in the teaching of science} therefore, we gave him an answer that meant something totally different to him in comparison to a teacher who had not undergone that experience

32:12

The suspicion that Daniel had of Uni3 is not in terms of expertise in scientific inquiry but in the level of trust that Uni3 put in the teachers. The issue with trust becomes circular, that is, Daniel is mistrustful of the level of trust that Uni3 placed in its teachers whilst, as afore-mentioned, the starting point is our/Uni1's assumption of lack of knowledge of the schoolteachers.

According to what is said by Daniel the trust sounds as if Uni3 is thinking that the schoolteachers can make an open scientific inquiry even though it is the first time they are doing it. However, that is seen as *"pessimism"*. Daniel presented the pessimism along with a stretched *"maybe"* and the irony of the *"chosen one"* which make the pessimism sound more the actual thing he wanted to say about Uni3 even though it is not. To give more credibility to that affirmation of Uni3 he said that *"in conversations, while we have worked together on projects"*. Regarding scientific inquiry, it appears the traditional – more simplistic – understanding of scientific inquiry is conceptualised as existing on levels from the lowest as limited or non-inquiry to the highest as open inquiry, with structured and guided inquiry in the middle. However, the levels of scientific inquiry rather seem contradictory because, according to Daniel, Uni3 is promoting starting with open inquiry avoiding the progressive 'jump' between levels which could be related to having higher expectations. Whilst, apparently, our proposal is to know in advance which level the schoolteachers bring – therefore the pre-test – and then decide the specific lesson plan to make them 'jump' from one level to another. In that sense, being respectful and coherent is important, which seems that this is something that Uni3 is not. What Daniel expressed as *"get to be respectful and at the same time coherent"* is showing the impossibility of our positioning: on one hand, we should be validating the experience of the schoolteachers teaching with inquiry; however, at the same time we have the assumption that they are lacking knowledge regarding inquiry.

The level of trust and the pessimism seems to be referred to us Uni1 especially when the example that Karen gave came up – a former student who is preparing a science fair focused on inquiry with the students – where Daniel pointed out that he will "*most likely be putting together a fair where the children are doing limited or confirmation inquiry*" so our level of trust is again thinking that the teacher will start from an inquiry that is in the lowest level *"at best"*. Going further, if we are honest with this teacher, we can dismantle his idea and he will drop his practice with inquiry, change to arts and become demoralised. Dropping inquiry, changing to arts, and being demoralised, along with the idea of the teacher being *"extraordinarily proud"* of what he has done, is at the very least condescending of the agency of the teacher as well of his knowledge of scientific inquiry. In this communication between Daniel, Karen and I, the

relationship that is established regarding the level of trust is not just with our former student, but also there is an implicit mistrust of what the initial version of the course achieved. The three of us agreed that there is no trust in either the schoolteacher doing the science fair or in our own previous work with this teacher.

Daniel closes his intervention talking about the presence of "*gaps and gaps*" and about the "*catharsis of failure*" that schoolteachers can experience in the training when they might see their conceptualisation and practice of inquiry dismantled. This brings us back to the issue about the level of trust, where we are certain that the teacher will be at the lowest level; in that sense, it is our confidence in their knowledge that is at the lowest level.

Mistrust, reservation, scepticism, speculation, and level of trust are the kind of issues that are at play given the uncertainty of not knowing the future students. We have ventured to speculate about half of the students whom we knew previously but also about half of the students whom we did not yet know, probably because of the low perception of the prestige that we had regarding other universities. In this scenario, the activity with the pre-test seems to function more as a control measure seeking security given the uncertainty, which also resonates with having very controlled outcomes and structured sessions in the CPD course. In this sense, not knowing the future schoolteacher participants, plus thinking that they were going to bring the lowest 'level' of understanding, made a more fragile initial relationship between the participants as a starting point which is filled with rules and structured procedures.

After the start of the course, the design meetings showed what I came to identify as trajectories. The following key moment is shaping the first trajectory *"We won the Nobel Prize"* as follows.

4.2.2 Trajectory I: "We won the Nobel Prize"

We won the Nobel Prize is an in vivo quote which reflects the first differentiated trajectory once NIPDE started. The ongoing process with the schoolteachers during the course took the shape of three certainties: flexibility; knowledgeability; and horizontality. The first trajectory with its three certainties will be illustrated with an extract from one meeting.

This meeting (first focus group) took place right in the middle of the course after the fifth session. The meeting carried out on 21st December 2017 was attended by nine people from the university team. As in other cases, my role was to run the meeting, so at the very beginning I posed the aim, which was: "*to talk about how the five sessions of the course have been so far, how we saw the schoolteachers' and our own role, and what is happening in the rest of the course in January*".

In what follows, I present a key episode of 8:78 minutes in total (between 3:01 and 21:56) of the meeting, separated into parts along with the analysis. The first certainty of flexibility is presented as follows.

4.2.2.1 Certainty: we are flexible

My initial question of, 'how has the course been so far?' was answered by Karen – the person in charge of the project – saying *"but Paulina, maybe you can start with an overview because you have been there, I don't know if anyone has been in every session the same as you"* then my answer was related to the number of activities we planned for every session. This first utterance is between Karen and me:

> 3:01
> **Paulina:** Maybe we were too ambitious (.) I think we planned more activities considering the timeframe we had in the session (.) sometimes we did not take into account the time that the schoolteachers would spend to do the activities (.) that happened a lo:t
> **Karen:** [Mmm
> **Paulina:** That brought frustration for the schoolteachers (.) frustration related to not understanding the task whilst we asked them to try to do it anyway (.) at the same time I think we were clever reacting and saying "this activity is left-out or this other one will have more time"
> **Karen:** I don't know how many sessions I went (.) maybe two (.) but what I can see is how the thing {talking about the course} has been working in terms of what is more interesting for us (.) regardless what is happening with the schoolteachers because this thing should be transferred to other universities (.) so the gained insight for the programme concerning the transferability is the flexibility (.) to have enough flexibility to be able to redesign the sessions considering what is happening with the schoolteachers (.) that is a success
> **Paulina:** Yes
> **Karen:** The other thing that I think is a success is that we have been working as a group (.) we are a large group of people at the same time in the session (.) and there is not the question of authorship but instead we {university teachers} are articulated, and there is continuity in our work regardless of who is the in the lesson
> 5:24

With the first utterance, Karen puts me in a position of credibility in her eyes because according to her knowledge I was in every session of the course so far; in that sense, my opinion would be more valid because I could *know* the process better. It bears noting that I have been working with Karen since 2008 so this boss-employee relationship was established long ago. With that responsibility on my shoulders and also because I was conducting the meeting, I answered considering the aspects that I was thinking we could improve addressing my own aim of the gathering. The design of the course was to a great extent my responsibility or at least I assumed that position considering that the CPD programme was part of my PhD research and I was full-time dedicated to the course. In that sense, my initial *"Maybe we were too ambitious"* is showing a shy position and then a criticism to myself. To which Karen interrupts with a *"Mmm"* as a doubtful agreement. The problem I am posing is in relation to the time and the activities that needed to be done in that time. The time of the sessions were on Saturdays from 10 am to 5 pm during the final term of the year in the Chilean school calendar. Time will also become

relevant when looking for explanations for the attendance at the CPD sessions, which I will explain in trajectory II.

The other aspect I brought up is the frustration that the schoolteachers, according to my viewpoint, felt. That frustration was in relation to the time needed both to understand and to complete the task. The feeling of frustration appeared in the fifth session[42]. The schoolteachers named their feeling as it is, as I was part of that session in addition to the fact that Karen had placed in me the credibility of having the best knowledge of the process so far; I showed some confidence in talking on behalf of the schoolteachers. During every session of the CPD course the university team was represented by at least six people (Dora, Javier, and I were in every session) so when I am referring to *"we were clever reacting"* I am again positioning myself as a spokesperson. Besides, I pointed out that the ambition and the cleverness are characteristics of the university teachers while frustration is a characteristic of the schoolteachers.

Karen again brought to attention the attendance in the sessions of the CPD saying *"I don't know how many sessions I went"*, showing uncertainty to the specific number, yet she went on with her evaluation of the course. In her utterance, Karen refers to what is interesting for the university teachers *"regardless what is happening with the schoolteachers"* which can be useful to the transferability of the course attending to the demand of the Ministry of Education. This answer is showing an element that distinguishes this CPD course from the traditional ones as an *"insight"* which can help to transfer the course to other universities. She realised that an important point is our flexibility to change the sessions and acknowledge what is happening to the teachers and us during the implementation time. My question was related to the process lived and the following time in terms of improvement; nonetheless, Karen's answer was trying to find our distinctive elements that could be helpful to other universities, so the focus of the question is shifted, indicating our contrasting positions. In this sense, I – in my view as responsible for the implementation – was showing my worries about the improvement whilst Karen – the person in charge of the project in the sight of the Ministry – was manifesting her worries regarding how the course would be transferred to the partner universities. Therefore, I was answering to my boss, namely, Karen, and she was answering to her boss, namely, the Ministry.

In Karen's words an interesting aspect for the university team – and for the Ministry – is our flexibility expressed as the ability to redesign the sessions considering what is happening with the schoolteachers. However, in her utterance what is happening with the teachers is not important or became less important in comparison to the process of the university team. In that vein, the flexibility is phrased as a paradox; whilst the process of learning is regardless of the schoolteachers, the university team's process of learning in the course is because of what is happening with the schoolteachers.

Twice in this utterance, Karen was referring to the course as *"the thing"* which could be related to where Karen has her attention regarding the development of the programme. The two

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[42] The feeling of frustration experienced by the schoolteachers and how that affects the university team, and the design of the course, will be developed in more detail in the following trajectory "*We don't know everything*".

aspects of the course that she posed as successful are in relation to the university team, not the schoolteachers; therefore, her answer is again in the arena of her colleagues at the university. In this point she refers to the other successful aspect of the course, that is, *"working as a group"*. In her words, inside the university team, there is not a question of individual authorship but instead, the group is working as an entity in which it does not matter who is there, the message will be the same. In this sense, the flexibility of the university team seems to bring to the group some plasticity that allows working as an entity despite its elements because the result is articulated and continuous. It bears asking the question: can an entity work regardless of the elements that gave shape to it? The functioning or the properties that emerge from the entity are going to be strongly associated with the elements and the interactions between those elements, therefore, what Karen is saying could be a process of homogenisation or replication of the elements forming the group (in this case, the members of the university team) rather than a system which works *regarding* what is forming it.

In the whole utterance, Karen and I were answering the same question putting our attention in different focal points; I was talking about problems assuming both the responsibility for the implementation and as the spokesperson of the schoolteachers and Karen was introducing the idea of flexibility regardless of both the schoolteachers and the university teachers yet posing herself from the perspective of the university teachers. Following this utterance, Alvaro kept talking about the flexibility and, specifically, he contested what I had said about the ambition:

> 6:10
> **Alvaro:** Ambition that gave orientation of what we wanted to achieve (.) <u>for me as a {university} teacher</u> that orientation shows me the plan and maybe that could be seen as too ambitious, but I don't think that ambition is negative (.) because we are moving to reach a goal (.) we have a plan I prefer <u>ambitious rather than not ambitious at all</u> (.)
> **Paulina:** [But (.) yeah, I agree-
> **Alvaro:** I see a goal that moves you, but <u>it moves you to reach that goal</u> and not because you are giving up or just because the activity must be done as it is (.)
> **Paulina:** [<u>Mmm, yes</u>
> **Alvaro:** Because – I watched some activities – our flexibility *demands* them {schoolteachers} to do the activity but also, we give them time to do it, that is,
> **Karen:** [<u>Sure, exactly</u>
> **Alvaro:** We could give up or ask them for doing it anyway (.) then that flexibility-
> **Paulina**: [It would have made no sense to do it anyway because we would have lost them (.) I also don't see the ambitiousness as negative (.) what I am saying is <u>we planned too much</u> (.) suddenly there was too much to do and all of us were <u>overwhelmed</u> {referring to school and university teachers} (.) at that moment we also had the <u>wisdom</u>, so to speak, to say "we leave this for the next session or we continue"
> **Karen**: [Mmm
> 7:12

Alvaro disagrees with my position of criticising the use of the time in terms of lesson planning. He was posing the ambition as something that is necessary; in fact, he prefers *"ambitious rather than not ambitious at all"*. He gave more weight to his position by saying *"for me as a teacher"* at the university which is directed specifically to me because I am not a teacher, so he is highlighting that fact to show the validity of what he is saying. What does it mean,

'ambitious' to both of us? It seems that in this case is also a matter of the focal point. The way I talked about ambitiousness is in relation to the time to both understand and make an activity in the session with the schoolteachers; Alvaro, in contrast, is considering ambition as having a plan, a path to follow as the person who is conducting the course. Therefore, I am talking from the perspective of the schoolteachers and Alvaro is talking from the perspective of the university teachers. Alvaro also adds that ambitiousness is a matter of perseverance, of moving regardless of the conditions to which I seem to agree doubtfully. As I said before, my position seems to be related to being the person responsible for the implementation of the course, so when Alvaro is saying the goal that we are pursuing with the course is invoking my position as the one who surely knows the purpose of the course, for that reason, my *"Mmm, yes"* is with doubt, because I should show that I am certain of our goal.

Then, when Alvaro is adding more features to the flexibility and he poses the flexibility as *"demands"* to the schoolteachers, I took the floor to make clear that I also do not think that ambition is bad; however, I am supposedly thinking as the schoolteachers with my position. It bears noting that Alvaro (a history and geography teacher) arrived at the programme just for this course which has incorporated the local territory element as a key content, while I have been working since its beginning in 2015; hence, we are measuring ourselves in front of Karen who is the leader of the programme. In that sense, when Karen emphatically agrees with Alvaro – *"sure, exactly"* – and doubtfully agrees with me – *"Mmm"* she is taking the stance I was explaining in the previous extract, where they are positioning themselves from the perspective of the university teachers and I am positioning myself from the perspective of the schoolteachers. What 'demands' this so-called flexibility? It seems that this understanding of flexibility is demanding that the schoolteachers do an activity and at the same time the university teachers take some decisions regarding asking participants to do the activity, anyways, changing the timing or giving up. Considering what Karen said previously and what Alvaro is saying here, the flexibility is the ability to redesign the sessions considering what is happening with the schoolteachers and demanding in the moment of the session that action be taken – by schoolteachers and university teachers – regarding what to do if the activity is taking more time than was planned. When I realised that the position of Alvaro is contesting mine, I tried not to put us in a position of antagonism; rather, I explain again that even though we have the same purpose of the course, sometimes *"we planned too much"*. Then, similarly to Alvaro when says that he is a teacher, I brought my 100% attendance 'card', observing that during the sessions there was this feeling of participants being overwhelmed but also having the wisdom to take the proper action at that time. In a way, I am closing the argument, alluding to the credibility given by my attendance at all the sessions.

The discussion is in fact shifted right after my intervention because Carlos picks up what Karen was saying about the transferability of the course. This change of the topic gives the space to another certainty, which is related to the knowledgeability of the university team. In this part of the extract, you are going to see the quote which gave the name to the trajectory, namely, *"We won the Nobel Prize"*.

4.2.2.2 Certainty: we are knowledgeable

The following utterance is between Carlos, Karen, Dora, and Alvaro, talking about what should be transferred to our colleague universities. Carlos made a comparison with the helical model of the solar system after which a possible name for the CPD course appeared:

> **7:13**
> **Carlos**: Going back to what Karen points out about the transferability of the course (.)
> **Karen**: [Mmm
> **Carlos**: From the design perspective of the model, I think that what we are experiencing is not described anywhere and from there we ((pointing at me)) we could contribute
> **Karen**: [Write a paper?
> **Carlos**: Make a paper of it or the thesis {referring to my research} would contribute with a grain of sand because there is nothing written about that (.) about helical formative models, yes?
> **Dora**: [What is that?
> **Carlos**: Nowadays when you design a model it is established in a single plane (.) in a single level, yes? Many of them are circular or linear (.) the he:li:cal model implies that whilst you are turning, these actors are moving towards a goal.
> **Karen**: [Mmm
> **Carlos**: Each of the actors is moving by a dynamic that is regardless of one another so everyone can carry different dynamics and trajectories
> **Alvaro**: The circle can be wider
> **Carlos**: Wider, faster, more helical, shorter, more elongated (.) and then every one of these individuals carries within the model a trajectory and a progression that is specific to each of them (.) if that it is possible to describe (.hhh)
> **Karen**: We {the university teachers} won the didactics Nobel Prize
> **Everyone**: Yes!
> **Karen**: The Chilean helical formative model ((laughing))
> **Dora**: But who is defining this helix-shaped?
> **Alvaro**: The adequacy is done by us
> **Karen**: Which was defined in the beginning
> **Dora**: I think that it is also defined by the schoolteachers' rhythm, I believe that the teachers are incorporated within these helices (.) they are incorporated into all of this
> **8:55**

Publishing the work, modelling, and proposing theories are important tasks in the academic world. The university is constantly asking for that kind of product from their staff. Half of the group has a full contract with the university, so they are accustomed to thinking in those terms. In this case Carlos, Karen, and Alvaro have full contracts with the university hosting the programme, so when Carlos brings back the transferability of the course to the other universities, he sees in this an opportunity of contributing to the current knowledge of professional development within the insight of flexibility that is being defined in this meeting. Similarly to Karen and Alvaro, Carlos is positioned from the perspective of the people who oversee developing CPD programmes and he goes beyond that saying *"what we are experiencing is not described anywhere"*; hence, he is also positioning himself as an expert in the literature on professional development. That blind spot that Carlos is pointing out called the attention of Karen with the form that is more common in the academic world which is,

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"write a paper". Carlos, Karen, and Alvaro every four years should go through a process of 'hierarchisation' inside the university to progress in their careers also meaning a higher salary. That means to demonstrate that they are 'good' researchers (with projects, both public- and private-funded, publications, awards, and so on) and teachers in their speciality. That kind of pressure, even though they can enjoy and chose this path, shapes the way they approach a project. In this case, this kind of requirement of the academic world also shaped the way that Carlos sees my research. In his suggestion is either 'write a paper' or my research could be 'about this process', which is called by him a Helical Formative Model.

When Carlos is referring to my research, he is putting me in a position of student, which I am; however, in this context I was positioned as his colleague where we are creating this course together without any of us taking a role of teacher or student. That kind of relation can be associated with an imbalanced power relationship that is hidden but can be brought out, such as when Carlos points at me and talks about my research.

Right after the naming by Carlos of the process as a Helical Formative Model, Dora asks *"what is that?"*, so Carlos starts to explain the model he has just created as if it was something that he read in the literature on CPD, almost like he is delivering a lecture about the model. One of the characteristics he gave is that the actors' part of the model is moving *"towards a goal"*; with that affirmation he is taking back what Alvaro was pointing out about the ambition and the flexibility which is the presence of that aim that is invariable despite the changes that the process could undergo. Another feature of this model is that the dynamic is "*regardless of one another*" which brings back what Karen was suggesting about the group working as an entity that could function despite the people in the sessions because the goal is clear and unchangeable. Then the model had more characteristics in terms of the shape of the helix after which the name of the trajectory is mentioned. Karen points out that if the model is described, that could result in the university team winning the highest recognition in terms of the contribution that could be made to the knowledge. *"Won the didactics Nobel Prize"* implies that the contribution will belong to the arena of didactics, bringing back what Carlos was saying about the gap in the literature on CPD programmes from the perspective of the people who oversee professional development training processes.

Considering the hidden presence of the schoolteachers, Dora, asks *"who is defining this helix-shaped?"*. She answers her own question by saying that the importance of the schoolteachers as well in defining the shape of the model cannot be forgotten. Why is she pointing this out? When Carlos is explaining the model, he is talking about people or actors, he is not saying university teachers; however, Dora (she is the only one of the group who is working at the school as a primary teacher) felt the urge to make explicit the role of the schoolteachers in all of this. This part of the quote is what was earlier mentioned in relation to Carlos, Karen, and Alvaro talking from the perspective of the university team or, more precisely, from the position of the ones who oversee developing CPD programmes regardless of the ones who are 'receiving' the training, namely, the schoolteachers. Could it be that this position is related to the fact that neither of them had 100% attendance on the course, so when the conversation is situated within what is happening to the NIPDE in particular, they cannot talk with full credibility from that position? And they choose to talk about the generalities of CPD

programmes. In the same sense, it seems easier to see the practice as a success in terms of the articulation of the team and the flexibility, a brand-new model of professional development and the clearness of the goal that the team is pursuing.

Carlos continues explaining the way that the model works with a drawing that he made at that moment. After his explanation I asked *"did we think that strategy in advance? Or it is becoming like that? Do we o:pen our minds? Or did we have this flexibility previously?"* which is answered by Alvaro as follows:

> 16:45
> **Alvaro:** I feel that it has to do with <u>sharing some assumptions</u> such as to value the schoolteachers' experience, their daily life, their personal qualities (.) because *all of us know* that the usual treatment towards the schoolteachers is <u>"you know nothing, you should know what I say"</u>
> **Karen:** Indeed! <u>I am the expert, you the novice</u>
> **Alvaro:** Or the <u>demand to follow the steps like a recipe</u> {talking about scientific inquiry} (.) I think we have <u>transcended that image</u>
> **Karen:** Which I think is the way Uni2 <u>has been training the schoolteachers</u>
> **Paulina:** <u>But</u> then I have been thinking about this and <u>I have talked to my supervisor</u> because we know - from <u>the things we read</u> - that you must consider the teachers 'experience {referring to CPD programmes} that it should be a more <u>collaborative</u> space, the <u>Spanish literature</u> is in that logic too. But I had not seen it <u>embodied</u>, so here comes my question of why or how we have made this <u>ali:ve</u>? because <u>teachers are bringing up their experience</u>
> **Carlos**: That is <u>incorporated in that model</u> and is <u>innate</u> in us (.) I believe that from a <u>Vygotskian</u> perspective we share the <u>language</u> of a community that has already <u>been working</u> in some way, we had our <u>own common language</u>
> **Karen**: Also <u>doing</u>
> **Dora**: And the <u>time</u>
> **Carlos**: Yes, mostly related to doing things together (.) We are coherent in thoughts and actions (.) Ask your tutor to what extent you can use the theory of <u>learning communities</u>
> 18:50

My questioning of whether we were flexible beforehand or became flexible in a way associated to Carlos' model during the course shifted the conversation to discuss which of the characteristics of the university team allowed for developing the course in the way that it was. Alvaro said that the team is *"sharing some assumptions"* about the right treatment that the schoolteachers should have in a CPD in contrast to what is commonly the case in CPD trainings. What is interesting about this quote is related to what I was describing as the starting point before the beginning of this course with both assumptions of lack of knowledge and level of trust (page 86 and 90 respectively). Under the uncertainty of who the schoolteachers would be, the reaction was trying to have some security by conducting pre-tests of initial knowledge and doubts of the role that other colleagues played in the previous training of the future participants among others fears. In that sense, what Alvaro is describing is more the initial positioning of the university team three months earlier (the previous extract is from September 2017 whilst the meeting in this section was held in December 2017). Perhaps the treatment was not as explicitly condemnatory as *"you know nothing, you should know what I say"*, *"demand to follow the steps like a recipe"* and *"I am the expert, you the novice"*; however, there were some assumptions about being insecure of the base knowledge of the schoolteachers

regarding scientific inquiry, assuming that, for example, the alumni who tried to make a science fair in his school was obviously showing structured or limited inquiry, and, even though the previous NIPD included the topic of creating a community of learning in both universities Uni1 and Uni2, there was no trust whatsoever that some schoolteachers would have tools to create one.

So, one option is indeed that Alvaro is describing the attitude of the university team three months ago; another is that what is said and what is done are not coherent. In that sense, the experience of the schoolteachers teaching with scientific inquiry is valued but at the same time is considered the 'lowest' level of inquiry, so he/she needs to jump to a more advanced level. Either way, Alvaro closed his argument saying that *"we (university team) have transcended"* the usual image that the schoolteachers have, which is added as a new characteristic to the pool that I already described, namely, the university team is a group that is flexible, knowledgeable (contributing the knowledge, winning the Nobel Prize), and now transcending the traditional image of the schoolteachers in CPD programmes. Regarding this last point, Karen places another layer upon that transcendence, making a distinction of what she is assuming, namely that the Uni2 – our colleagues who are participating in the programme in the same region – *"has been training the schoolteachers"* in a relation to their understanding of scientific inquiry as a recipe. In that sense Uni2 has not transcended the traditional image and, therefore, Uni2 does not share the same assumptions as Uni1/us.

From the beginning of this part of the meeting, my utterances are critical of the position of Alvaro, Carlos, and Karen. I can see that from the way the initial question is phrased as *"do we open our mind?"* where the word 'open' is stretched, showing some kind of irony. Irony because, apparently, I am looking for a specific answer which is not the one that Alvaro and Karen are giving; therefore, after Karen's intervention, my intervention starts with a *"but"* and following that opposition I am looking for a figure of authority by referring to two things, namely my supervisor – *"I have talked to my supervisor"* – and the literature – *"the things we read"* and the *"Spanish literature"* – trying to give more credibility to my intervention. Why credibility? In this whole key moment, the academic world has been illustrated as embodying the urgency to publish, the act of naming a process, or the calling to fill the gap in the existent literature, so when I referred to my supervisor and the readings, I am positioning myself inside this academic world doing a PhD and as an expert in publishing-related knowledge where my initial question *"did we think that strategy in advance? Or it is becoming like that?* has not been answered.

I am also making assertions here such as the *"teachers are bringing up their experience"* and the collaboration in CPD programmes is core and embodied in this course. These affirmations are not questioning the success of the course – which were referred to among the certainties as flexibility and knowledgeability – apparently, I am agreeing with that; what I am questioning is our ability to learn from this experience. According to Carlos, we (the university team) always knew how to bring this process to life. He says that the way we are working is *"incorporated in the model"* – a model named minutes ago – and is *"innate"*; therefore, we are not learning something new because it is the way we act. As a response to my way of giving more credibility by bringing up literature, Carlos does the same, referring to a Vygotskian perspective of

language and community of learning. In biological terms a behaviour could be innate or learned; it is *innate* when it is independent of the history of interactions of the organism, that is, it is genetically determined. When the behaviour is the result of a particular history of interactions between organisms it will be called *learned*. When Carlos is talking about the common language, working together in some way, Karen adds doing things together and Dora incorporates the time; it sounds as if they are talking about a *learnt behaviour* rather than one that is innate. That learning could explain what Carlos refers to be *"coherent in thoughts and actions"* because we have been working together on the same project, at least since 2015. Carlos closed this part of the episode, again making a reference to my thesis, also because I talked about my supervisor's support, as the same as when he said that the thesis could describe the model which can win the Nobel Prize. As mentioned above, my position shows some antagonism to what Karen, Alvaro, and Carlos are saying; then, when Carlos refers to my tutors and my thesis, he puts me again in the position of student, shifting our roles from colleagues to teacher-student.

To extend this argument of how the group is defining/positioning them/ourselves, the following extract offers another illustration.

4.2.2.3 Certainty: we are horizontal

After discussing the features of the model and the process lived so far in the course, Alvaro posed the relationship between the National Curriculum and CPD programmes in general. In the following utterance Alvaro, Carlos, Dora, and Karen commented in that regard:

> 19:50
> **Alvaro**: But look, not <u>officially</u> but <u>every one of us has his own curriculum</u> and when you have -I believe all these teachers have gone through all these cycles- through all these <u>CPD courses, through achievements and disappointments too</u>, at the end you do your own curriculum with your orientation the purposes that you want to achieve (.) so deep down, there's like a (.) I understand it as the most concrete <u>expression of milestones, options, techniques, purposes, experience</u>
> **Carlos**: But <u>there is a decision</u> making that is not made by you as a schoolteacher
> **Alvaro**: Yes, however, it is what is part of the experience of making your own curriculum (.) in the sense that it has your own decisions that are <u>conscious, autonomous, and reflected</u>, right?
> **Dora**: I think here, the issue with the curriculum (.) <u>is showed to the teachers like having everything we need to teach</u> (.) is made like that (.hhh) but here {talking about this CPD course} I think the difference is that the teachers <u>have felt part of the university team</u> (.) it is so <u>vertical the way we work</u> in the sense of being able to create (.)
> **Karen**: [<u>Too horizontal you mean</u>
> **Dora**: <u>That is forgive me</u> (.) *horizontal* because they are creating their own indicators and ideas of science unlikely other CPD courses because I don't know (.) you can go to too many trainings but usually there is not this option of teachers suggesting ideas that are considered <u>by those who are guiding me</u> (.) that is new (.) we are working with the teachers' self-esteem when they <u>dare to say many things</u>
> 21:56

Alvaro is bringing up an interesting situation regarding the curriculum. There is one official intended National Curriculum in Chile; every teacher should use that guideline to teach their

subject. What Alvaro is introducing is the 'hidden' fact that despite the official National Curriculum, schoolteachers have their own curriculum. Not just despite the National Curriculum but also despite the CPD courses the schoolteachers go through, it will be more important how teachers use those guidelines in their teaching. In that sense, there is a difference between the sense of ownership of the curriculum versus a curriculum that could be imposed on them. In Chile, the curriculum is presented as a suggestion and the schoolteachers should take it and make it their own in the same vein as what Alvaro is proposing, a curriculum which reflects the *"expression of milestones, options, techniques, purposes, experience"* of every teacher. However, as Carlos pointed out, even though the curriculum is a suggestion, the decision of what to teach is not made by schoolteachers and that is reflected in the low sense of ownership that the teachers in Chile have regarding the curriculum. Alvaro agrees with Carlos. Decisions are made by others but, as part of the experience, the teachers can take that and make their own orientation of what to teach in a way that is *"conscious, autonomous, and reflected"*. this dialogue between Alvaro and Carlos is related to a discussion of the awareness and autonomy that the schoolteachers could have regarding their decisions on what to teach and with what purpose. In doing so, Alvaro introduced the CPD training as a trigger of "*achievements and disappointments*" to the schoolteachers which could shape that intended curriculum. In that regard, Dora intervened saying that the curriculum *"is showed to the teachers like having everything we need to teach"*; the 'we' she is referring to is not the 'we' of the university team, rather it is the 'we' of her as a schoolteacher, her, and her schoolteacher colleagues. She is bringing her experience in the school, saying that the curriculum is made to contain everything, so as a teacher you do not need other elements to define your teaching. In that sense, she is criticising the way the curriculum is read by the people who made it and by the schoolteachers. Then she pointed out that in this CPD course schoolteachers *"felt part of the university team"*, almost saying that in this CPD teachers are treated differently as if they are part of the academic world – "*being able to create*" the knowledge – in contradistinction to the way the intended curriculum treats them where the knowledge is decided by others.

It bears noting that Dora was the teacher from the school whom I was also following in phase one of the fieldwork. From her position as a schoolteacher, regarding Carlos' helical model she asked for the role of the schoolteachers in shaping the helix. She works full time in a school and her role in the NIPDE was in the dimension of reflection; she was asked in that role because of her experience working in a school for 34 years. In this sense, she is a reliable spokesperson for the experience of being schoolteacher.

In her explanation of why this CPD represented different treatment towards schoolteachers, Dora had a slip of the tongue saying that *"it is so vertical the way we work"* in this case 'we' being the university team. As a knee-jerk reaction Karen, who is the leader of the programme, corrected her by saying *"too horizontal you mean"* to which Dora, after asking for forgiveness, kept explaining. She corrected herself; however, the following explanation of the horizontal relationship still sounds as different groups playing inside the course: those who are guiding and those who are being guided and 'dare' to say things. What is telling about the lapsus linguae? On one hand, the discussion was about the curriculum and the possibilities the schoolteachers had to create their own curriculum considering their intentions and decisions,

so when Dora said *"vertical"* this could be reflecting the sense of imposition that the intended curriculum has towards the schoolteachers. On the other hand, she is talking about the schoolteachers feeling part of the university team because of the way we work; in that sense, the *"vertical"* is reflecting the hierarchical relationship inside the university team and the relationship between the university team and the schoolteachers, the hierarchical relationship that is also shown by the correction that Karen made to Dora.

One of the main topics during the meeting was the sense of 'horizontality' in the way that the university team is treating the schoolteachers; the term horizontal was mentioned 17 times whereas vertical was mentioned only twice. In this case, horizontality is used to mean equality in a relationship regarding the relationship with the teachers from the school during the sessions but also within the university team during our planning time. In opposition, 'verticality' is used to indicate some sort of a hierarchy. In that sense, whilst the horizontal relationship was the desire, the vertical relationship was the taboo in the CPD course.

The slip of the tongue of Dora is also confirming the idealised way that Alvaro is seeing the possibilities that teachers have to develop their own curriculum in Chile. The position of Alvaro is abstracted from the schoolteachers' practice, making it vertical and the position of Dora is embedded in the schoolteachers practice, making it horizontal.

The opposite case is presented with the following trajectory II with the accordingly key moments where the people gathered are mostly without a contract in the university hosting the project.

4.2.3 Trajectory II: "We don't know everything"

"We don't know everything"
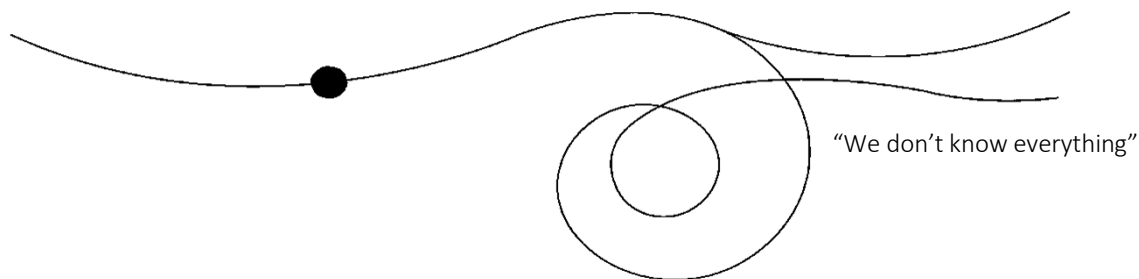
We don't know everything is an in vivo quote which reflects the second differentiated trajectory once the NIPDE started. In opposition to the above-mentioned trajectory, the ongoing process with the schoolteachers during the course took the shape of two attempts: destabilisation and getting to know the schoolteachers. This second trajectory with its two attempts will be illustrated with an extract from one meeting.

This meeting took place right before the fourth session of NIPDE. The aim of this meeting was to talk about the next day's session on the 2nd of December and the following, fifth session on the 16th of December. The meeting held on 1st of December had an attendance of six people from the university team. As in other cases, my role was to conduct the meeting, so at the very beginning I pointed out that the next day's main activity would be to finish the activity started in the past session. It bears noting that the activity in the third session of the NIPDE was a very controversial one because the discussion was focused on the difficult challenge of creating

research questions. Schoolteachers were talking about chaos and frustration, referring to the process they experienced (more on this on Chapter 5). In that sense, part of this design meeting was around what happened with the schoolteachers and what happened to us, the university team, in that session.

In what follows, I present a key episode of 5:85 minutes in total (between 29:47 and 35:52) of the meeting, separated into parts along with the corresponding analysis. The first attempt at destabilisation is presented as follows.

4.2.3.1 Attempt at destabilisation

Right before the excerpt, we were discussing the 'chaos' (schoolteachers' words) that emerged in the third session regarding the process of creating research questions. Here, Dora, Javier, Juan, Patricia, Carlos, and I analysed the process experienced by the schoolteachers in the previous session to prepare ourselves for the following one. Dora asks what can trigger the teachers to be aware of what they are doing in terms of scientific inquiry:

> **29:47**
> **Dora**: I remember this moment of <u>breakdown</u> (.) there were schoolteachers that were feeling <u>unwell</u> (.) it was <u>necessary</u> (.) it was a <u>shock therapy</u> and I value that (.) however not everyone learns at the same time (.) not everyone can say what they are <u>feeling at the same time</u> (.) everyone has <u>different moments of awareness</u>, <u>levels of reflection</u> and so on (.) the schoolteachers are different (.)
> **Javier**: [They are really different
> **Dora**: For that reason, it was important last session when <u>we {university team} open up the space</u> to talk about feelings (.) talk about this shock therapy and everything that is happening {in the course} because <u>all of them are having some difficulties so that is a good thing</u> (.)
> **Patricia:** Another thing is that the schoolteachers can put themselves in the students' place <u>realising that this is difficult</u>
> **Dora:** <u>But talking about it</u>, because if one does not mention that- I mean this *movement* that is not just in theory {about CPD courses} because <u>we have seen</u> it in the schoolteachers
> **Paulina**: Yes, so for tomorrow afternoon the idea will be to <u>discuss the whole process that the schoolteachers have experienced</u> with you two {Dora and Javier} in charge (.hhh) trying to make explicit what <u>we are doing and why we are doing it</u> (.) how this can impact on our practice and how we are feeling about it (.) In the same line, we could also refer to what they are <u>writing in their journals</u>
> **Dora**: Yes
> **31:01**

Dora is explaining what happened in the previous session. The schoolteachers refer to the process of creating a research question as chaotic; here, Dora is using different words such as *"breakdown"*, *"unwell"* and *"shock therapy"* which seems to be related to some sort of collapse of the schoolteachers. Why is she valuing that kind of reaction from the schoolteachers? According to her intervention, that kind of feeling was *"necessary"* at this point of the course. Also, she is acknowledging that the schoolteachers are different and learn and express their feelings in particular ways. Hence, it could be that the moment of sharing feelings in the past session opens up the particularities of everyone on the course.

It bears asking: if everyone has different moments of awareness and levels of reflection, could it be that the frustration was related to opening the space to talk about that with the schoolteachers? It seems that what Dora is posing is that the learning process implies some suffering to mediate the awareness. When she says *"all of them are having some difficulties so that is a good thing"* she is acknowledging that that suffering is what the strategy during the session was looking for. In this sense, the feeling of frustration and unwellness becomes the best outcome, which is similar to what Patricia said of the schoolteachers feeling what the students felt in front of a task, that is, empathy because, as well as the students, the schoolteachers are *"realising that this is difficult"* – the task of creating research questions. In Dora's words, the university team *"open up the space"* which means that the moment was not considered in the lesson plan; however, the people from the university team who were present during that session decided to give the space to talk about what the schoolteachers were feeling regarding the task.

These utterances are grounded in what happened in the session; what is acknowledged from there? It is recognised that the activity in the previous session of the NIPDE generated in the schoolteachers some sort of destabilisation of what they thought that the research question was, a resulting feeling of frustration, of unwellness and empathy towards the students when they found some activity challenging. This is not a history of success where everyone felt that they learnt something; in contrast, there is the realisation of the possibility of having difficulties before that learning, because somehow learning is painful. The content of the course is moving towards the feelings of the schoolteachers whilst in the background is the creation of a research question[43].

Dora continues explaining the importance of talking about the difficulties of the process; she refers to the *"movement"* of the mind, considering that at the beginning she suggested the *breakdown*, which can be understood as a collapse in the mental health of a subject. The movement that she had mentioned is said with emphasis because she could be referring to the literature that talks about conceptual change or other theories that refer to a reshaping of the previous conceptions of something when the new conception 'took the place' of the previous one. In that intervention she is saying again the importance of talking about what the schoolteachers are feeling, even though at the beginning she acknowledges that everyone is different, having different moments of awareness and levels of reflection so when she said that *"talking about it"* is important this is more referring to the discussion that could be made with the theory of learning because *"we have seen"* the movement in the schoolteachers rather than the benefits that we are making to the schoolteachers while opening these kind of issues. In that vein, the 'we' that Dora is referring to in this episode is a 'we' regarding the university team in contrast to the positioning she took in the previous episode where, when talking about the curriculum, she was talking from her experience as a schoolteacher for 34 years in one school. In this case, the positioning of Dora relies on who she is talking with, that is, if she is talking with Karen, Alvaro and Carlos, all of them with a PhD and full contract with the

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[43] It bears noting that this part of the discussion is in the following Chapter 5 where I will address in detail what happened in the course during the process of creating research questions and how the content and the process are mixed creating the spiral that is represented in the diagram in Figure 4.1.

university, she is positioned from her experience as a schoolteacher, whilst if she is talking with Javier, Patricia, Juan and myself, all of us without either a contract with the university or a PhD (except Juan), she is positioned as part of the university team, and the schoolteachers are 'they'.

That position 'we' with the university team agrees with my intervention when I said that she and Javier are going to oversee the next session with the aim to *"discuss the whole process that the schoolteachers have experienced"*, trying to reflect about the process so far and the feelings about it. That explicitness is phrased as *"what we are doing and why we are doing it"* where the 'we' is referring to the university team, so, in a way, I am asking Dora and Javier to make explicit the pedagogical decisions involved in the NIPDE. I follow the intervention, changing the subject of the question, talking about the impact on *"our practice"* and *"how we are feeling about it"*. Finally, I referred to what the schoolteachers are "*writing in their journals"*; hence, there is a mix of 'we' and 'them' which could be related to not having it crystal clear who is suffering the process of frustration, unwellness, breakdown, shock therapy or empathy described above. It seems that these utterances are going around what was happening with the schoolteachers but also what was happening with the university team.

The conversation then turns to the conceptual issue regarding the topics of the research questions that the schoolteachers are creating and will keep developing the next day. In this part of the key moment, the name of the trajectory appears – *"we don't know everything"* – as another characteristic that this part of the university team is realising.

> **31:02**
> **Juan**: Do you know what we could do with this? deal with the issue of the content or this idea that <u>we don't know everything</u> (.) the schoolteachers do not know everything either, but we have the possibility of finding out together (.) we know what we have to find out, <u>so we can work on something</u>
> **Paulina**: [Exactly
> **Juan:** Maybe at the end of the session (.hhh) if there is time
> **Paulina**: We don't have a plan for the closure of the day
> **Juan**: Listen to me, maybe we can make a brainstorm with the conceptual keywords from <u>their questions</u> (.) and <u>tell them</u> that there are concepts that we are supposed to know but that nobody really knows in advance (.) <u>so we should work with it</u> (.) <u>go deeper on the conceptual issue</u> (.) make it clear that that has also happened to them and they must deal with it
> **Dora**: How are these scientific concepts
> **Juan**: <u>Nobody knows everything</u>
> **Paulina:** [And nobody knows everything
> **Juan:** We must work on it
> **Paulina**: I think <u>we should calm down</u> and I think we should not (.) what we were talking about before (.) we do not have to know everything because it's impossible (.) and if we think we must know everything <u>we are going to get frustrated</u>
> **Patricia**: [Exactly
> **32:30**

Juan introduces the issue with the knowledge in the discipline in opposition to the certainties that were shown in the first trajectory in this document (p. 97). If in the former trajectory the

central point was the contribution to the knowledge in the didactics field that the university team is making, in this trajectory the certainty is paradoxical, that is, we just know that *"we don't know everything".* In that realisation is not just the university team who do not know everything but also the schoolteachers, according to the university team. That not knowing everything by the schoolteachers is not said under the assumption of lack of knowledge though, it is assuming a similar position that could be addressed together.

According to Juan, the university team and the schoolteachers are positioned similarly regarding the scientific content. Therefore, the 'we' in *"we can work on something"* includes both university and schoolteachers establishing for the first time that both parts are participating in the same group. As I mentioned before, in this key moment there is a mix in the way the university team is referring to themselves, that is, being a group with the schoolteachers conforming a new 'we' or being part of the university team referring to the schoolteachers as a 'they'. Juan makes visible that mix, talking about *"their questions"* and *"tell them"* with *"we should work with it"* in the same utterance. The explanation to this combination of grouping could be related to the attendance at the course; that is, Dora, Javier, Juan, and myself were participating in the previous session where there was room to talk about the feelings of frustration, chaos and so on; hence, the shock therapy was not just for the schoolteachers, which is reflected by Juan saying, *"nobody knows everything"*. In doing so, I added the impossible illusion to know everything because *"we are going to get frustrated"* if we think we must. With my intervention, frustration becomes recurrent, as the feeling that came up when the schoolteachers realised that creating a research question is harder than they thought and is also happening when there is the idea that everyone should know everything.

Regarding the scientific content – which will be developed in more detail in the following chapter – it bears noting that in this episode Juan refers to going *"deeper on the conceptual issue"* and his meaning here is different from the idea of enrichment posed at the starting point (and in Chapter 3). The initial assumption was that schoolteachers would have their base knowledge of scientific inquiry enriched, which has implicitly invoked the idea that this knowledge is poor while in this trajectory the phrase, 'go deeper' refers to extending what is already there because *nobody* knows everything in advance.

Apparently, there is an agreement in this meeting regarding the realisation of *we don't know everything* and that is not a problem because nobody knows everything, and it would be impossible to think otherwise until Javier made his utterance as follows:

> **32:46**
> **Javier**: Now, I do not want to <u>sound Nazi</u> with this comment
> **Paulina**: ((gasp))
> **Javier**: Because <u>I believe a lot in learning</u> (.) but I think <u>the anguish was not in the majority rather some specific people</u> (.) and it also has to do with the fact that there are people who have taught for a long time in the same way
> **Paulina**: Ye:p

> Javier: And I think it also has to do with the fact that the mind has certain <u>fixed structures</u> (.) so is not easy to demand someone to "ok, abstract yourself from that" when you are in a more <u>concrete space</u>
>
> Paulina: [And also with the <u>experience of all the previous CPD trainings</u>
>
> Javier: Exactly, it is too much
>
> Paulina: And this is already different since we are <u>nine or ten facilitators in the room saying different things</u> (.) with a common goal or theme but we {university team} <u>are different people (.) with different experiences, different knowledge</u>, so it is a particular space
>
> Javier: [Then the <u>accompaniment with certain people must be different</u>
>
> Paulina: Yes
>
> Javier: And <u>perhaps not push them s:o much</u> huh? make the best of them but not push them (.)
>
> **34:09**

In front of this agreement, Javier offers a contested position. What Javier shows could be related to at least two things. First, he is both limiting and acknowledging the possibility of learning. He is limiting it because he is assuming that there are people who are not going to change the way they teach because of their *"fixed structures"*. He is acknowledging because he *"believes a lot in learning"* so there is a possibility to change those fixed structures. Secondly, it is related to disrupting the idealisation that the rest of the team was creating regarding the egalitarian position in front of the knowledge of both schoolteachers and the university team.

With his comment Javier, in a way, breaks the illusion that the rest of us were creating about everyone being empowered and willing to change because there is always room to reflect and be aware; my ((gasp)) because of the mention of 'Nazi' is reflecting that rupture. In his utterance, Javier comes back to the initial idea of the key episode about everyone being different, saying *"the anguish was not in the majority rather some specific people"*; hence, the reaction of the schoolteachers would vary according to their conditions and mind. In doing so, he is forcing the rest of us to think that even though there is the room to talk about feelings and open up the practice there are still people who cannot change just because the other is saying that. When he uses an extreme analogy as being 'Nazi', he is making a warning that the rest of us were going to think that the change is easy, achievable for everyone, and the schoolteachers are behaving similarly. With his comment, he is showing that the university team was creating another idealisation of the schoolteachers regarding their knowledge, in opposition to the starting point where there is an initial assumption of lack of knowledge among the schoolteachers. In this trajectory, the assumption was that nobody can know everything, neither the schoolteachers nor the university team and of the different ways in which different individuals do not know things.

At that moment, Javier disrupts with his comment not allowing us to forget that there are different rhythms, experiences, and conditions. The *"concrete space"* could be related to the structure of the school which can restrict the practice of the schoolteachers because too often school time is spent in *doing* the lessons, not *reflecting* on what has been done. That is in general the case in Chile because the ratio of the hours in contact with students and the hours to reflect on practice is 3:1. Apart from the school conditions, the utterance of Javier also brought the acknowledgement of the possible previous experiences of the schoolteachers in other CPD courses supporting the issue with the fixed structures. I was trying to say that the

experience in the CPD can also contribute to the impossibility of changing practice, which is somewhat related to what Alvaro said in the former trajectory of the usual image that schoolteachers are treated as not knowing enough and following recipes from the so-called experts.

Once the space was opened to talk again about the difference amongst the schoolteachers – which was suggested by Dora at the beginning of the key episode –another element appeared, which is the variety within the university team. I am adding the fact that we are *"nine or ten facilitators in the room saying different things"* as an effort to make clear that this is a particular CPD course and, therefore, could be chaotic just because of that fact. Then, I extend that element, saying that the university team is formed by *"different people, with different experiences and knowledge"* which is supported by Javier with the assertion that the way the schoolteachers are accompanied should be appropriate to that variety of experiences.

Even though there are moments of homogenisation, in this key episode the dialogue unfolds an effort to understand the individualities of both the schoolteachers and the university team which is clearer in the following part where the conversation turns to talk about the behaviour of some schoolteachers during the sessions.

4.2.3.2 Attempt to know the schoolteachers

After the *"Nazi"* comment from Javier, the conversation turned to address the individualities of the schoolteachers. Carlos started this final part of the key episode by asking about the behaviour of the group of schoolteachers who had their initial version of the course with Uni2.

> **34:13**
> **Carlos**: I have a question <u>along the same lines as what you are saying</u> (.) the <u>level of work or the progress</u> with the teachers that come from Uni2 is different from the other teachers?
> **Paulina**: [<u>I would say no</u> (.) they are aligned brilliantly (.) Patricia was saying that earlier (.) <u>they are willing to work with everyone</u>
> **Juan**: At the beginning <u>they have their structure fixed</u> though which is related to the previous training (.) for example if you ask them to do an activity, they are always thinking about the learning cycle (.) they put the cycle and then they adjust the activity to it (.)
> **Patricia**: <u>Without questioning</u> "pucha[44], I learn this from Uni2 and in here I did not use it"
> **Paulina**: I have not felt a difference with them, in fact, <u>I have felt more difference with the group that comes from D1[45]</u>
> **Dora**: Yes
> **Paulina**: In that table where <u>Pedro, Paloma, Caro, Nicia, Marita[46]</u> sit together, for me they are far away from the rest, but the girls from Uni2 not
> **Juan**: [But <u>Pedro sits next to</u>
> **Patricia**: Paloma
> **Juan**: Nop, the other one
> **Paulina**: <u>Caro</u>

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[44] *Pucha* means something similar to 'that's a shame'.

[45] D1 is the anonymised name of a local district in the region.

[46] Names of schoolteachers that are from the same district and who sat together. The organization of the room was always like that, that is, teachers from the same district or a neighbour district sitting together. Sometimes we tried to rearrange that organization, but this was not always possible.

> **Juan**: Pedro and Caro talk to everyone and <u>push the work</u>
> **Paulina**: <u>In that table specifically</u> (.) I can see some difference
> **Javier**: [Yes, I can see some difficulties as well, but <u>Pedro is engaged</u>
> **Juan**: I think Pedro is engaged, yes
> **Dora**: And he has an important <u>level of reflection</u> because he looks at others like what impact he will have on the students, he is always looking at other things
> **Juan**: <u>He is always looking</u>
> 35:52

Carlos is addressing Javier directly, *"along the same lines as what you are saying"*, so he is taking the final comment of Javier of *"perhaps not push them s:o much"* if he was referring to the group that was not trained with us/Uni1. In this sense, Carlos is bringing back the fear of the starting point where the schoolteachers who came from Uni2 could behave differently in terms of *"level of work or progress"* in comparison with the teachers who were our Uni1 former students. My answer overlaps with his question because I rushed to say that is not the case, almost saying that our fears were baseless. Then I added that there is a sense of alignment among the whole group of schoolteachers and *"they are willing to work with everyone"*. This part of the behaviour is not random, it has to do with the acknowledgement of a previous discussion that the university team had regarding the different groups that were at play during the sessions. That is, one way of grouping was related to the university of the initial training, so it was one group of schoolteachers Uni1 and another group of schoolteachers Uni2; then, another way of grouping was related to the district of the school, so people who were from the same district or neighbouring districts sat together. It bears noting that the room used for the sessions had eight round tables and the schoolteachers were usually seated according to the district criteria around five tables. So, when I say *"they are willing to work with everyone"* I am referring to our effort to mix it up with the tables and organise the whole group to work with different people; regarding that, the schoolteachers from Uni2 did not experience any difficulties.

Juan and Patricia answered Carlo's question differently. Juan is referring back to the beginning of the course when there was a difference related to the training received from Uni2 in terms of the way they understood the learning with a cycle, so every time a task was presented to this group of teachers, they were using the cycle to adjust the activity. Juan is saying that the *"fixed structure"* was formed at the beginning of the course, to which Patricia replied that they are not questioning or making any comparison between the training with us and the training with Uni2. Hence again, as in the starting point, there is an assumption, demonstrated as a fact in this utterance, about Uni2 having a different approach to scientific inquiry in comparison with Uni1. If the schoolteachers are not making any comparison, it is because they are thinking that this version is going beyond what was taught in the initial training either with Uni1 or with Uni2, so the comparison is just in the mind of the university team in an implicit effort to compare universities which can be related to the usual way of putting these academic institutions into rankings.

Juan and Patricia are talking about the content; however, I kept pointing out the behaviour, not in relation to the content but rather focusing on the relationship between the schoolteachers regarding with whom they sit or talk. In that sense, I was not answering Carlo's

question but changing the subject to the appreciations of the behaviour as a group of the participants. After that intervention, the topic is shifted to what I was intending. If we had the fear that the former students of Uni2 could not mix it up with the rest of the course, namely, our former students; on the contrary, I suggested that *"I felt more difference with the group that comes from D1"*, which are our former students of the NIPD version.

Even though I was answering Carlos' question of the level of work or progression, what is interesting in this part of the key moment is the attempt to know the schoolteachers in terms of how they are seated, besides whom, with whom they establish conversation, who is working with whom and so on, to which Dora, Juan, Patricia and Javier engaged. In that sense, the fact that we can say the names of the schoolteachers is not showing-off; rather, it is an acknowledgement of what can move us forward to make some pedagogic decisions; for example, when Juan asks besides whom Pedro is seated, that offers the possibility to talk about Pedro's engagement, how he pushes the work because he is seated near Caro, and even though there is some separation of the table from the rest of the course, *"Pedro is engaged"* and he has demonstrated an *"important level of reflection"* and *"is always looking"*. Therefore, the turn of the conversation is less assumption-based and more grounded in what is happening during the sessions in terms of how the schoolteachers behave.

4.3 Discussion

The purpose of this chapter was to explore the university teachers' subjectivity and its shifts produced throughout the design meetings. The question around knowing the schoolteachers beforehand shaped the positionings that the university team had at the beginning which was shifted when the course started. The shift in the subjectivity illustrated with Figure 4.1 and described in the chapter can be related to what Butler pointed out as a "necessary restriction in this subject production" (Butler, 1997, p. 84), meaning the subject production is not just in one moment nor completely; rather, there is a constant production where the subject emerges in the process of being repeatedly produced (Butler, 1997). The shifting subjectivity, in this case the teacher educators' subjectivity, is indicative of this very idea of repetition where there is a necessity of constantly being rearticulated while remaining, ultimately, inarticulable. The two trajectories emerging from the starting point of not knowing in advance the schoolteacher participating in the CPD (starting point titled *"We don't know them"*) constitute an indicative of this rearticulation of the experience of being teacher educators in this context in particular, that is to say, the context of a CPD led by a teacher educators' team at a university in Chile.

The importance of the institutional context in producing a particular subjectivation experience is revealed in this chapter, directly related to the emergence of the two trajectories. Subjectivity is defined as "as the lived and imaginary experience of the subject" (Butler, 1997, p. 122) within a contingent historical and political context (Heyes, 2010) while being shaped in a discursive tension with power and knowledge (Phillips, 2011). Thus, subjectivity emerges within the bounds of power structures highlighting a socially-situated understanding of subjectivity (Zemelman, 1997).

The salient features of the teacher educators' subjectivity started with the starting point of not knowing the schoolteachers, which led the university team to assume that the schoolteachers were not prepared to create, for example, communities of learning. This assumption is manifested in two kinds of discourse during the implementation of the course, where there is a disruption (in the form of agreement/antagonism) of the unified university team with different identifications within the group. One discourse moves towards a self-recognition with certainties on what the university team knows about scientific inquiry and previous CPD trainings (trajectory I); the other is a contested discourse of realising that the university team does not know everything, which is enhanced by starting to know the schoolteachers (trajectory II). The differentiation in both trajectories of the subjectivity of the university team produced during the course was greatly influenced by our institutional positionings and practices, for instance, in attendance at the sessions or contested aims of the course because of institutional requirements.

The subjectivity shifted considering the requirements of the university mostly of the teacher educators with full-time contract who have to answer to that requirement or the positionality of the teacher educators as denying others' expertise, taking 'preventive' measures such as a pre-test, thereby trying to control some of the uncertainty of not knowing the schoolteachers. Regarding this positioning it is possible to make connections to Moje (1997) who pointed out that the word position "focuses on how people move in and out of positions or are positioned by others as a result of asymmetrical power relationships" (p. 37) which is applicable to the teacher educators-schoolteachers relationship when assuming, for example, that the purpose of the CPD is just update the schoolteachers on what they do not know (Geldenhuys & Oosthuizen, 2015; Luneta, 2012). In so doing, the schoolteachers are positioned as lacking something (see *4.2.1.1 Assumption: lack of knowledge* and *4.2.1.2 Assumption: level of trust*) and the teacher educators are positioned as experts with certainties on what they bring to the course (see *4.2.2.2 Certainty: we are knowledgeable*).

Related to the hierarchies, and as previously noted, not knowing the schoolteachers beforehand produced the discourse of assuming that the schoolteachers will not know how to create communities of learning nor how to use scientific inquiry to teach science which led the university team to adopt a position of safety (in the format of a pre-test) to be prepared for diversity among the schoolteachers, an adoption which is inspired by fear and is 'resolved' by control. In this position, the schoolteachers (their knowledge and tools) are the problem to be resolved, not the conditions in the schools or the actions of the Ministry. The diversity of languages, knowledge or tools is not something to be amazed at; rather, it is something to control. Related to this is what Moje (1997) describes as the discourses in a chemistry classroom where there was a subjectivity of "the teacher as expert and producer of knowledge, whereas the students took up positions as consumers and demonstrators of knowledge" (p. 35). Moje states that these discourses are invisible to those who are reproducing them, suggesting that for those was involved in the CPD programme, this discourse of producer/consumer was invisible to us. Bazzul (2014) pointed out that understanding the process of subject formation which happens in a particular cultural context (such as the science classroom or the university) brings forth grounds to reshape how we come to see ourselves

and others. Educational institutions are central to the subjectivation processes of those involved in them, having a role in the *re*production of subjectivity (Bazzul, 2016). The discourses of those institutions might determine how people understand aspects of their identity, such as race or gender, while also validating political orientations and ethical actions. Similarly, in terms of the discourses interpreted from the key moments of dialogue, the words of those in charge of the CPD disclosed our positions regarding the institutional context inside Uni1 but also regarding other universities while producing a sort of competition between universities in the same region. Part of the State funding to the universities is related to students' enrolment, meaning that the universities are competing for more money which brings to the table the idea of *better or worse* universities. In that light, it is assumed that NIPDE participants have different experiences of training, with those from Uni1 being supposedly better prepared and those from Uni2 or Uni3 being apparently less well prepared after the training, which also is influencing the two resulting trajectories.

Another salient feature of the teacher educators' subjectivity is the hierarchies within the university team: who is taking the decisions, who is less heard, or who has more power inside the university team? A possible answer has to do with the presence during the design meetings or the sessions of the course which gives some 'authority' to take the decisions as developed in trajectory I. In that light, some linguistic markers constitute identifications between individuals (both present and not present in the sessions) such as the use of 'we', which initiates a differentiation within the group or the different aims we pursued in relation to what we are responding to (Ministry requirements or NIPDE requirements). On the other hand, there are institutional conditions, namely, who has the contract with the university and who does not, which results in some sort of agreement/antagonism within the university team. In this regard, it is interesting to notice through dialogue how different identities combine and differentiate at different moments. As explored in trajectory II, there is a mix in the way the university team refers to itself, that is, being a group with the schoolteachers, thus constituting a new 'we', or being part of the university team and referring to the schoolteachers as a 'they', or Dora positioning herself either as schoolteacher or as part of the university team depending on whom she is talking to during the meeting.

Why is the question of the production of subjectivity important? It is in part because the subjectivity of teacher educators is usually neglected (Montenegro, 2016). Montenegro (ibid) pointed out that the path to becoming a teacher educator has been barely explored and their identity "frequently go[es] unnoticed in the field of teacher education" (p. 527), while the professional development of teacher educators is a "relatively young and under-researched area" (Vanderline et al., 2021). In the context of this thesis, the professional learning of the university team/teacher educators is important because, as revealed by trajectory II, they showed they could also learn and change.

The question of subjectivity in science education is related to the call to engage and explore the sociopolitical discourses rarely studied within the science education field (Bazzul, 2012). By using a sociopolitical lens, the very notion of hierarchies and asymmetrical power relationships between teacher educators and schoolteachers as hegemonic discourses in science education (Carter, 2004) can be disrupted and challenged (Carter, 2008). This disruption is in line with

the invitation of Pathi Lather (2012) to embrace both the limits of their own knowing and the affective response to the research work towards the constitution of a **new scientific subjectivity**, arguably opening the possibility to be applied to teacher educators who can challenge the power relations understanding that knowledge is partial and situated within our experience (Haraway, 1988).

In the following chapter, I will explore what happened inside the snail shape curvature of Figure 4.1. Appendix 7 provides for the reader a short pause which resonates with an iterative process of thinking with theory that was evoked with this chapter, namely, the first Interlude.

CHAPTER 5

Inside the course: shifting positions in relation to activities on research questions generated by schoolteachers

5.1 Introduction

The purpose of this chapter is to contribute to answering the research question *'How are teacher educators' and schoolteachers' subjectivities produced in a CPD programme focused on big ideas of science education?'*. This chapter discusses the subjectivation process of schoolteachers while the previous one dealt with the teacher educators' subjectivity. In this and the previous chapter, key moments of dialogue in and around NIPDE – the CPD programme focused on big ideas – were used. NIPDE, a CPD programme with schoolteachers from pre-primary to secondary education, had four main components relevant to science education, developed in an intertwined way. These components were: contextualisation to the local territory; big ideas of science education; scientific inquiry; and community of learning. During the implementation of the course, a cross-cutting skill was developed which was the creation of research questions by participating schoolteachers. The aim of working with research questions in the CPD course was that schoolteachers could develop a research project according to their knowledge, school context, interests, and students. The work around the research questions grew in significance throughout the course and this was expressed in changes in both the design and the implementation of the course.

The main focus of this chapter is to explore the moments of the course where the creation of the research questions was discussed, specifically the reflections and commentaries around that work which was unplanned at the beginning. The research questions became a generative theme that allowed both the university teachers and the schoolteachers to question them(our)selves while attempting to develop the skill of posing fruitful research questions. Also, as a generative theme, the work around research questions framed my analysis to depict positionings and feelings about pedagogical and epistemological issues in science education by the people working on it, namely, the schoolteachers' subjectivity produced in the context of the CPD course. In that vein, it uncovered the schoolteachers' subjectivity by depicting the complex and challenging aspects of how to create research questions, the role attributed to guiding or being a teacher/student, the meanings of concepts such as chaos and the ways in which participants engaged with the work around research questions in the NIPDE course.

As with the first chapter of findings, the analytical process presented here involved selecting some key moments that allowed me to make a dialogical analysis. My selection and analysis was focused on scientific, social, and affective markers. Scientific markers include the discussion of the importance of questions in science while developing the skill of creating research questions and how scientific knowledge is built – its nature – constituting an *'epistemological positioning'*. Social markers include the understanding around the roles of teacher/student and teaching/learning, constituting a *'pedagogical positioning'*. Affective markers include the different meanings of trust and frustration or positions – influenced by

empathy – articulated by the schoolteachers while reflecting about the questions. These three sets of markers are at play in an intertwined way in the different key moments that are examined in this chapter. In this analysis, the words uttered are understood as constitutive of participants' positionings.

In what follows I attempted to explore the subjectivity of the schoolteachers based on three main arguments:

1. There is a movement from one positionality to another in pedagogical and epistemological terms.
2. This movement might be because of the reflections on the work around the creation of research questions.
3. The creation of research questions also generates references to chaos, frustration, and empathy in the schoolteachers, as well as different ways of involvement/engagement with the CPD course.

These arguments are illustrated with a starting point followed by the shifting pedagogical and epistemological positionalities and the affective register at play while showing what happened while creating the research questions.

5.1.1 A new starting point and its trajectories: continuing the diagram

Figure 5.1 maps the analysis of the work around research questions, organised as a starting point and the trajectories that emerged from it. The names of the starting point and the trajectories are inspired by the key moments selected to illustrate the movements in the discourse during the work around the research questions created by the schoolteachers.
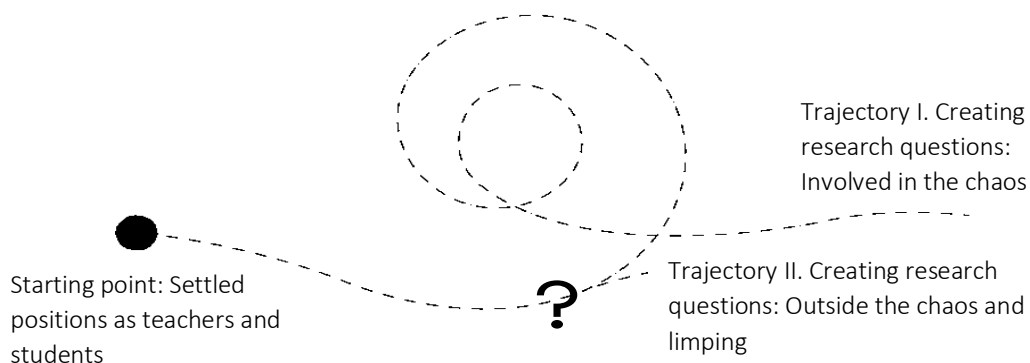
Figure 5.1: Schoolteacher subjectivity. The black dot illustrates the Starting Point *'Settled positions as teachers and students'* and its two trajectories. In this case, the difference in length between the trajectories is related to the number of people that each is symbolising.

Figure 5.1 includes a question mark, symbolising the importance of the work around research questions, to then follow the sort of snail shape curvature or spiral which is the first separation of the central line into trajectory I, titled *Creating research questions: Involved in the chaos.* Then, we should come back to the separation of the central line to go to trajectory II, named *Creating research questions: Outside the chaos and limping.* This organisation is important because is the way in which the findings are described. In Figure 5.2, it is possible to see the subjectivity of the university teachers from Chapter 4 and the subjectivity of the schoolteachers

from this chapter, thus showing the intertwined and crosspiece character of the analysis as it attempts to answer the first research question of this study.

Figure 5.2: The schoolteachers' subjectivities from Figure 5.1 have been added to the university teachers' subjectivities from Figure 4.1 in Chapter 4.
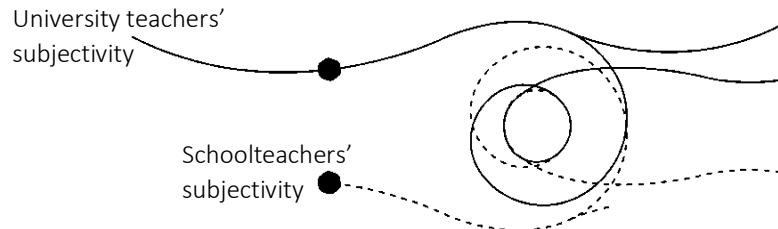
The starting point called *'Settled positions as teachers and students'* is illustrated with a first key episode depicting the fixed – sometimes contested – positions before the schoolteachers started working with their research questions. This key episode took place after an activity which led to a conversation around guiding. Inspired by that discussion, the episode is divided into two parts: i) Contested participants' positions: meanings of being a guide or being guided; ii) Contested participants' positions: meanings of being a teacher/student. My analysis of this first key moment identifies the initial pedagogic positioning of participants yet the epistemological positioning is absent, unfolding the starting point of both positionalities.

The work around the research question is symbolised with the question mark in Figure 5.1 after which the starting point is differentiated into trajectories. Trajectory I, called *'Creating research questions: Involved in the chaos'*, illustrates the schoolteachers' narrative as getting involved in a chaotic situation. The spiral in the diagram indicates chaos, frustration, and destabilisation of thoughts in the schoolteachers' words. This trajectory allowed me to illustrate what the schoolteachers experienced as they worked around the creation of research questions, what they meant by 'chaos' concerning that work, and how I am interpreting the shifted positionalities in pedagogical and epistemological terms. Pedagogically, regarding the understanding of the roles of teachers and students, the work around research questions disputes the positioning of the schoolteachers as students. That change of positionality was taking shape while discussing questions such as *'who is teaching?'* and *'who is learning?'*, challenging the fixed position of the teacher teaching, and student learning. Epistemologically, the assumption that the creation of research questions was something simple was destabilised, allowing discussion around how scientific knowledge is built. In doing so, the schoolteachers' understanding of the nature of scientific investigation became evident. Alongside this trajectory, feelings of empathy and frustration are also at play.

The schoolteachers' Trajectory II, called *'Creating research questions: Outside the chaos and limping'*, allowed me to illustrate a contested example of a schoolteacher not being willing to be involved in the chaos, which constitutes a different mode of frustration and engagement with the CPD course.

To sum up, the work entailed in creating research questions during the CPD course is important for the purposes of my research because it allows me to illustrate how the subjectivities of the schoolteachers around the role of being a teacher/student and their understandings of the scientific process are shaped by their pedagogical and epistemological positionalities produced in relation to the school and the NIPDE course. In doing so, different schoolteachers' emotions, such as frustration and empathy, are depicted as well as ways of engagement with the CPD.

Table 5.1 presents short descriptions of the schoolteachers who feature in this findings' chapter. The whole group consists of primary teachers, apart from Ivan and Pedro who are secondary teachers. The schoolteachers sat together at round tables according to the version of the NIPD and their district. Nicia is the only one in this group who did not finish the course.

Table 5.1: Short descriptions of the backgrounds of the schoolteachers in alphabetical order (pseudonyms) and their presence in the key moments used to illustrate either the starting point (SP) or Trajectories I (Tr I) or II (Tr II) of the analysis.

Pseudonym	Role	District	Starting point or Trajectories
Caro	Primary teacher	D1	Tr I
Cesar	Primary teacher	D1	SP; Tr I
Eliseo	Primary teacher	D1	SP
Franco	Primary teacher	D3	Tr I
Ivan	Chemistry teacher	D4	Tr I; Tr II
Javiera	Primary teacher	D5	Tr I
Jorge	Primary teacher	D6	SP; Tr I
Karla	Primary teacher	D7	SP
María	Primary teacher	D8	Tr I
Nicia	Primary teacher	D1	Tr II
Pedro	Biology teacher	D1	SP
Ricardo	Primary teacher	D7	SP; Tr I

The university teachers involved in these key episodes are Javier, Daniel, and I. Javier is a psychologist who oversaw the focus of community of learning and some motivational activities; Daniel is a biology teacher who oversaw the focus of scientific inquiry; and I am a biologist who oversaw the content of big ideas of science education.

5.2 Analysis

5.2.1 Starting point: Settled positions as teachers and students
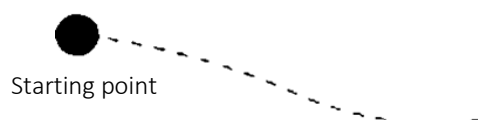
Starting point

'Settled positions as *teachers* and *students*' is the title inspired by the key moment which reflects the starting point of the schoolteachers before the work of creating research questions commenced. The starting point will be illustrated with an extract from the third session where there was a motivational activity called '*Lazarillo*' at the beginning of the session (in Chapter 3,

p. 72 there is a brief discussion of this activity, as it is a word that I did not translate). In the *Lazarillo* activity, university or schoolteacher members worked in pairs with one teacher being blindfolded and the other asked not to speak as they walked around the university together. The role of research questions is discussed while thinking of who guided whom? Even though a first version of the research question was produced by the schoolteachers in session two, the commentaries and reflections about the process of creating research questions started in this third session (see Appendix 4).

This moment in the third session set up the question of the pedagogical and the epistemological positioning which I use to illustrate the starting point. The pedagogical positionality took shape under two subtitles: "Contested participants' positions: meanings of guiding or being guided" and – into the classroom – "Contested participants' positions: meanings of being teacher/student". While the meanings of 'teacher' and 'student' appear to be settled positions, these meanings are also contested which may open the possibility for shifted positionalities towards Trajectory I.

5.2.1.1 Contested participants' positions: meanings of guiding or being guided

From the key episode, two key issues emerged. First, the question of who does the guidance in the interactions between the pair. Is it one of them? Is it both? Is it neither of them? Secondly, the question of where the responsibility is placed and the role of trust in that interaction and whether it might be dependent on a prior relationship between the pair.

Before examining these points in more detail, a summary of the activity will be presented. The exercise consisted of allocating participants to pairs – one a schoolteacher and one a university teacher or both schoolteachers – where one member was blindfolded and the other one was asked to not speak. The blindfolded individual walked in front asking questions about the path to follow, and the silent one was behind, answering by squeezing the shoulders of the former as 'yes' or 'no' (Figure 5.3). Each person in the pair walked for eight minutes around the campus asking and answering questions. Everyone had the opportunity to take both roles. Once the activity was finished, the group came back to the classroom and Javier – university team and in charge of motivational activities – posed the initial question of *"How was your experience? How did you feel?"*, starting the episode with reflections and commentaries around the activity[47].

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[47] See Appendix 8 for the transcription (in translation) of the key episode from 29.38 to 36.38.

Figure 5.3: Pair, with one blindfolded and the other one asked to not speak.

The discussion following from Javier's question continued for seven minutes and eight participants contributed. Although each participant articulated slightly different positions, the complexity, and their positioning in relation to the common themes of responsibility in the issues of guidance and trust, can be illustrated in a brief exchange between Ricardo, Pedro, and Jorge.

Regarding the issue of responsibility in the guidance, Javier focused the discussion around *"who guided whom?"*, which was asked three times and emphasised the impossibility of a straightforward answer. For Ricardo it was a *"mix of both"* so the pair as a unit was guiding the path. Even though Ricardo said that both guide each other, for him it seems that the one not talking is the primary guide because the blindfolded individual is *"also groping"* which sounds less responsible. Ricardo pointed out the role of the questions in guiding as well because without them there would not be an answer. With a different understanding, Pedro explicitly identified the responsibility to guide on one person in the pair: "*that experience that someone is guiding you or you are guiding someone"*; he felt that he was guiding when he was in one position (without speaking), and he felt guided when he was in the other position (blindfolded).

Regarding the issue of trust, Pedro added another layer of complexity to the question of who guided whom related to knowing the other person in advance, because the other member of his pair was a colleague from the same district: *"I do not know if it is easier because I already (.) easier than people who do not know each other"*. Supporting what Pedro said, Ricardo also identified the issue of trust as being attached to knowing the person before because he was working for the first time with his partner. Another position is offered by Jorge who, acknowledging what was said about trust, also mentioned empathy:

> **36:02**
> **Jorge:** I think it also has to do with trust and empathy (.) between the two, there is only one guide (.) because as you go along you also know how the other person sees your

surroundings which is transferred to you through just two words {'yes' or 'no'} (.) I don't think there's just one guide here, and I think it is a game played together, teamwork.
36:38

Jorge is doubtful and he explains that between the two, there is "*one guide*", unfolding a complementarity in the pair without which the action would not be complete. Jorge said that what happened was a *"game played together"*, so neither the one not talking nor the one who is blindfolded can play alone. In this sense, Jorge is adding to the discussion a necessary hyphen in the relationship guiding-guided.

Summarising, from the metaphor of the *Lazarillo* exercise, some participants seem to take up positions where there is one who is responsible for being the guide – usually the one who can see. Other positions include a mix of both highlighting the questions' role in guiding and the complementarity of the pair in the guiding-guided relationship. Underlying all this is the issue of trust. The conversation on the metaphor of guide/guided is translated to the classroom as follows.

5.2.1.2 Contested participants' positions: meanings of being teacher/student

After the initial discussion of trust and responsibility for guiding, Javier introduced a question that shifted the conversation to what happens about guiding in the classroom between the 'pair' teacher-student. The role of teachers/students is unsettled by the introduction of questions in science inquiry and understanding and curiosity having a role in guiding, leading to question whether it is an individual (teacher/student) or their understanding of questions that guides. This translation from the metaphor to the classroom is not straightforward, also presenting contested positions:

5.2.1.2.1 Position 1: "Who guides the lesson is the teacher"

> **37:10**
> **Javier:** Ok, but here comes a difficult question; if we are not certain who guides whom, (.) how does this relate to inquiry in the classroom? What has this to do with inquiry when you are with your students? (.) Who is the guide? One is *living* the moment, right?
> **Ricardo:** It is assumed that when one is in a lesson, the teacher is the one who is guiding, but for example, if one gives the students some exercises (.) who does not *see* has to trust the partner, the former can contribute but the one who ultim:ately guides is the person who understands what to do (.) Who guides the lesson is the teacher (.) you can still draw conclusions, you can share, but in the end the one who has to give the definitive guide is oneself
> **Karla:** Yes, because in the end, one can corroborate (.) the student asks every 5 or 10 minutes to the teacher because they {students} want to feel the reassurance that what they are doing is correct (.) one evaluates and sees the results of the students to direct the topic
> **Javier:** Ok, so if I understand correctly, the teacher will *always* be the one who is deciding where to go, yes?
> **38:53**

Javier posed the question as "*difficult*" with a sense of uncertainty of what happens in the classroom. This elicited a discussion of the positions of the schoolteachers regarding scientific "*inquiry*" and beyond that, the position of the students. Javier is going from the warm-up

activity to professional practice. He positions himself as part of the question because *"one is living the moment"* so now it is not them in the metaphoric pair, or ´you´ with your students, it is ´I´, as the *"one"*.

These first utterances are drawn in the pedagogical positionality where the teacher is the guide, and the students are guided. This was expressed first by Ricardo, who started by saying *"it is assumed"* as a general understanding that the teachers would be the ones guiding. Although he tries to make it a contested point, it seems that he is giving more examples when the teacher is the guide, because *"if one gives the students some exercises"* the students would *"not see"*; instead, they *"can contribute"* but without understanding completely *"what to do"*, so there is a disparity in which the teacher is the guide.

In a classroom context, Ricardo – and later on Karla – points out that the teacher and students can both *"draw conclusions"* or *"share"* but the *"definite guide"* or the one that *"can corroborate"* is the teacher. When Ricardo said *"ultim:ately"* and both said, "*in the end",* they are making the point that there is a path where teachers and students can share the possible decisions of where to go during the process. Still, there is a destination which is decided by just one of them. In this sense, teachers will know the starting and the final point; what is happening in the middle of that journey could be decided by teachers and students.

Ricardo and Karla also raised the issue of trust in the classroom scenario. Ricardo was talking about trusting the partner in the situation of not being able to see and Karla when talking about the *"reassurance"* as something that the students wanted to feel. In both utterances, it seems that the role of the teacher is as the one who is both more responsible and removes the students' doubts or fears. Either way, teachers are called to lead the way and the students to follow.

Javier, closing this part of the key episode, includes the emphasised *"always"* where the teacher unquestionably will be the guide and the one who decides; however, he also added some doubt *"if I understand correctly"* which suggests that at this moment the authority rests with the schoolteachers. This utterance triggered a contested position.

5.2.1.2.2 Position 2: "The questions are going to be the guide"

Eliseo's intervention, in response to Javier, seems to vacillate between the possibility that the teacher is guided by the students' questions and a reiteration of the teacher as ultimate guide. Javier picks up on the opening that Eliseo offers, the possibility that the questions – rather than one individual – might be the guide:

> **38:56**
> **Eliseo:** Also, according to the students' <u>questions</u>, their <u>curiosity</u> (.) the <u>teacher is guided as well</u> (.) if they ask, "why this does not happen?", we look into that (.) the teacher is *always* the guide, and the students contribute with their curiosity and also the <u>guidelines where the thing is going</u>
> **Javier:** <u>Now, the questions are going to be the guide</u>, the guideline of where to go
> **39:14**

Eliseo incorporates some doubt because the *"teacher is guided as well"*. He is not going against the position of the teacher as *"always"* guiding; rather, he brings the role of the *"questions"* and *"curiosity"* of the students into play. The role of questions is placed as a contribution, but in a different way compared to what was posed by Ricardo and Karla – subjugated to the teacher´s role; in Eliseo´s position, the student's curiosity provides the *"guidelines where the thing is going"*. Hence, the role of the student is more similar to what Jorge said regarding the *Lazarillo* activity, where the two members of a pair guide each other, playing the game together, both being essential. Acknowledging that, Javier said *"now, the questions are going to be the guide"*, giving importance to the questions rather than only the teachers or the students.

In the first part of the key episode, I concluded saying that Jorge added the ´hyphen´ to the metaphoric pair because both are essential in the guiding-guided relationship. Considering what is presented as 'position 2', the hyphen could signify questions [hyphen = questions] in the 'teacher-student' pair, meaning that teachers and students are interacting because of questions.

5.2.1.2.3 Position 3: *"The student is the one who guides us"*

Cesar´s utterance dismissed the position of the teacher 'always' being the one who guides; Cesar's view is disputed by Ricardo and Karla who are the ones supporting 'position 1':

> **39:50**
> **Cesar:** I think that the teacher does <u>not necessarily</u> have to be the guide because also <u>the student</u> is the one who <u>guides us to a problem</u> (.) that is <u>the heart</u> of the matter
> **Ricardo:** I think it is different (.) <u>the teacher must be the guide</u> *without disputing* that the student can also generate steps to follow (.) because you may discover things with the students and realise new steps reaching a common guide; however, the most <u>quote-unquote</u> responsible of the path is the teacher
> **Karla:** Besides that, <u>one has the *clarity*</u> where you want to go with the student? (.) because they can be guiding but where to? Where are we going? That clarity is the teacher's <u>responsibility</u> (.) in this case, <u>the person not talking has that clarity</u> because someone told him "I want to go to a place", and you trust that the person was guiding you there (.) <u>the north</u> is important, where are we going?
> **41:17**

According to Cesar, the teacher is *"not necessarily"* the guide, and he refers to the role of the students not as a secondary contribution, similar to Eliseo's and Jorge's position because in Cesar's words the student *"guides us to a problem".* In Cesar's intervention, the student is *"the heart"*. In my interpretation when he says, 'the heart', he is adding another 'organ' to the conversation. In the metaphoric pair the organs involved were – at least – eyes, tongue and ears; the discussion was regarding the functions of those organs in terms of 'the one not able to talk'; 'the one who can see'; 'the one who listens'. The heart's function in pumping blood through the organism's body is vital, so when Cesar refers to students being the heart, he is giving to the students the role of 'pumping' the lesson without which the lesson could not 'live'.

First, Ricardo's and then Karla´s intervention strongly react to Cesar´s use of the heart. Ricardo supports the contribution of the students but believes this is subjugated to the teacher because *"the teacher must be the guide"*. Ricardo used to say this expression *"quote-unquote"*; for example, in session five talking about an 'ideal lesson' he said:

> **Ricardo:** The problem is that in the national teacher evaluation {which includes a surprise recorded lesson} one can say quote-unquote that the lesson is fixed in advance and one redoes it I don't know how many times before! Some colleagues even take out problematic children.

Coming back to this episode, Ricardo's use of the expression sounds as if what he is saying he is forbidden to say; hence, the use of the figurative form might be suggesting something less popular after Cesar's intervention of the students being the heart, similar to what Ricardo said regarding the national evaluation when the lesson is fixed.

Karla, supporting her previous intervention of the contribution of the student as subordinate to the teacher's role, talks about *"clarity"*, saying that *"one"* – herself as the teacher – *"has the clarity"* of where to go. Coming back to the analogy with the *Lazarillo*, Karla finalised her intervention by saying *"the person not talking has that clarity"* because he or she can see the destination, hence knows in which direction north is, and the one who is guided – the one not seeing – should trust in his/her guiding. Even though it has been discussed that the path is important, according to Karla, the destination is more important. She is granting the role of the students guiding but she added another layer of complexity which is to know the destination. Teachers can let the path take different approaches by the students' decisions, but the teacher must decide the final point: the "*north*".

After Karla's intervention the conversation continued for a few minutes more with Cesar bringing up a foundational question *"are we just talking about the word 'guide', uh?"*, pointing out that it was assumed that the whole group understood it in the same way. Cesar was troubling the meaning of guide in the last part of the commentaries, concluding that if the question is applied to the classroom, the students would be the guide which is different if the scenario is a scientific project where the teacher will pose the question. Cesar and Javier reached an agreement regarding the role of the questions guiding, talking about the key *"place of the questions"* made by the students in the classroom. Javier was sealing the agreement with an *"exactly"* closing the discussion. In doing so, Javier revealed his understanding of the role of questions regarding inquiry saying that the *"questions are going to guide the inquiry in the classroom"*. With that intervention, this motivational part of session three finished making room for the main activity of the morning.

After the *Lazarillo* activity, the schoolteachers worked with different versions of research questions they produced. The work around them allowed me to depict what I came to identify as Trajectories. The following section explores the work with research questions before unpacking Trajectory I.

5.2.2 The role of research questions in the course

Schoolteachers
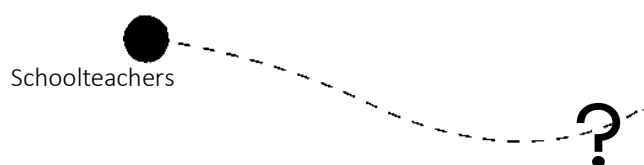
In the above diagram, the question mark illustrates the work around research questions in the CPD course. This work gained in significance throughout the course, and this was expressed in changes in both the course's design and its implementation. In terms of the design, the sessions were changed to give more space to work on the creation of research questions, which also allowed discussion and reflection regarding that work. In the third session (afternoon) there was another motivational activity to reflect about an activity held in the morning (called face-to-face activity, see Appendix 4) which is depicted in Trajectory II. In Trajectory I, the key episode of the fourth session (afternoon) is unpacked. In this session the schoolteachers were working with their different versions of the research questions aiming to compare them.

During my analysis, I came to identify that the process of creating research questions was worthy of attention because it allowed me to illustrate the subjectivities of the schoolteachers around the role of being a teacher/student and their understanding of the scientific process shaped by pedagogical and epistemological positionalities. Besides, this process was also significant for the schoolteachers working on it. In a follow-up question through email sent on 9th May 2019 – the last day of the course was 11th January 2018 – I asked: "*Thinking on the NIPDE course, do you have recollections of some content, topic or situation that feels more meaningful?*". I received 11 answers. One of the answers was Javiera's:

> Many things come to mind (.) for example, the creation of the research question in the eightathon (.) how difficult it was for me and my colleagues (.) Many times we commented how difficult the NIPDE was; because it was a situation that collapsed you a little (.) everything you have learnt before does not help you much since it puts you in another position, as in another place (.) then it makes you think twice, it makes you think how you can teach these things to your students to go home feeling more than that one had learnt something (.) that was what we talked about when we {she and her colleagues} were on our way home, what we have learn to teach in our classroom, uh? what was that 'chaos' that you {university teachers} provoked in us (.)? A snap on our mind that allows us to identify what to do (.) because now I know that my students are going to learn if I ask them question after question after question to make them answer or generate more questions; like you did with us (…) (audio record follow-up question).

Javiera said that the course put her *"in another place"*, which is part of what I attempt to illustrate in this chapter. Similarly to what is said by Javiera, the work creating questions generated that *"collapse", "chaos", "click"* to reflect how to teach and what is learnt. In what follows, I will develop further what was elicited during the course regarding the creation of research questions.

5.2.3 Trajectory I. Creating research questions: Involved in the chaos

Creating research questions: Involved in the chaos
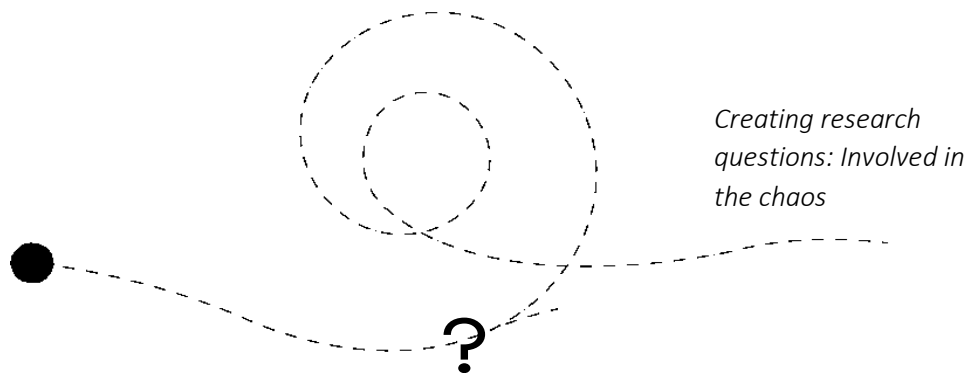
"Creating research questions: Involved in the chaos" is the title inspired by the key episodes which reflect the trajectory of the schoolteachers while working on developing research questions. The pedagogic and epistemological positionality is explored, trying to understand the meanings associated with 'chaos', how these are contested, and the ways in which engagement with the development of research questions might affect participants' positioning in relation to 'chaos'. The trajectory (drawn as a spiral in the diagram) will be illustrated with extracts from the third and fourth sessions of the course.

5.2.3.1 Shifting pedagogical and epistemological positions: research questions generating chaos

The schoolteachers, when commenting on the process of creating research questions, used the word 'chaos' to refer to it. Even though the word was repeated in various participants' utterances during the episode, the meanings attributed to it were different.

Before diving into those meanings, a summary of the key moments. The main activity of the afternoon part of the fourth session was to compare the various versions (at least three) of the schoolteachers' research questions. After working on that, Daniel – from the university team – conducted a plenary intending to create a list of *essentials*[48] of 'how schoolteachers can create research questions with their students', eliciting the first moment that 'chaos' appeared. Related to the ways of engagement, part of the third and fourth session will be used.

5.2.3.1.1 What participants' meanings are associated with 'chaos'?
5.2.3.1.1.1 'Chaos' means difficulty
Ricardo seems to associate 'chaos' with a process that is 'hard' and 'difficult', while Daniel disputes that position, suggesting that the hard work is optional:

> **46:08**
> Ricardo: It was <u>hard</u> to <u>make the structure</u> (.) that was the most <u>chaotic</u> for me (.) it was difficult to identify the <u>variables</u> (.) taking my question to something more schematised.

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[48] The resulting list of essentials: The topic should be significant (self-interest); To share, to comment and to validate the question/process with others; To feel comfortable with the question; To identify factors and variables involved; To generate guidelines/a structure that guides the work; The generation of chaos/de-structuration from which build it again; To reflect on the process; Progressing from the general to the most specific; To get involved in the process; To be humble, recognising that you do not know everything, do not get frustrated and admit that everything is perfectible.

> **Daniel:** Ok, I could interpret your answer as "if it is difficult for me better not to do it" <u>why make my life difficult</u>, uh?
> **Ricardo:** Nope, because that activity, later on, allowed me to build the final question (.) without that I would not have the schematisation of what I have to do (.) then I will not be able <u>to reach a final structure</u> (.) and I <u>must learn how to do that organisation</u> (.) ma:ybe with the children I will also have to get a schematisation from where the structure is generated
> **47:01**

Ricardo seems to be using *"hard", "chaotic"* and *"difficult"* as synonymous while talking about the process. When Ricardo says *"make the structure"*, he is referring to an activity that consisted in separating the question into its parts, such us identifying dependent or independent variables in a cause-effect relationship. Daniel, as if the difficulty were avoidable, draws out a reaction from Ricardo who strongly disagrees because the process of separating the question into its parts seems to be important to *"reach the final structure"*. This epistemological understanding of questions that can be separated in parts or parts that can be put together to build questions is the first approach to unpacking the nature of the process of creating questions whilst also acknowledging the necessary difficulty associated with doing this.

With uncertainty, Ricardo stretched the word *"may:be"*, which seems to be implying his sudden idea that the students could experience the same process. Pedagogically, Ricardo's intervention also suggests a position where a teacher first *"must learn how to do that organisation"* to then teach the students how to do it. In that sense, the process of creating the research questions seems to be a demanding but necessary requirement for someone who wants to learn how to create questions.

5.2.3.1.1.2 'Chaos': the engine getting going

Javiera seems to associate chaos with an individual experience, a process of reading, and energy necessary to continue; as before, Daniel challenges Javiera's position, eliciting a deeper explanation:

> **47:26**
> **Javiera:** It happened to me that <u>his *chaos*</u> was also <u>my chaos</u> because I didn't come to the last session (.) so even though there was chaos I said I must get a question regardless of my non-attendance (. hhh) it was quite significant because I realised that it w:as possible (.) you had <u>to read it five times</u>, but you could get the <u>final question</u> (.) you could get the variables, the cause-effect relationship and so on (.) it was difficult but possible
> **Daniel:** Could you <u>avoid</u> that <u>anguish</u>?
> **Javiera**: *No*
> **Daniel:** Do you think <u>that chaos is necessary</u>?
> **Javiera**: *Yes*, for me chaos was necessary because it was the initial <u>engine that moves</u> you to reach a research question (.)
> **48:20**

Chaos seems to be felt as an individual experience as indicated by Javiera when referring to *"his chaos"* as opposed to *"my chaos"* which could mean that it is different for everyone, somehow a subjective process. Daniel added another synonym to chaos as *"anguish"* and, similarly to what happened with Ricardo, with this provocative question of avoiding the

chaos/anguish, Javiera answered with an emphasised *"no"* which was followed with *"chaos is necessary"*. Javiera's utterance implies that chaos is an individual experience which provides the initial energy that triggers the process, which would have pedagogical implications considering the different students in a classroom posing the necessity of awareness of how this initial energy is experienced individually. That also has consequences in the CPD course which I will refer to when examining the schoolteachers' ways of engagement.

Javiera – like Ricardo before – is talking about reaching a final product – *"final structure"*, *"final question"* – suggesting that the research question is something that could be reached, finished, completed. This revealed another epistemological understanding of the scientific process of creating questions which could be iterative – *"read it five times"* – but reaching a culmination point.

5.2.3.1.1.3 'Chaos' in the process of creating a research question

A contested meaning of chaos is posed by Ivan, influenced by his disciplinary understanding. In addition to a question about the meaning of 'chaos', there is also a question about how 'chaos' is related to the process of creating research questions:

> 48:55
> **Ivan:** There are entropy and chaos, uh? What do we mean? Because usually chaos is considered as disorder and <u>chaos is not disorder</u> so I´m still thinking of that –
> **Daniel:** [It seems that during the process of creating a research question it will be necessary to <u>unstructure oneself a bit</u> (.) do not be afraid that the things I would pose at the beginning are not correct (.) <u>we are</u> <u>treme:ndously</u> accustomed to deliver the activity with the question already made (.) we felt <u>secure</u> (.) In <u>this exercise</u>, you have somehow been exposed to a *basic* <u>level of chaos</u> (.) you had realised that the initial question wasn't researchable (.) that was stressful (.) having gone through a full course in 2017 and still having difficulties with the research question which seems <u>tremendously simple</u> while it is not
> **Ivan:** However, <u>when one teaches physics</u>, entropy is chaos (.) so one of the questions that one asks is what is chaos? The majority answers that chaos is a disorder, and that is a <u>tremendous mistake</u> because chaos is not mess, uh? chaos refers to the fact that there are <u>unpredictable situations</u> (...) that is why it is said that the butterfly moves the wings and something happens elsewhere, and that is because there are several variables immersed in the process that sometimes a single variable generates an absolute change in the entire system.
> 52:34

Ivan and Pedro are the only two teachers who work in secondary education. Ivan is a biology teacher, and he seems to be addressing the understanding of chaos from a scientific perspective. For that reason, he remarks that *"chaos is not disorder"* which seems to be a common misunderstanding. Daniel's point is rather different to Ivan's; he tries to unpack the point of the discussion about chaos related to the process of creating questions whereas Ivan makes a point about the scientific meaning of chaos.

When Daniel said *"we are"* he is positioning himself in the role of a teacher. He is bringing back the conversation to a pedagogical positionality. With this utterance, teachers are encouraged to design learning activities that do not necessarily start from the students´ questions. With the stretched word *"treme:ndously"*, Daniel seems to be saying that it is the most common situation in a typical classroom that it is felt as "*secure"* and from that, the necessity is to

"unstructure oneself a bit", namely, embrace the chaos. In this utterance, chaos also meant not to be afraid of being incorrect in the classroom.

Nevertheless, when Daniel talked about *"this exercise"*, he was coming back to the scenario where the schoolteachers are the students creating research questions in this CPD programme; in that scenario the schoolteachers have been *"exposed to a basic level of chaos"*. That seems to be related to Daniel saying that chaos is something external to the teachers, different from Javiera's understanding of personal experience. Daniel is talking about two positions, one as a teacher in a classroom where there is one fixed way to undertake the activity and another where chaos seems to be the motto to learn. It bears noting that in the first scenario Daniel said *"we"* teachers are accustomed to delivering the activity without the students´ questions while in the second scenario it is *"you"* as students who have been exposed to chaos. It seems that in terms of the pedagogical positionality, the schoolteachers have been experiencing the position of the students while the university team takes on the role of teachers.

Epistemologically, Daniel suggested that the creation of research questions had been understood as a simple task and now the schoolteachers realise that is not the case which triggered Ivan's comments about the meaning of chaos. Ivan attempted to use his authority in the matter: *"when one teaches physics"* refers to the scientific understanding of chaos. He is more direct delivering his position about the meaning of chaos as a disorder, using Daniel's adjective (tremendous), which he says is a *"tremendous mistake"*, invoking the scientific definition of chaos as the unpredictability of the situations and their results in a system. With this utterance, the 'unpredictability' associated with 'chaos' seems to be part of a pedagogical (in relation to learning) and/or epistemological (in scientific understanding of the word) which opens up the following question.

5.2.3.1.1.4 Meanings of 'chaos': pedagogical or epistemological?

Throughout the previous section, I showed how participants were using the term 'chaos' differently. For some, this seemed to connote their experience of the process of constructing research questions, while for others it was part of the epistemological discourse of science which also has to do with the nature of science. Some tensions arose within the epistemological dimension of the work as a secondary teacher, Ivan, reverted to the scientific definition of 'chaos' which differed from definitions being applied by other members of the group, such as Javiera, Daniel, and Ricardo who define 'chaos' as an accompaniment to learning. However, there seems to be agreement regarding what happened while working with research questions as something that generates anguish, mess, restructuring and analysis of one's own learning processes. In that sense, 'chaos' is used in both a pedagogical and an epistemological sense; the pedagogical position seems to be moving the schoolteachers in a similar direction while the epistemological dimension of the work shows some tensions between the schoolteachers which could be related to the level – primary or secondary – at which they teach.

> 52:38
> **Javiera**: so, it was a chaos
> **Ivan**: a little mess
> **Daniel**: unstructured (.) thinking of what Ivan said, we can leave it like th-
> **Franco**: [I think that the *sweep-you off-your-feet* feeling was because of the analysis of one's own process

> Javiera: that is the <u>problem that we, teachers, have</u> (.) because we do not analyse as deeply as it should be to reach the research question (.) <u>we ask our children to create a question</u> and when they show us the result we say "Ok, that's fine" so <u>we don't sit down</u> with them to check if the question is <u>ready, or something is missing</u>
>
> 53:29

Javiera's utterance assumed that all of them are referring to the same thing. Ivan corrected her saying a *"little mess"*, Daniel offered a buffer position saying that we can call it *"unstructured"*, and Franco closes the conversation using another phrase to refer to the process which is the *"sweep-you-off-your-feet"* kind of movement.

Considering the pedagogical positionality, Javiera introduces the *"problem that we teachers have"*, meaning the problem of an absence of reflection, but not just in terms of the teacher's process but the students´ process as well. The work with research questions opens up the possibility of analysing the train of thought, regarding the scientific process and also the learning processes of both teachers and students. It seems that Javiera is comparing the situation with the students in their classroom to what is happening in this CPD course because *"we ask our children to create a question"*; however, it seems that in their classroom – contrasting with the CPD – there is no space to discuss the resulting question. Arising from this realisation of the 'problem' of teachers not adequately reflecting on either their own or their students' learning experiences, it becomes possible for the teachers in the CPD to adopt this student position, assuming an awareness of developing the skill first in themselves and then in their students.

One could think that Javiera is also exposing how she read the strategy used in the course where we (university teachers) ask the schoolteachers to create a research question which is analysed by the schoolteachers or a colleague or with the university team – trying to identify if it is *"ready, or something is missing"* which could generate the 'chaos'. That process of creating research questions was developed in a subsequent part of the key episode, addressing the idea of how 'one' could experience this process alone and how 'one' could be involved in the process.

5.2.3.1.2 How were the schoolteachers engaged with the process of creating research questions?

5.2.3.1.2.1 Involvement in the process

The engagement with the development of research questions affected participants' positioning about 'chaos'. That is expressed as the 'involvement' in the chaotic situation, meaning "*something internally said to oneself to look for the thread*" and as a result if *"one becomes more involved in the subject it is possible to delimit the research"* (Caro's utterances). Daniel took that intervention to ask about how one can get involved:

> 58:23
> **Caro:** It makes you get involved when you start <u>talking about the problem</u> because <u>happily,</u> we are a team from D1, right? when we leave for D1 or <u>in the house</u> or <u>at any time</u>, we are talking about the topic (.), so you begin to ask <u>more and more questions</u> (...)
> **Daniel:** [It may also contribute to the involvement that <u>another known, or not-so-known, colleague</u> asks me <u>questions that I had not thought</u> about it
> **María:** That <u>involvement happened differently</u> for me (.) I left the first session thinking that my <u>question was excellent,</u> but in the following week the <u>question was destroyed</u> ((laughs)) (.) what cost me the most was <u>to change it,</u> but when I got involved <u>I never felt comfortable</u> with it (.) I

thought the question also has to do with me feeling that it is <u>possible to carry out</u> with my students (.) so I never felt comfortable until I reached the third version.
1:01:00

Caro, considering her experience, offered an answer based on *"talking about the problem"*, acknowledging that it is important to share something, in this case, the district, but also the house or the travel, with the one you are talking to. As in other parts of the key episode, the positionality gave rise to some affective response; in this case, Caro said *"happily"*, referring to the shared district. The result of this familiarity – colleagues from the same district equal to *"in the house"* – is *"to ask more questions"*. In that sense, Caro´s utterance is suggesting the idea of getting involved because of talking with another who knows you in a familiar way which allows you, rather than receiving answers, to continue the questioning. This involvement, because of the familiarity, resonates with the discussion of trust in the metaphoric pair where knowing the other in advance seems to have positive results in the guiding – in this case, in the ability to question.

Caro seems to suggest that to get involved and ask more questions to oneself *"at any time"* during the process of creating research questions trespasses the school or the CPD situation. In that sense, asking oneself questions could be understood as generative *("more and more questions")* and transversal *("at any time")*, meaning also that the process of questioning can become an epistemological position.

Similarly to what happened with the meaning of chaos as personal experience (Javiera's position), María offered another experience of involvement. The reflection around the question is not harmless; in María´s terms *"the question was destroyed"* and on top of that, the involvement was translated to *"never felt comfortable"* until she reached a third version of the question. In that sense, the involvement is reached talking with others; however, as a result of this talking, the question may be destroyed, and this may generate an affective response such as a degree of discomfort.

In terms of an epistemological position, María pointed out another situation regarding the question as a product that is finished; *"my question was excellent"* seems to be related to a thought where knowledge cannot change or where it is not usual for an idea to be changed. In that sense, the question could be *"destroyed"*, because the question was previously settled. Therefore, what generates more effort was to *"change it"*, not just the question but also the understanding of how the process of creating a research question happened; namely, questions can change. Finally, María added that it is not just conversation with others that is important for involvement but also feeling that it is *"possible to carry* {it} *out"* with the students. In this sense, this other who is giving feedback to the question is also the student in the mind of the teacher.

5.2.3.1.2.2 Involvement with *others*

The role of this other – colleague, student, theory – in the process of involvement is also discussed as generating a change of vision. Pedagogically, there is also a recognition of this other as more knowledgeable, assuming a position of willingness to receive feedback. Epistemologically, there is a movement from thinking that the question could be the best or perfect – or worst/imperfect – to creating a question that can be shifted without that dualism.

1:01:40
Ricardo: <u>At the beginning,</u> we all thought that our question was the <u>most spe:ctacular</u> but then in the <u>interaction</u> or holding <u>the other who knows a little more than oneself</u> helps you get ahead and transform that *vision* (.)
Ivan: <u>We believe</u> that we <u>are sure of many things</u> (.) in the morning {talking about a motivational activity} my word was *disappointment* but not for the course, I said disappointment because I was not able to solve something that <u>appa:rently is or seemed simple to me</u> (.) I found my question <u>specta:cular</u> I wanted to go out with it in a banner ((laughs)) but when I was interacting with my colleagues, or I saw more <u>theoretical foundation</u> I realised that the question was embarrassing.
1:03:23

The process of creating the research question has a mode of restructuring which allows you to get involved in the process that cannot be conducted alone, so it is not just the process of creating the question but also the conversation with *other* which opens one up to the possibility of changing the *"vision"*, in Ricardo's words. The change of the *"vision"* seems to be related to both the fact that the question was not complete and to the existence of an *"other who knows a little more than oneself"*; in that sense, there is also a recognition of this *other* as more knowledgeable, demonstrating an open mind/willingness to receive that feedback.

Epistemologically, the change in the vision allows the movement from thinking that the question could be the best or perfect – and the contested worst/imperfect – to envisaging a question that can be shifted without that dualism because the nature of questions is to be generative. Pedagogically, accepting this other as more knowledgeable or having some knowledge that can complement/extend one's own knowledge opens the possibility of a more democratic dialogue between the ones who are participating in the interaction.

Ivan answers to both positionings, agreeing that *"we believe"*, meaning the teachers, *"are sure of many things"*, so the initial positioning as a teacher is his/her knowledge and when that position is shifted, Ivan introduces the affective reaction of *"disappointment"*. In terms of the nature of science, Ivan is saying that the creation of a research question *"appa:rently"* is simple, that stretched word seems to be referring to the common knowledge of thinking that questions are easy to manufacture. Using Ricardo´s words, Ivan also stretched the *"specta:cular"*, meaning that the question was right away complete with a sense of immediacy in doing it. He jokes around with the feeling of being proud of the work done; however, that pride changed to embarrassment while interacting with this other. Here, Ivan is defining 'other' as *"theoretical foundation"* colleagues, students or the theory could be this 'other' that allows you to modify the initial version of the question. In terms of the affective register, it seems that there are some affective responses more oriented towards epistemology uttered by Ivan, such as pride or the feeling of deep pleasure because of their own created questions or disappointment or embarrassment while realising that the question could be changed while talking to this other.

With Ivan´s utterance, there seems again to be a sense of differential tensions around the epistemological dimension of the work from being a secondary teacher teaching science where the understanding of creating research questions has this sense of immediacy which is expressed in the *"seems simple to me"*, as a process that he is accustomed to undertaking.

Following Ivan, Daniel reveals the positions of both school and university teachers in the CPD programme:

> 1:03:24
> **Daniel:** The <u>awareness</u> about the interaction between <u>you in this role of students and for us in the role of teachers</u> is important because for us will be <u>a lot easier</u> to tell you <u>"NO, Ivan</u> (.) <u>that is not the question</u> you must go this way" (2) how do I <u>get the balance</u>?
> **Ivan:** With this <u>interaction between colleagues</u> and something extremely important which is <u>humility</u> when you offer feedback because if others tell you "hey, that is wrong" it is <u>hard to accept</u> –
> **Ricardo:** [<u>Trust</u> the person who –
> **Daniel:** [Because you get <u>desperate</u> as a teacher, I want my students to feel that they can do it (.) if I see them struggling, I shouldn't say "this is the answer, stop" ((laughs))
> 1:05:23

Daniel´s utterance seems to be explicitly addressing a pedagogical positionality when he introduces the different positionings, *"you in this role of students and for us in the role of teachers"*, as the roles that all of us are taking on in NIPDE. The schoolteachers as the students are the ones who are creating the questions and the university teachers are the ones who are evaluating that question. At another level, Daniel imagined a fictional teacher in a role where he or she is the owner of a correct answer which can be delivered to the student, giving importance to the product rather than the process. With this very conversation, there seems to be an agreement that this fictional teacher is not present in this CPD, because, as Daniel uttered, there is no one saying *"NO, Ivan"*, which could mean that the CPD is not an Initiate-Response-Evaluate (IRE) model of questioning. In this case, it seems that the CPD generates more and richer questions.

The awareness of being the students in the CPD course is indicated by Ricardo acknowledging both the *"interaction between colleagues"* – or students in the case of the classroom – and the *"humility"* to accept the feedback that could be *"hard to accept"*. Ricardo and Ivan are talking as students, almost speaking to themselves – the humility to accept the feedback, trust the person – and Daniel from the perspective of teachers who can get desperate because their students are having problems reaching the answer. In here, as opposed to the affective response of Ivan (proudness, embarrassment, and disappointment), the affective register of 'desperation' uttered by Daniel seems to be more oriented towards pedagogy because of the impossibility to provide an answer to the students. Another affective response that appeared is the schoolteachers' frustration which could be oriented towards epistemology (or the nature of creating research questions), which is explored in depth in what follows.

5.2.3.1.2.3 Involvement: frustrated and challenged

This sense of a necessary struggle which is expressed by some schoolteachers as feeling frustrated but challenged, resulting in their being willing to be involved in the 'chaos'. Those utterances were delivered in a conversation before the main activity of the afternoon[49] of the third session. Javier started the conversation saying that *"regarding what you have been*

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[49] The main activity of the afternoon third session was the eightathon which consisted in separating the research question into its parts, allowing the identification of variables, relationships and/or other elements.

writing in your journal we wanted to ask you how you have felt at today's session? Whatever the feeling is it would be good if you could share it? Feelings are not wrong". Ricardo and Cesar answered as follows:

> 05:10
> **Ricardo:** When I come here <u>I have not felt tired</u> (.) when I'm tired I fall asleep, but here there is no feeling of tiredness (.) today I felt that I don't <u>know much</u> and that makes me <u>frustrated</u> but also to be <u>awake</u> and have that <u>urge</u> of learning more (.) I always question myself if I know something if not, I like to learn, and I <u>need to know more</u> (.) what does that lead me? To feel that <u>I'm behind</u> so I like <u>what happens here</u> it makes me <u>happy.</u>
> **Cesar:** Ricardo, you're *absolutely* right (.) in fact, I feel like <u>I'm nothing</u> or I don't know anything ((laughs)) I don't know, like <u>what are we in the universe?</u> I talked with you {pointing to another colleague} <u>do we lack that mu:ch?</u> that is a reflection that <u>one as a teacher</u> often <u>struggles</u> to assume (.) so thanks to the work we are doing with the questions we realise that (.) we have <u>flaws,</u> we still have a lot to learn and here one <u>critique oneself</u> (.)
> 07:10

As previously developed, in this extract there are relevant affective responses to the work around creating research questions. When Ricardo said, *"I have not felt tired"* he might be referring to the fact that the sessions are conducted on Saturdays from 10 am to 5 pm, but even though each session is almost a whole day, he did not feel the necessity of sleeping. When explaining why he is not feeling that *"tiredness"*, he said that he is *"awake"* because of feeling *"frustrated"* and realising that he does not *"know much"*, which leads him to the "*need to know more"*. It seems that Ricardo has a set of contested feelings, namely not knowing much and frustration along with being *"awake"* and the *"urge"* to learn, at the same time feeling *"behind"* but *"happy"*. The struggle is *"what happens here"* in the course, which could be interpreted as how Ricardo felt the challenge of being a primary teacher in a science education course.

Building on Ricardo´s feeling of not knowing much, Cesar shows an existentialist perspective when he said, *"I'm nothing"* and, more than that, he questions *"what are we in the universe?"* followed by a profound question of *"do we lack that mu:ch?"*. It seems that the positioning as a teacher or even as a being in the universe is scrambled; the stretched 'mu:ch' may sound as if it is almost an incomprehensible amount of lacking. Cesar seems to acknowledge that *"one as a teacher"* is very knowledgeable, which may feel different in the course because of the work around questions. His epistemological positionality seems also to be affecting somehow his ontological position regarding the knowledge and his role. Cesar´s struggle has to do with teachers recognising that they have flaws and do not know everything; he is positioning himself as that teacher, and he also signalled that the whole group of schoolteachers share the same struggle. The questions seem to be facilitating the awareness of these shortcomings in what some imagine the role of a teacher to be and the possibility of criticism, which is related to learning, in Cesar´s words.

5.2.4 Trajectory II. Creating research questions: Outside the chaos and limping

Creating research questions:
Outside the chaos and
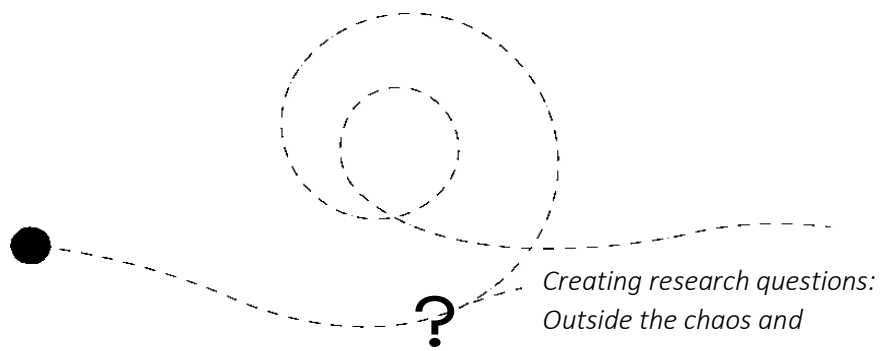
"Creating research questions: Outside the chaos and limping" is the title inspired by the key moment which reflected the trajectory of schoolteachers' subjectivities as an example of not engaging with the work around research questions. Trajectory II is illustrated with a continuation of the afternoon of the third session.

5.2.4.1 Unwillingness: frustrated and limping

Before continuing the episode, and to give more context to this section, I will present a flashback in the morning of the third session via the following comic strip:

Nicia was one of seven schoolteachers who did not come to the second session of the course, so she did not have an initial version of her research question before this third session. To take account of this, the university team took all the schoolteachers who were not in the second session to another room; in there, Nicia and the other six schoolteachers developed their initial version of the question in 20 minutes (the activity called *the flower*, with the initial version of the question was developed in three hours during the second session). Then, these seven participants returned to the main classroom, and the face-to-face activity took place. It was

presented as an encounter between pairs where the criteria to evaluate research questions[50] were created. The activity lasted until lunchtime and Nicia came back to the classroom after lunch. Javier asked if there was *"any final opinion"* which was answered by Nicia and Ivan:

> 09:02
> **Nicia:** regarding how we feel today, personally and like my classmate over there (.) I missed the lesson last week (.), so today I felt like *limping* (.) I couldn't finish the activity, so I felt frustrated (.) I don't think that if I am not sure about what I did I can criticise my partner (.) neither to accept any criticism of my unfinished work (.) personally, I do not like the designated work (.) because I have to feel comfortable working with the person (.) I understand that we are talking about community (.) but like at school, we create a community with whom we have some affinity (.) that bothered me, and I show my discomfort (.) I can't hide it; it is the way I´m (.) I will show my discomfort (.) I felt limp in the activity (.) I saw Paulina's email, but I did not read it, I did not have time, I feel tired (.) but it did happen to me that when I get here, I forget everything else and I have a good time (.) it is a shame to get up early on a Saturday to come here, but when we get here the feeling change (.) I leave happy, I have a good time, it's a nice atmosphere, but today I felt limp, frustrated
> **Ivan:** I think we are in a time of the year where we don't want any *more*, our students don't want any more and besides the course, we still have a lot to do (.) however, I can also say that when I get in the car in the morning to come here (.) I come happy (.) trying not to exceed the permitted speed ((laughs)) but happy and as many have said, I feel good (.) we knew the teachers {university teachers} and I feel very pleased with you (.) also grateful because it is more practical (.) I have very good experiences but also with a lot of theory that does not always match the reality of the classroom (.) so what I expected was to be more practical, and I think we are achieving that (.) I realise that others know more than you (.) we realise many things ((noise)) there were things to change and maybe everything changes and I got frustrated and felt complicated but eager to move on.
> 13:13

Nicia started her utterance, remembering her non-attendance in the second session, so her presence in this third session felt like *"limping"*, and as a result, she felt *"frustrated"*. Here, the meaning of frustration seems different to what was discussed before where Ricardo posed his frustration along with being *"awake"* and the *"urge"* to learn at the same time of feeling *"behind"* but *"happy"*. Nicia says she is frustrated and *"limping"* and this makes it more difficult for her to answer the question.

Regarding this *"unfinished work"* she said that it is not possible to *"criticise my partner* (.) *neither to accept"* criticism which is also different to what was discussed in the second key episode, Trajectory I, where the conversation was around the impossibility of conducting this process alone *"because sometimes one is narrow-minded and this other can tell you if the question makes sense"*, uttered by María. In that sense, Nicia is occupying a very different

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[50] Criteria: 1. It should be natural, phenomenon-based; 2. It should allow data to be collect and measured; 3. It should be objective in terms of not being based on an intuition of personal interests; 4. It should be executable, in terms of: (a) available time; (b) resources; (c) appropriateness to the level of schooling; 5. It shouldn't be a factual question, namely, it cannot be answered with a bibliographic reference. It should be a question which requires research; 6. It should considerer diverse variables; 7. It should be able to guide to the proper methodology (qualitative, quantitative). These criteria were evaluated under the question *"Does the question meet the criteria?"*.

positioning regarding what does it mean to be frustrated and to receive feedback from others, also resulting in another way of engagement.

When Nicia said, *"personally, I do not like the designated work"* she might be revealing the origin of her frustration mixed with the short time to complete the work. First, she had 20 minutes to create the question and then she had this designated other to work with. Who is this other to her? It seems that the other is not, as Daniel uttered before, a *"known or not-so-known colleague"* (in Trajectory I), meaning that, as far as Daniel is concerned, it does not matter who is this other. In Nicia´s case this other should be someone with whom she has some *"affinity"* and she *"feels comfortable"*, which maybe is not going to be the case with the designated other. She suggested that this affinity is the way to build community *"at school"*; when this situation of her school is changed – the designation of another to work with – she is *"bothered"* and she *"can´t hide it"*. Why did the designation bother her? It seems that the designated person has a negative connotation to her as a punishment.

Nicia did not finish the course, which makes me think that she may never have felt comfortable with the methodology used. She recognises that she saw an email sent by me to keep the unattended teachers up to date. However, she *"did not have time"* to do something in advance, which is understandable considering the workload of the schoolteachers in Chile but nevertheless says something about her commitment to the course. Even though she may *"feel tired"* because of that pressure, the *"good time"* in the course makes her *"forget"* that tiredness because she *"leaves happy"* and she acknowledges the *"nice atmosphere"* which could perhaps be related to the relationship with her colleagues rather than her engagement with the topics of NIPDE. It seems that in this session, the feeling of having a good time was not enough for her not to feel *"frustrated"*, which makes her feel like she is limping.

Acknowledging what was said by Nicia of not having time or feeling tired, Ivan´s utterance starts with the *"time of the year"*; this session was nearly at the end of the school year in Chile which is usually full of finishing tasks with the students and with the school. The following part of his utterance seems to be in direct opposition to what Nicia said. The tone of Ivan is relaxed, making jokes to which people laugh in contrast with the bothered tone of Nicia when she says, *"it is the way I´m"*.

In direct opposition to Nicia´s *"like at school"*, Ivan said that this way of being more practical matches *"the reality of the classroom"*. Regarding the other, that could *"know more than you"*, he could get *"frustrated but eager to move on"*, realising that there are many things to change. Aware as well of the mismatch, the gap between what is taught in teacher education and what is happening in the practice of these teachers. It seems that Ivan is contesting every part of the intervention of Nicia, talking as the conceptualisation of the rest of the teachers – *"we knew the teachers"* and *"we realise"* – while Nicia was talking *"personally"*, being also the only one who went out of the room and who did not finish the course. In that sense, Nicia was alone in her position while the interventions of Ricardo, Cesar, and Ivan were more typical of the schoolteachers as a group. Maybe that can also help explain why she did not finish the course; this could be partly from an unwillingness to shift her pedagogical and epistemological positionality but also the way that she was left – by the university team, including myself – in her unshifted position.

5.3 Discussion

The purpose of this chapter was to explore the schoolteachers' subjectivities and its shifts (showed as trajectories/movements of the discourse) produced throughout the implementation of NIPDE. The work around research questions was planned in the initial design of the course; however, the university team did not consider in advance the productive nature that these types of activities were acquiring during the course while commenting and reflecting on them. The reflections around the activities of creating research questions became generative of responses in terms of scientific, social, and affective registers.

The main argument of this chapter is that when the course started, the schoolteachers presented settled – or if I may say 'oppressive' – positions where the teacher teaches and the student(object) learns (echoing Freire; see *2.1.1.2 Subjectivity from sociological perspectives applied to teachers' subjectivity*). However, because of being positioned in the CPD as students learning how to create questions, the schoolteachers started to develop a **new teacher-student-subject** relationship where the schoolteachers problematised – by critically unlearning – how they were initially positioned due to the reflections and commentaries around creating research questions in a space where they were involved with others (dialoguing with either other schoolteachers or teacher educators).

The generative potential of the work around research questions unpacking a new teacher-student-subject subjectivity was also pointed out by the schoolteachers, as shown in Javiera's utterance depicted in *5.2.2 The role of research questions in the course*. Javiera said the course put her *"in another position, as in another place"* which can be connected with Freire's understanding of the subject. Freire (1970) pointed out that there is a divergent relationship between a teacher-subject who deposits knowledge on an object-student as a container who receives knowledge, and that that relationship is shifted by a dialogical pedagogy where there is a reconciliation in the relationship towards being at the same time both a teacher and a student which seems to be what Javiera and the other schoolteachers felt as being in another position themselves, namely, the student-subject position. As depicted in the starting point 'Settled positions as teachers and students', a first reverberation of the teacher/student role is troubled by the introduction of the role of questions, understanding and curiosity also having a role, which can be related to unlearning something that 'must' be known as a teacher, thus, unlearning an oppressive position where the "teacher teaches and the students are taught" (Freire, 1970, p. 73). The position of being students allowed the schoolteachers to make a reconciliation with the students-subject, because they became that teacher-student-subject with a hyphen, illustrating the recognition of the other as depicted in trajectory I.

Trajectory I allowed me to illustrate the shifting positionalities in epistemological and pedagogical terms, as well as participants' contested meanings of concepts such as *chaos*. The notion of *chaos* repeatedly appeared on the commentaries and reflections around the creation of research questions, having both pedagogical and epistemological meaning for the schoolteachers. On the one hand, chaos meant unpredictability, from a physics understanding of the term. On the other hand, chaos in creating the research questions meant difficulty,

energy, and individual experience, at the same time as being productive, generating the schoolteachers' involvement. Even though the word meant different things to the schoolteachers, chaos was crucial yet elusive and polysemic, remaining indefinable but generative. Related to its elusiveness, Freire (1970) talks about the unfinished character of the beings "in the process *of becoming* – as unfinished, uncompleted beings in and with a likewise unfinished reality (…) In this incompletion and this awareness lie the very roots of education as an exclusively human manifestation. The unfinished character of human beings and the transformational character of reality necessitate education be an ongoing activity. Education is thus constantly remade in the praxis. In order to *be,* it must *become"* (Freire, ibid, p. 84). In Freire's words, there is a recognition of this unfinishedness yet acting on it throughout education, as a process of always-already becoming. During the course, and because of the work around research questions with the teachers, we did both; we tried to think how to teach/act – to make the students to experiment *"a snap on our mind"* as Javiera put it, but also we were able to unpack the moment of chaos/crisis, attempting to imagine, in a provocative way, the self-narration while failing yet becoming, or, as the schoolteachers pointed out, being frustrated yet challenged (*see 5.2.3.1.2.3 Involvement: frustrated and challenged).*

My claim is that the reflections around the activities of creating research questions became generative; why is this process a generative theme? In Freire's (1970) understanding, a generative theme trespasses the school to in a dialogue of "education as the practice of freedom" (p. 81), which in this case meant the shifting of epistemological and pedagogical positionalities of this teacher-student-subject. The dialogue between colleagues and the recognition of the role of *others* in the process helped the schoolteachers to shift their initial positionalities (see *5.2.3.1.2 How were the schoolteachers engaged with the process of creating research questions?)*. According to Freire, humans "exist in a dialectical relationship between the determination of limits and their own freedom" (p. 99), which makes them act in response to the challenge of, as in this case, thinking critically on the pedagogical or epistemological position regarding the creation of questions. In this exercise of reflections and commentaries around creating research questions, the schoolteachers 'became praxis' because they critically reflect on their positionalities, generating new ones on how they understand the process of creating questions (epistemological position) and how they are going to teach that process (pedagogical position). Freire concluded that a generative theme is generative precisely because it enables the possibility for a human being to "*emerge* from their *submersion* and acquire the ability to *intervene* in reality as it is unveiled" (p. 109 italics in the original). That is related to what Freire called an "attitude of awareness" (p. 109) which, for me, started with the commentaries and reflections on what does it mean to become a teacher-student-subject.

Regarding the salient features of the epistemological positioning, the schoolteachers understood that the creation of questions was not easy, and it was an iterative process. The questions can change which allows the schoolteachers to avoid thinking that there is a point where the question is finished or the best. Regarding the process, a question can be separated into parts or, conversely, from its parts they could create a question. When the nature of questions as generative was understood, the involvement with *others* (students, colleagues, theory, or oneself) in the process of creating question became more important. Pedagogically,

the question is not something that can be delivered via the common way to do lessons, namely as lectures. The position of the schoolteachers as students allows them to realise the complexities of their learning process and its implications for teaching their own students. A central component of this experience is the identification of the central role of humility and an openness to external inputs. In that sense, there is a change of vision with willingness to receive feedback, recognising the value of others' knowledge in fostering their professional capacities. Finally, the schoolteachers realised that is not mandatory that teachers know everything because the process of creating research questions involved more people; this echoes the teacher educators' subjectivities of allowing themselves to not knowing everything in advance (see *4.2.3 Trajectory II: "We don't know everything"*).

Regarding the affective register, the work around creating research questions elicited from the schoolteachers a response in terms of frustration, disappointment, and embarrassment, while realising what it means to create research questions; happiness and a sense of familiarity because of being involved in the task with others; or the affective reaction of leaving and not finishing the course because of the frustration depicted in trajectory II (see *5.2.4 Trajectory II. Creating research questions: Outside the chaos and limping*). All these affective responses were prompted by reflection on the work around research questions, oriented towards either epistemology or pedagogical positionings in the schoolteachers and in the university team. An important affective response was teachers recognising they have flaws and do not know everything. The questions seem to be facilitating the awareness of what some imagine the role of a teacher 'should' be and the possibility of criticism, which is related to (un)learning. I would add there is also the possibility of becoming by recognising our incompleteness. In here, I can see what Butler (2005) refers to a pedagogical narrative that seems very coherent yet begins to be unbound in relation to others which, ultimately, meant a particular subjective experience. In Butler's words unfinishedness could be the acknowledgment of the opacity which may not be conducive to transformation, rather to acknowledge the limits of the acknowledgement itself. There is a 'fail' to define the 'I' and the 'you' in the process of self-narration, in Butler's (2005) words:

> If the identity we say we are cannot possibly capture us and marks immediately an excess and opacity falls outside the categories of identity, then any effort to give an account of oneself will have to fail in order to approach being true (…) By not pursuing satisfaction and by letting the question remain open, even enduring, we let the other live, since life might be understood as precisely which exceeds any account we may try to give of it. (pp. 42-43).

When Butler refers to not pursuing satisfaction, this, for me, is related to the affective responses the schoolteachers uttered such as disappointment or frustration yet happy and willingly experiencing the chaos which may imply some sort of necessary suffering to mediate the awareness and the shifting positionalities.

As the work around the creation of research questions was crucial to unpack the schoolteachers' subjectivities in terms of epistemological and pedagogical positionalities as well as their affective response to it, then, my proposal is related to the way we were working

on the CPD unveiled to us (teacher educators) as we went. This emergent strategy opened the room for a sort of *pedagogy of the question* (Freire & Faundez, 2013) based on the dialogue amongst the participants of the CPD course as commentaries and reflections on the activities. What is generated in this pedagogy of the question? There are shifting positionalities in pedagogical and epistemological terms; this shifting is because of the reflections on the work creating questions; and this process also generates an affective response with references to chaos, frustration, and empathy, as well as different ways of involvement/engagement with the course. I argue that a pedagogy of the question can also reshape what is understood as professional development. Bell and Gilbert (2005)'s understanding of professional development – more in the sense of professional learning – is related to an interplay amongst personal, professional, and social dimensions of the teachers' practice which involves the revision of one's own practice necessarily associated with a process of deep reconstruction of the meaning of what it means to be a science teacher towards, as is in this case, a new science teacher-student-subject. This reconstruction occurs in the interaction with others, where the reconceptualisation of the meaning of teaching science becomes the first step to change one's practice or to act on the limit-oppressive-situation as Freire would put it.

As previously pointed out, this understanding is more related to a process of professional learning rather than professional development (Nilsson, 2014), where development could be related to developing some knowledge in relation to effectiveness, posing the issue on the other (Vaillant & Cardozo, 2016), rather than assuming a personal role and one's own responsibility on the process at the same time as positioning the actors (hooks, 1996). This understanding could be related to what Clarke and Hollingsworth (2002) pointed out as professional growth associated with a continuing process of learning illustrated in this study with the schoolteachers shifted position towards teacher-student-subject while understanding the complex process of learning (Clarke & Hollingsworth, 2002; Subitha, 2018). In doing so, teachers are situated as learners in a process of professional learning that it is not done *to* teachers rather it is *with* them. Thus, the word 'development' is related to effectiveness towards some standard/image defined by others, while 'learning' is related to one's own process, based on the position of teachers as learners from their own daily practices (Ávalos, 2002).

This positionality of teacher-student-subject could be related to what is described as the positionality of teachers as learners (Beavers, 2009; González et al., 2014; Loughran, 2007; 2014; Postholm, 2012; Shulman & Sherin, 2004; Smith & Loughran, 2017; Wallace & Loughran, 2003). Considering Loughran's understanding, this notion of teachers as learners is associated with an attitude of on-going learning which involves collecting and analysing evidence about one's own practice, which is what was happening on the moments of commentaries and reflections of the process creating research questions. If we consider the process of learning as social and situated, and learning in mutual interaction from others and with others (Couso, 2016; Postholm 2012), learning in collaboration with others became crucial. As shown in the chapter, the encounter with other could shape what we do, how that is interpreted and who we are in that interaction (Lieberman, 2007). In this CPD programme we move from the so-called culture of individualism related to teachers working in isolation without collaboration

between peers (Brookfield, 1995; Day & Sachs, 2004) towards a pedagogy of the question based on the commentaries and reflections with others.

To sum up, the salient features of the schoolteachers' subjectivities was initially characterised by fixed positions of who learns and who teaches in the science classroom. That positionality shifted because of experiencing the position of the *other* (in this case, a student's role) challenging the oppressive positions of the teacher only teaching and the student only learning. As a result, the schoolteachers' pedagogical and epistemological positionalities were also shifted. Affective responses, including disappointment, frustration and embarrassment, were prompted by these shifting pedagogical, and epistemological positionalities. However, the encounter and involvement with the *other* (colleague, student, university lecturer or even theory) became generative.

In the following chapter, I will explore the subjectivity of Dora and Ricardo teaching big ideas in science education. In Appendix 9 I present a second short pause which resonates with an iterative process of thinking with theory that was evoked with this chapter, namely, the second Interlude.

CHAPTER 6

Teachers' experiences of school science: problematising big ideas from policy to classroom

6.1 Introduction

The purpose of this chapter is to answer two research questions, namely, '*Under what conditions and institutional discourses do science schoolteachers develop their practice using big ideas of science education?* and *'How do science schoolteachers participating in a CPD programme conceptualise and respond to the curricular change of big ideas in science education and the CPD programme?*. In doing so, this chapter aims to explore teachers' subjectivities when teaching big ideas of science education that are produced in a scenario where discourses of the science curriculum, the university, and the schools are at play. The argument of this chapter is that in these contexts, there are contested understandings of what big ideas are, their role in the curriculum, and in science. In turn, these different understandings enter the classroom when teachers display their understanding of big ideas. This argument is built through an analysis that seeks to contribute to the science education field, adding other perspectives to the conceptualisation of big ideas and, as in previous chapters, the use of the analytical tool of dialogue by depicting discourses around big ideas in different contexts.

The first half of this chapter is concerned with problematising discourses from the policy level to the university level. The second half of the chapter explores the classroom level by drawing on the accounts of: Dora a facilitator in NIPDE; and Ricardo a student in the CPD course. In the chapter I examine the ways in which Dora and Ricardo are in dialogue with the curriculum, the university, and their schools.

The big ideas approach was incorporated into the Chilean school science curriculum soon after its translation into Spanish; it was externally informed and did not include schoolteachers' participation. At the university level, the NIPDE course has a conceptualisation that is broader than the curriculum. There is a tension between situated understanding and misrecognition of some consensus in science, and another tension between applying or questioning the big ideas approach. At the classroom level, Dora goes beyond what is asked by the curriculum at a specific level of schooling, showing fluidity between domains of science and in her pedagogy, like in NIPDE. Ricardo's experience is characterised by a situatedness absent in the curriculum, based on the use of daily things and self-appropriation of the approach related to the broader conceptualisation of NIPDE. Dora and Ricardo are teaching in different schools with discourses of standardised tests or the image of students being vulnerable and in need of pastoral care. Those school discourses are drawn on later in this chapter alongside an examination of the teachers' practice.

6.1.1 A summary of the context

6.1.1.1 The big ideas approach in the Chilean science curriculum

Under the leadership of Wynne Harlen in 2010, a group of ten international experts in science education developed a set of ten big ideas of science – theories, models and principles that explain the natural world – and four big ideas about science – how those scientific ideas have been developed (Harlen, 2010). In its genesis, big ideas were defined as "ideas that can be used to explain and make predictions about a range of related phenomena in the natural world" (Ibid., p. 17). This definition includes the concept of progression of scientific knowledge which is understood in the scientific domain and in daily life, from concrete experiences to broader ideas, and through levels of schooling (Harlen, 2010).

When the big ideas report was translated into Spanish, it was rapidly incorporated into the Chilean science curriculum. In 2012, a Spanish version of the big ideas approach was launched, and in that same year the big ideas' notion was incorporated in levels 1 to 6 of schooling. In 2015 it appeared in levels 7 to 10, and in 2019 it was included in levels 11 and 12. By 2019, the approach was incorporated in every level of schooling with the exception of pre-primary education. Before exploring in depth, the conceptualisation of the big ideas approach in science education in Chile, I will provide a brief account of Dora and Ricardo.

6.1.1.2 Dora and Ricardo

In a preliminary phase of my research in 2016, Dora and Ricardo – amongst other schoolteachers – answered a questionnaire regarding a possible personal account of their experience of teaching big ideas. In the main phase of my research, I conducted interviews with Dora and Ricardo, classroom observations of both, and interviews with the leading team in their schools (see Chapter 3 for a detailed explanation of my research design).

Dora has a full contract in a semi-private school and a zero-hours contract with the university, where she was hired only for this course. Dora was in every session of the NIPDE and most of the design meetings. In Chapter 4, I showed a Dora who was playful with her positionality, related to whom she was talking and considering the institutional context to which she was referring. If she was talking with Karen, Alvaro, or Carlos, all of them PhD holders with full-time university contracts (see for example *Trajectory I: Certainty "we are horizontal"* Chapter 4, p. 102), Dora was positioned from her experience as a schoolteacher in a school moving from 'we' the schoolteachers to 'we' the university teachers. If she was talking to Javier, Patricia, Juan, or myself, all of us without a contract with the university or a PhD except for Juan (see for example *Trajectory II: Attempt to know the schoolteachers* Chapter 4 p. 110), Dora positioned herself as part of the university team as 'we' and referring to the schoolteachers as 'they'.

Ricardo is a primary teacher in a public school invited to participate in the NIPDE after having also been a student in NIPD in 2015. In Chapter 5, I described Ricardo identifying the role of the teacher as the 'ultimate' guide of the lesson (see '*Starting Point: settled positions as*

teachers and students' Chapter 5, p. 122). Ricardo was one of the first schoolteachers who uttered the word *chaos* regarding the process of creating research questions (see *Trajectory I. Creating research questions: involved in the chaos* Chapter 5, p. 129). He suggested that chaos was unavoidable, not just in his professional process but also in the teaching of how to create research questions. Even though the creation of research questions was in his words 'chaotic', 'hard' and 'difficult', he realised the crucial role of questions in any science lesson.

6.2 Analysis

6.2.1 Different contexts: Problematising the big ideas approach in science education

This section depicts how the national policy – through the science curriculum – and the university – through the NIPDE course – are conceptualising big ideas of science education which are contested between these two contexts.

6.2.1.1 Discourse of big ideas in the Chilean science curriculum: Big Ideas in uppercase letters[51]

6.2.1.1.1 Curricular changes externally informed

The incorporation of the big ideas approach was not discussed by the schools, teachers, or students in the Chilean educational system. Rather, it was introduced by the Ministry who drew on "the world's trend" (Mineduc, 2015, p. 18) and "international comparative experience" (Mineduc, 2019, p. 11) to justify its inclusion. The big ideas approach was externally incorporated into the curriculum.

According to Mario, the Regional Coordinator of Science Education, the changes in the curriculum in Chile are usually based on international literature:

> It [the incorporation] has to do with the vision of literature that the Ministry coined. You can see how the literature influenced the changes, that is, who were the consultants or those who worked in it said, 'this is the line that prevails today worldwide'. It is common that we commissioned an international study of the curriculum of, let's say, twelve top countries seeking for common factors. (Mario's interview)

Since 2012, the changes in the Chilean science curriculum regarding the big ideas' framework have been dialoguing with the literature. As pointed out by Mario, there is a *"vision"* held by the Ministry that is also stamped in the curriculum. The literature selection by the Ministry is related to the political stance of the government at that time, which unilaterally decided which *"consultants"* would work on what is going to be included. The dialogue between the Ministry, the literature from selected countries, and the people called to work on the comparison is held far away from the schools. It is unclear what criteria were used to choose those *"top countries"*. 'Top' might refer to 'best' performance/practice in an international standardised test like PISA,

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[51] The idea behind referring to uppercase/lowercase letters in the title is a provocative way to identify the different conceptualisations of the big ideas approach. When I am referring to Big Ideas in uppercase letter is to indicate a concrete, fixed position which is going to be built in this section. In contrast, the term in lowercase letter refers to a more fluid conceptualisation which is the one attempted in the CPD programme developed later.

or 'top' may refer to OECD countries. Whatever the criteria, the strategy used seems to build a comparison with countries that differ from the social-political-economic reality of Chile even though Chile is an OECD country as well. The approach taken creates an idealised image of the 'best' guidelines rather than a curriculum that considers the context and draws on a situated dialogue between the Ministry, schools, teachers, and students.

6.2.1.1.2 Personal viewpoint of Inclusions and omissions

It can also be argued that the National Curriculum is the result of an individual vision. The changes in the curriculum are based on the judgement of external consultants or employees of the Ministry who have not consulted the teaching profession which is subsequently expected to receive the changes as an unquestionable mandate. In concordance with Mario's utterance, the responsibility of the curricular changes lies in some people, also addressed by Ramiro, the Regional Coordinator of Teachers' Professional Development, as follows:

> Do you know why the big ideas are in the curriculum? Because of Caroline Stevenson [pseudonym], she worked in the area of the curriculum of the Ministry at that time, and when they were discussing the changes, she was there, then you have her vision. But in my opinion, what the curriculum is missing is that if you have big ideas as cornerstone scientific knowledge, you should delete everything else. (Ramiro's interview)

There is an individual responsibility shaping that dialogue. In Ramiro's account, he clearly identifies who is responsible for the incorporation of big ideas into the curriculum. It seems that it is not a question of situatedness considering particular teachers, students, or schools; instead, it is *"because of"* the visions of some people working at that time or place. Following the idea that the changes in the curriculum are influenced by personal viewpoints, Ramiro offered his opinion that the curriculum should not have the same amount of content as before the incorporation. It equally is not just a question of inclusion but also what should be omitted. This was not, according to Ramiro, discussed openly during the curricular changes.

The curricular document of 2019 stated that from level 1 to 10 the work should be around the big ideas *of* science – seven out of ten – and then at levels 11 and 12 the big ideas *about* science – all four – are also incorporated. For some unexplained reason, three big ideas of science of the set are omitted: (2) Objects can affect other objects at a distance; (6) The solar system is a very small part of one of millions of galaxies in the Universe; and (7) Organisms are organised on a cellular basis. This could be related to Mario's commentary on what is added:

> So, if we have, I am going to say a silly thing, a hundred big ideas, we get eighty which are the most common, the ones that we can develop (.) the curriculum is very, how I can say this? It is very levelling down because teachers and students are grossly underestimated. I think that the Chilean curriculum should be growing every year. (Mario's interview)

In Mario's account, the explanation for the possible omission is related to an underappreciation of teachers and students. It is as if the teachers do not know Harlen's (2010) notion or they do not take their own decisions regarding what to teach. As I will explore later

in this chapter, Ricardo's lesson teaching big ideas is all to do with big idea (2) 'Objects can affect other objects at a distance' which, according to the new curriculum, should not be taught to the students.

In Chapter 4, I explored how the university team, while designing the course, were talking about 'levelling up' teachers who were not in the first training with our university. Here, according to Mario, policymakers are *"levelling down"* teachers. In both cases, there is an assumption of a lack of knowledge on the part of schoolteachers. However, concerns related to the excessive workload experienced by Chilean schoolteachers perhaps counter Mario's view that *"the curriculum should be growing every year"*.

6.2.1.1.3 Contested understanding of big ideas between levels

How the approach is expressed in the curricular documents is not stably articulated between levels of schooling in terms of its meaning, learning objectives, and aims in science education.

The conceptualisation of big ideas for levels 1 to 6 is understood as giving meaning *"to the natural world through identifying the relationships between phenomena"* (Mineduc, 2012, p. 71). Levels 7 to 10 treat them as *"relevant ideas or concepts, which are generative and applied to a diversity of phenomena within an area of knowledge"* (Mineduc, 2015, p. 18). For levels 11 and 12, big ideas are *"core concepts and ideas of science that can build other knowledge"* (Mineduc, 2019, p. 30). To 'give meaning' to *"relevant ideas"* or *"core concepts"* may mean a different level of hierarchy of the notion. It seems that the conceptualisation of 2019 is considering that the big ideas are embracing the whole content of science, being central to its existence in the science curriculum as Ramiro pointed out. However, in 2015 and 2012, big ideas are assumed just as a pertinent suggestion – *"relevant"* – to organise the natural world but not vital.

How inclusive big ideas are in terms of learning objectives is another issue. Learning objectives in the curriculum include the scientific content, scientific skills, and attitudes. For some curricular documents, the learning objectives are stated as 'developing' the understanding of big ideas plus skills and attitudes; in other documents, the learning objectives 'are' the big ideas (see Chilean science curriculum and its changes in Chapter 2).

From levels 1 to 10, Mineduc (2015, p. 133; 2012) stated that "*these Learning Objectives promote the understanding of the selected big ideas of science*". In this sense, the learning objectives are bigger and 'developing' understanding of the big ideas and the associated skills. Big ideas are only disciplinary content. In an appendix of the 2015 curricular document, there is a double-entry table[52] showing the learning objectives separated into biology, physics, and chemistry as columns concerning the seven big ideas from the set as rows (plus one big ideas that is not part of Harlen's proposal). Conversely, in levels 11 and 12 the big ideas 'are' the learning objectives. It is stated that "*the understanding of the big ideas of science is expressed*

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[52] The complete table is shown in Appendix 10 with the big ideas plus what was stated before without any deletions.

as Learning Objectives focused on learning outcomes and competencies" (Mineduc, 2019, p.11). In this 2019 curricular document, the double-entry table disappeared, and instead there is a proposition of how eight big ideas could be developed into three integrated new subjects, that are not biology, physics, or chemistry.

Because of the way the Chilean educational system is currently organised, the same teacher would teach from levels 7 to 12. Given discrepancies related to the meaning of learning objectives, the teacher is expected to shift her/his understanding of big ideas as disciplinary content when teaching levels 7 to 10 (separated by biology, physics, and chemistry) to understand it as skills and attitudes without the separation into biology, physics, and chemistry when teaching levels 11 and 12.

Another difference is how big ideas are posed in relation to the aim of science education. In levels 1 to 6 the aim is *"for the students to have a successful process of functioning in today's society"* (Mineduc, 2012, p. 70). This suggests a practical understanding of what science could mean to students' lives because it is seen as useful for functioning in society. However, for levels 7 to 12 the aim is about the scientific literacy of the students since *"Big ideas as a construct allows events and important phenomena of students' lives to be explained during and after their time in school"* (Mineduc, 2019, p. 30), which, in this case, is related to understanding any life event as visible through the eyes of science.

The policy discourse is the result of the confusing imposition of the notion on what I came to call the discourse of Big Ideas that is in *capital letters*, meaning that the conceptualisation of big ideas in the Chilean curriculum is externally informed and sudden, with incorporations or deletions made without the participation of Chilean science teachers. It is also not consistently articulated between levels of schooling. This discourse is passed to the schoolteachers, although there is another layer of complexity. The usual strategy used by the Ministry to make the curriculum accessible to teachers is through universities running CPD programmes. The universities are called to be a conduit between the curriculum and the teachers. As pointed out by Mario, *"NIPD is what is empowering the teachers regarding the new changes in the curriculum, the rest of the teachers who do not go through any NIPD do not reflect on those changes"*. In Mario's account, CPD programmes are the strategy preferred by the Ministry to make sure that the curriculum is understood. Without them, there would be no reflection. That utterance is assuming the teachers do not read the curricular documents by themselves or reflect on them without a CPD course. Besides, it is assumed that the CPD would have the same understanding of the curricular change.

The dialogue with the literature moves to the translation by the Ministry, then the Regional Authority, then the university, then the school, and finally, the teacher in his/her classroom. It bears asking how the university understands the conceptualisation of big ideas before exploring the experience of teachers in their classrooms.

6.2.1.2 Discourse of Big Ideas in NIPDE: big ideas in lower case letters[53]

6.2.1.2.1 Broader conceptualisation of big ideas without scientific content

We (the university team) did not receive any instruction on how to address big ideas – neither epistemologically nor pedagogically – when developing NIPDE. This is because there is no such thing as a 'curriculum' for teachers at the university level[54]. That freedom led us to start with an activity without scientific context to *"introduce ourselves to what the big ideas are"*. In the course, without giving a definition, the question of 'what a big idea is' was raised in the second session. It draws on the common knowledge of the schoolteachers using movies:

> **3:24**
> **Paulina:** What we are going to add is another main content of the course. That is big ideas of science (.) to <u>introduce ourselves</u> to <u>what the big ideas are</u> we want to invite you that on your trio or duo to <u>choose a movie</u>
> **Karen:** [One <u>you have seen</u>
> **Paulina:** [Yes, one that <u>you know</u> because you must answer three questions. <u>What</u> is or are the big ideas of the movie? <u>Why</u> are those the big ideas? And finally, <u>how</u> did you come to define that those are the big ideas? So (.) you should describe your process defining them (.) you have about <u>20 minutes</u>.
> **4:49**

The big ideas approach was a central topic in the course. It answered the call to act as the conduit of the Ministry regarding the curricular changes. Karen and I were the people in charge of this central topic. The activity with the movie had only one requirement which was to choose a movie that *"you have seen"* or *"you know"*, giving the possibility of different versions of what is going to be a big idea starting from different movies. That selection also assumed that it could be easier or friendlier to approach the construct from a non-scientific scenario where any film could have identifiable big ideas. This questioned the discourse in the curriculum that big ideas are necessarily related to science. There is another hidden assumption in the task we gave the schoolteachers, namely that every answer could fit as a conceptualisation of a big idea. That is also opposite to the approach in the curriculum where the big ideas are described and prescribed – although contested between levels – from the beginning.

The phrase *"introducing ourselves"* seems to have the disguised question of 'what do you believe is a big idea?', so it is a mix of beliefs and knowledge. In the audio-recordings of these small groups the different understandings are revealed. For example, when a facilitator asked, *"what is the underlying idea of the movie?"* one schoolteacher refers to the *"more essential"* aspect (group 1). Another group asks, *"which is the central idea?"*; *"it should be one that leaves a message"* (group 2). In my journal, when designing the session, I wrote that our aim was *"to identify what is common between the answers"* (Paulina's journal). This strategy could be similar to what Mario identified as the usual way to incorporate changes in the curriculum by

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[53] As similar as the previous section, the use of lowercase in the title is a provocative way to show the contested understanding of the big ideas approach. In the case of NIPDE, there is no initial fixed conceptualisation.
[54] There is a current (2021) effort to provide standards of initial training to every university that is conducting a pedagogy degree in science (biology, physics, or chemistry); however, is not as comprehensive as the Chilean school science curriculum.

the Ministry, i.e. *"seeking for common factors"* (Mario's interview) between top countries. However, in this case, the top countries are the small groups, and the seeking for commonalities starts with the situated answers of the schoolteachers.

6.2.1.2.2 Every conceptualisation fit: empty signifier approach

The way we introduced big ideas in the second session gave the impression that every definition could fit as a big idea. This led to contested understandings which rendered the conceptualisation somewhat empty.

In the group activity aiming to "*build a definition focusing as well on the procedure"* (Paulina's journal), we asked to define *"what", "why"* and *"how"* were those big ideas of the movie. The question of "*why"* is asking for an argument tending to theorise the conceptualisation of the approach without taking into consideration that why questions could bring a contested response. For some small groups, the why question is related to a summary, *"because it* [the big idea] *works explaining the whole movie"* (group 2), while for others it is an issue of personal experience regarding the movie: *"one can decide what is a big idea because of your experience"* (group 3).

The pedagogy used in the session involved facilitators re-shaping the teachers' answers which is similar to what Dora does – a theme I return to later in this chapter – in her classroom. After time spent discussing in groups, there was a plenary summarising the answers to the three questions per small group. Each response was paraphrased and written on the whiteboard by Karen or me. Afterwards, Karen asked for the commonalities focusing on the 'how' to establish a procedure: *"what do you see in common in all these explanations of how the big idea was reached?"* (48.50). Then, after examining the procedure, I posed the central aim of the activity which was to *"define as a group what we think is a big idea, do we?"* (51:56). An example of that dialogue is below:

> 54:30
> **Caro:** Because it has to do with *my* interests (.) with what *I* think is a big idea (.) it may be a big idea for me, but for her ((touching the arm of her colleague)) maybe the big idea is another.
> **Paulina:** *So*, we can think that big ideas are particular (.) are different for everyone?
> **Caro:** YES, I think if we see from the viewpoint of the essence of a person (.) we can also think that the big ideas are not BIG for all
> **Paulina:** Just to pose the opposite (.) can we have big ideas shared with everyone?
> **Caro:** Yes, when there are common interests
> **Paulina:** In other words, we could have both types (.) big ideas that have to do with my experience and my values and any other that are common with more people
> **Caro:** [It has to do with what is *mine* and what is *ours*
> 55:44

In Caro's utterances, she is depicting a concern that big ideas could be the result of personal interest. In my interpretation, because the question was what the big ideas are in general not particular to science, it gave the impression that it is related to personal interests rather than assumed universalities in science. There is a particular understanding of what a big idea is – *"big ideas are not BIG for all"* – which could mean that it is possible to have one's own

conceptualisation. That does not mean those big ideas cannot be shared. According to Caro, the big ideas could be collective if *"there are common interests"*. There is a possibility that what is *"mine and what is ours"* can coexist.

The principle of the personal understanding of what is a big idea could be related to the strategy of the policymakers developing the curriculum. The vast difference is that in this case, the teachers are *discussing* if personal interests could be involved in what is understood as a big idea. In contrast, the possibility of personal viewpoints is not raised in the national document. Rather, one conceptualisation of big ideas became mandatory to everyone without debate.

If the conceptualisation of big ideas is related to personal interests, *"experiences and values"*, then the individual experience of what a big idea is could be broader than what is expressed in the curriculum. In that sense, the dialogue between the schoolteachers and the university teachers depicts a conceptualisation of big ideas that is empty because it could be 'filled' with every conceptualisation, an empty signifier. The empty signifier could mean something that is vague, unspecifiable, having the possibility to mean different things to different people which seems to be the case in regards to how big ideas are treated in the NIPDE.

The utterance between Caro and I suggests that the big idea could start from personal interests which also invites one to seek the common interest, looking at whether the big ideas could be big for all or not.

6.2.1.2.3 Applying or questioning the approach

Big ideas as empty conceptualisations could open at least two paths. If every big idea fits the conceptualisation, the dialogue generated, for example, between schoolteachers and students creating their big ideas could bring a more situated understanding of the notion resulting from that situated dialogue. Conversely, if everything is a big idea it is possible to have misrecognition of what is agreed as scientific knowledge. That tension, which I think summarises the approach of NIPDE versus the approach of the National Curriculum, is pointed out by Ivan – a schoolteacher – during the session and right before we created NIPDE's definition of big ideas:

> 58:00
> **Ivan:** I agree that we can take big ideas from different viewpoints (.) right? But if I look at this text ((showing the curriculum)), big ideas are more than a personal vision (.) they should summarise everything we know in science (.) So, there is a difference if I'm *questioning* the big ideas or we are *applying* big ideas (.) if we are applying them, it means that we took them as they appeared here which is different to this exercise to discuss our own big ideas.
> 59:30

In Ivan's account, he is asserting that the curriculum is *"more than a personal vision"*, which might be the general assumption of schoolteachers reading 'the' National Curriculum.

Ivan points out the tension between the approach in NIPDE (*"questioning the big ideas"*) and the approach of the curriculum (*"applying the big ideas"*). Both of these approaches start

without a conversation with the schoolteachers about what *they* understand of big ideas of science or how *they* want to approach the notion in their classrooms. Even though in NIPDE there is an effort to conceptualise them with the schoolteachers, according to Ivan, NIPDE seems to fail: *"big ideas are more than a personal vision (.) they should summarise everything we know in science"*. There is an assumption that the approach taken might give the impression that what is understood in science may be being discredited.

During the conversation, a group definition of big ideas was developed as:

"A sentence that contains one or more scientific concepts that can be related to my personal or group interests, it can be interpreted personally, it synthesises the fundamental ideas, it is communicable, and it can be shared."
(written on the whiteboard at the end of the conversation)

That definition includes the personal or group interest. It makes an explicit statement of the interpretation, addressing what Ivan said about not forgetting that scientific knowledge above the personal interests can be an attractive solution to the tension between the discourses of the curriculum and NIPDE.

In NIPDE's conceptualisation, the big idea is developed from conversations in small groups. Then a conversation between the whole group occurs to determine what big ideas are. That path here is different from how the big ideas appear in the curriculum where they are presented as an unquestioned external definition. The discourse of big ideas in NIPDE is blurred, negotiable, and unfixed. It starts from common sense and the possibility of everything being a big idea which means it is also empty, becoming an empty signifier. Related to that emptiness, I came to call the NIPDE's conceptualisation of big ideas' discourse in *lowercase letters* because it is different from the imposition of the curriculum but still far away from the schools.

The tension between dualities of fixed/changeable or following a definition/creating a definition is still outside the schools' classrooms. At this point, I turn to how Dora and Ricardo conceptualise the big ideas approach, and, more specifically, to what the experiences of these two teachers teaching big ideas are, regarding those discourses.

6.2.2 Accounts of Dora and Ricardo's experiences teaching big ideas

In what follows, I explore how Dora and Ricardo's subjectivities regarding teaching big ideas are produced in a scenario where the discourses of the curriculum, NIPDE, and their schools are at play. First, I explore Dora and Ricardo's subjectivities in relation to the curriculum's discourse.

6.2.2.1 An account of Dora's and Ricardo's experience, dialoguing with the science curriculum's discourse

6.2.2.1.1 Dora's accounts of teaching big ideas

Dora's practice of teaching big ideas goes beyond both what is asked in the curriculum in terms of scientific content to a specific level and the aims of science education. Before depicting Dora's reflections about her practice, the following helps set the scene.

6.2.2.1.1.1 Setting the scene: Dora's lesson

In the second lesson observation I did, Dora and the level 4 students mentioned concepts related to ecology such as habitat, family, species, and some skills such as observation. This key moment lasted for about 19 minutes at the beginning of the lesson. The visit of one student (María) to a wetland – which was later visited by the whole course – started the question of what constitutes a family. Discussion of this question moves between a taxonomic classification, where families and species are categories within such a classification, and other opinions that seemed to be related to the family in a social-based organisation. The conversation also includes elements of a genetic dimension with the idea of producing offspring from different species resulting from a crossbreed bird named "*Garzapilen*", and an evolutionary question of how species *"have survived over the years as they are"*. The following comic strip illustrates a vignette captured verbatim from the video recording:
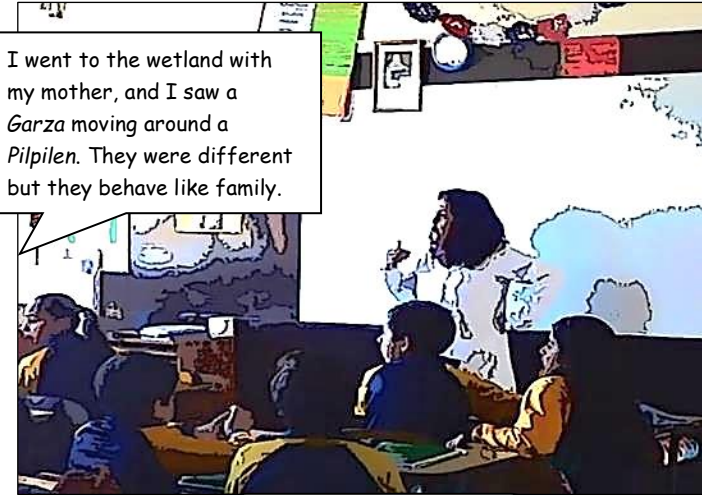
Panel 1:
I went to the wetland with my mother, and I saw a *Garza* moving around a *Pilpilen*. They were different but they behave like family.
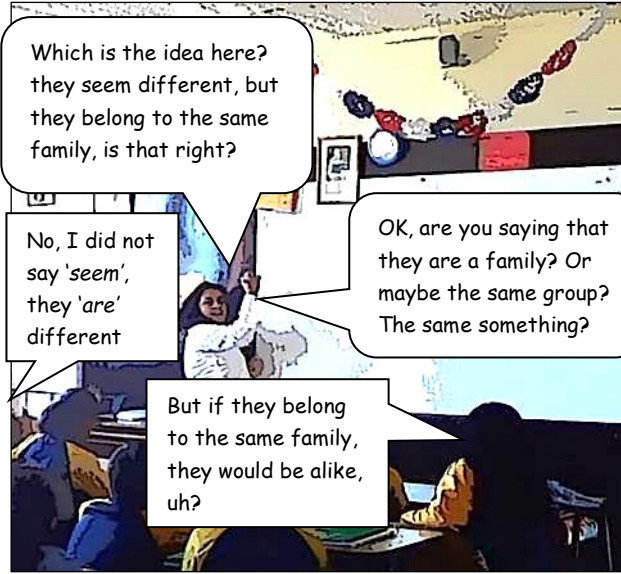
Panel 2:
Which is the idea here? they seem different, but they belong to the same family, is that right?

No, I did not say 'seem', they 'are' different

OK, are you saying that they are a family? Or maybe the same group? The same something?

But if they belong to the same family, they would be alike, uh?

Panel 3:
Aha! here are some important concepts for later, but first what does the rest of you think?

I think that if the birds are family as María is saying, they should be alike, but every animal has their own features, everyone is different.

So, families share features. They are similar but not equals.
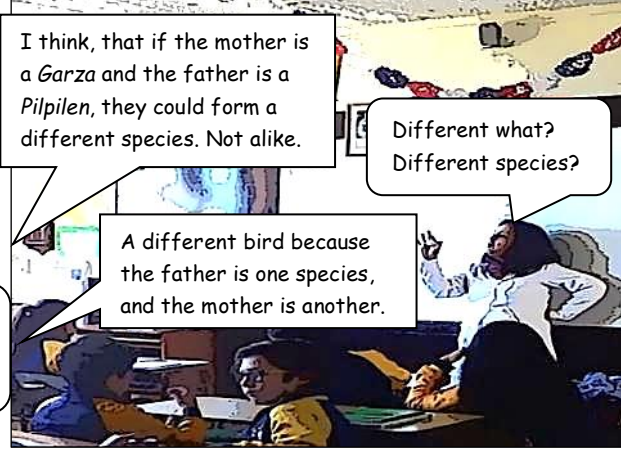
Panel 4:
I think, that if the mother is a *Garza* and the father is a *Pilpilen*, they could form a different species. Not alike.

Different what? Different species?

A different bird because the father is one species, and the mother is another.
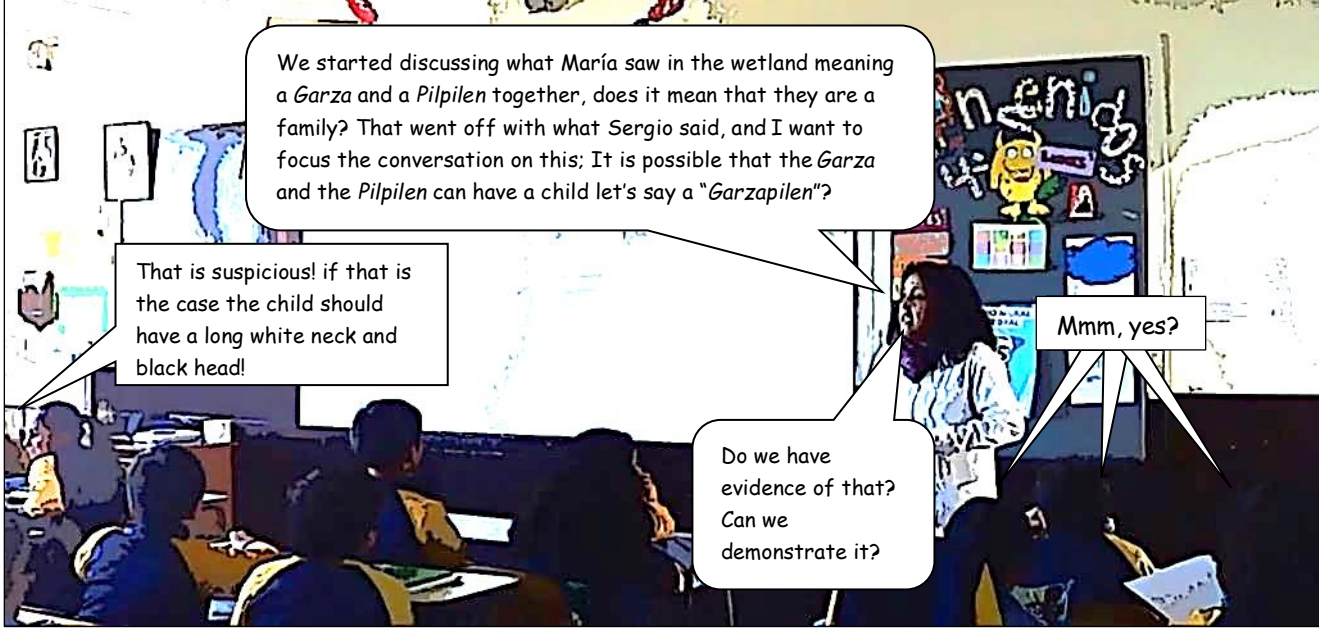
Panel 5:
We started discussing what María saw in the wetland meaning a *Garza* and a *Pilpilen* together, does it mean that they are a family? That went off with what Sergio said, and I want to focus the conversation on this; It is possible that the *Garza* and the *Pilpilen* can have a child let's say a "*Garzapilen*"?

That is suspicious! if that is the case the child should have a long white neck and black head!

Mmm, yes?

Do we have evidence of that? Can we demonstrate it?

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6.2.2.1.1.2 Beyond the Scientific Curriculum

In the vignette, Dora goes beyond what is expected to be taught in level 4 of schooling by the curriculum regarding big ideas. Dora's conceptualisation of big ideas seems to be related to the crossover of different domains 'of' and 'about' science (of/about as described by Harlen's 2010 approach) which, according to the curriculum, should be taught in levels 11 and 12. The curriculum suggests that level 4 students should *"approach the big ideas"* (Mineduc, 2012, p. 70). Instead, by starting from the link between the big ideas and daily life experience, Dora makes a crossover of different scientific domains, building a mix of scientific content related to her notion of big ideas.

Maria's utterance was used as a starting point to discuss what is the meaning of a family of birds moving to other questions in the domain of science related to: **behaviour** *"I said that the Pilpilen climbed on the Garza. I wonder if that meant that they are family"*; **taxonomy** *"I think that if the birds are family as María is saying, they should be alike, but every animal has their own features";* **genetics** *"I disagree because the child wouldn't be the mix of both (…) The mix would be an IMPOSSIBLE child!";* **evolution** *"why the Garzas are still Garzas and the Pilpilen still Pilpilens, and we cannot see Garzapilenes? Nor Pilpigarzas?";* and about the **nature of science** *"Do you think that the scientists have this kind of discussion?"*. The situated dialogue between the students and Dora suggests fluidity between the domain 'of' and 'about' science. That fluidity between scientific ideas shaping her big idea is reflected on by Dora here:

> They [students] must recognise different types of birds because I wanted to address the content of adaptation, but you must be prepared in advance to understand it. Alongside, to what a feature of a bird is and why it changed, or which are the structures that are allowing the species as it is at this moment (Interview 2).
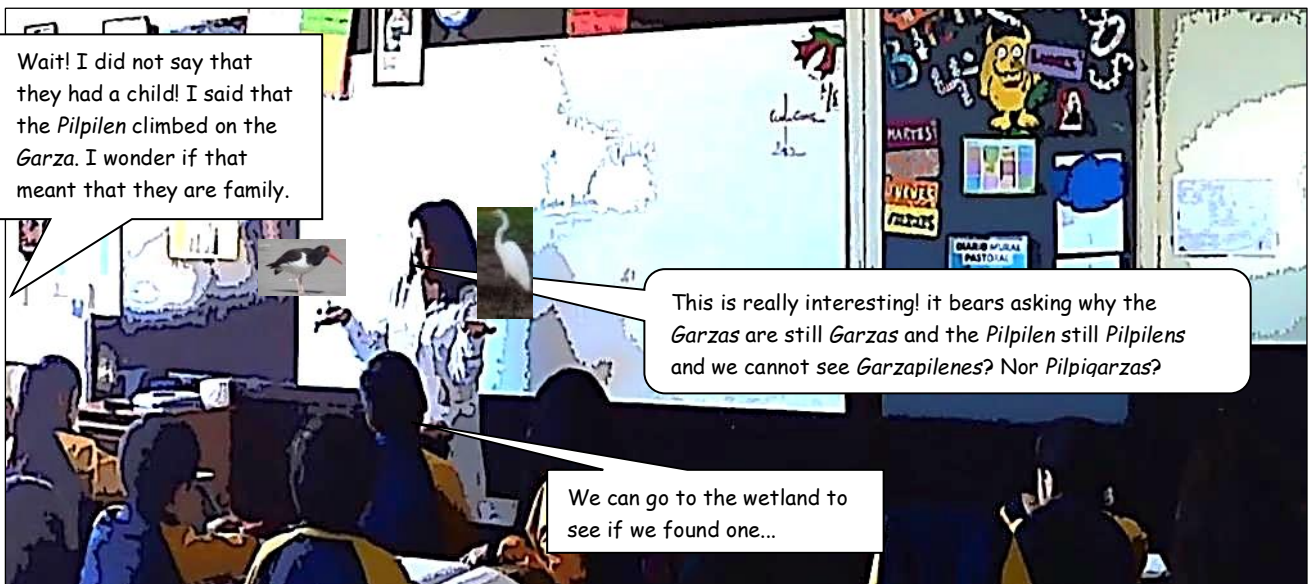
Those scientific ideas come directly from the observations and opinions – sometimes contested – of the students while she is picking and directing them towards her lesson's aim. The science curriculum for level 4 stated that the learning objectives related to adaptation are supposed to be taught in two lessons. Still, in Dora's case, she used three lessons to start developing this mix using more time than is prescribed. Nevertheless, when analysing this mix that resulted in a big idea, Dora might be raising questions of genetics and evolution, which in the curriculum correspond to levels 10 and 9, respectively. Hence, Dora could be 'gaining' time, connecting scientific domains of levels 4, 9, and 10 of schooling. From levels 1 to 6 the science curriculum states that the *"Learning Objectives promote the understanding of the big ideas of science and the acquisition of skills"* (Mineduc, 2012, p. 71). However, Dora seems to hold that the big idea *is* the learning objective, incorporating the content, skills, and attitudes which are expected at levels 11 and 12. In that sense, students are framing the big idea while Dora allowed them to look at everyday phenomena in new ways, attending to their surroundings differently focusing on aspects that maybe they did not see before such as, in this case, the wetland near the school.

6.2.2.1.1.3 Students shaping the lesson and the science education aim

If, since 2012, the Chilean science curriculum has been dialoguing with the literature, Dora, in this case, has been dialoguing with the students to build big ideas. The big idea started from a personal aim/interest which is shaped with the students. It is situated instead of imposed.

During the conversation, she suggested the possibility of an imagined species named 'Garzapilen'. This is disputed for some − *"That is suspicious!"* − and doubtfully or tentatively accepted for others − *"Mmm, yes?"*. Instead of giving the answers about the restricted possibilities of sexual reproduction between different species, Dora enables the students to provide feedback to each other until the imagined species becomes out of question *"The mix would be an IMPOSSIBLE child!"*. Referring to this moment, Dora expressed her position:

> It is essential to give credit to that discussion and avoid saying 'nooo that is not possible'. I remember that I thought what would happen if I told them now that is rare the crossbreeding of two different species, and we know about some cases like the horse and the donkey, but the *hybrid* is a sterile mule; that would be like saying 'St. Nicholas does not exist'; instead, I follow the conversation and afterwards they realised that alone. (Interview 2)

In Dora's account, the phrases *"to give credit"* and *"they realised afterwards"* seems to be related to her confidence that the aim of the lesson would be reached at some point. The discussion might be considered as something irrelevant and yet it should not be interrupted by bringing in an external idea, even if the interruption is the most accepted agreement of the science community regarding crossbreeding of different species. However, in a broader sense, Dora has been shifting her understanding of what should be expected in a science lesson:

> At this point in my life, I understood that everything is shown as fragmented, and we should put it together. In doing so, we can understand that the knowledge is inside life, if I do not know why scientific knowledge is useful, I'm losing time. (Interview 1)

Dora is aiming to connect scientific concepts that most of the time appear *"fragmented"*. She moves beyond the link between big ideas and the life of the students towards an understanding that knowledge is *"inside the life"*. Dora's utterance reveals a perception of the knowledge as being 'useful'. It is not completely clear what she means by this term, but it might explain her use of the time connecting topics in science. It might also be related to the instrumentalism of scientific knowledge, but she demonstrates an interest in starting from the students' interest and ideas, and does not impose what might be considered useful. Either way, her goal goes beyond the aim of the curriculum which seeks for the students *"to have a successful process of functioning in today's society"* (Mineduc, 2012, p. 70). Here, Dora might be suggesting that big ideas allow students to understand life through the eyes of science which could be related to her definition of big ideas: *"the basic issues that all of us as Earthlings should know, the essential things that one should understand. We can improve both the quality of our life and other species as well"* (Interview 1). By allowing the students to shape the lesson, Dora could be addressing her aim as a science educator which is to incorporate the interest and knowledge of the students, making the aim of the lesson situated.

6.2.2.1.1.4 Dora's fluidity between domains of science and in her pedagogy

Moving amongst scientific domains and allowing the students to shape the lesson might be related to Dora's fluidity regarding her scientific knowledge and her pedagogy. She describes this fluidity as 'sharing the control' of the lesson:

> The aim of the lesson is created together by sharing the control. Is it uncomfortable? Which control I'm talking about? I learnt that it is an attitude that you should develop slowly; now I've been working like that with the fourth grade. The students want to share, they don't have problems to say 'aunty, you are wrong'. Sometimes they told me 'we don't want to keep talking about this topic?' and I'm also bored, so I say, 'don't worry, we will change it'. (Interview 1)

In the lesson above, Dora seems to have a plan; however, the topics uttered by the students shaped the conversation and later the visit to the wetland. The purpose of the dialogue between her and the students is to have *"the aim of the lesson created together"* which develops a situated aim. The students are sharing their ideas and knowledge about birds, and Dora acts as a mediator. Dora's questions of *Is it* [sharing the control] *uncomfortable? Which control I'm talking about?"* seems to suggest that it is assumed that the role of the teacher is to have the 'control'. When that control is not in the teacher's hands, she questions how comfortable this is. When discussing why she took the stance to share the control of the lesson, she reflects:

> It has been challenging to get rid of the role of the teacher that knows everything, and I should be the one who gives all the knowledge. When I understood that it was like 'ahhhh'. ((sigh of relief and gesture of taking something off her body)) (Interview 2)

Dora has been a primary teacher for 34 years. In her account, it seems that the realisation of not knowing everything was recent, and she might be still fighting the authoritarian teacher role. The gesture of taking something off her body, maybe the 'suit' of the controlling teacher, could be related to the awareness of her different positionalities and her fluidity between roles as shown in Chapter 5 related to NIPDE which is explored later on this chapter.

6.2.2.1.2 Ricardo's accounts of teaching big ideas

This chapter now turns its attention to Ricardo's account of teaching big ideas. Unlike Dora, Ricardo' practice of teaching big ideas is related to self-appropriation of the approach and a sense of situatedness that, according to him, the curriculum is missing. Before depicting Ricardo's reflections about his practice, the following helps set the scene.

6.2.2.1.2.1 Setting the scene: Ricardo's lesson

In the first of Ricardo's lessons that I observed, Ricardo taught his level 6 students one of the three big ideas that were inexplicably omitted in the curriculum, namely "Objects can affect other objects at a distance". To show what the big idea means, Ricardo used everyday objects available in the classroom such as a coin, a cloth, and thread. Ricardo emphasised that while gravity is a force that cannot be seen, with some thread it is possible to 'see' its effect. The coin

and the cloth are objects that are attracted by the force of gravity symbolised by the 'magic' thread to the centre of the Earth, which, as pointed out by a student, is the floor. The following is again a verbatim vignette from the video recording in the form of a comic strip:
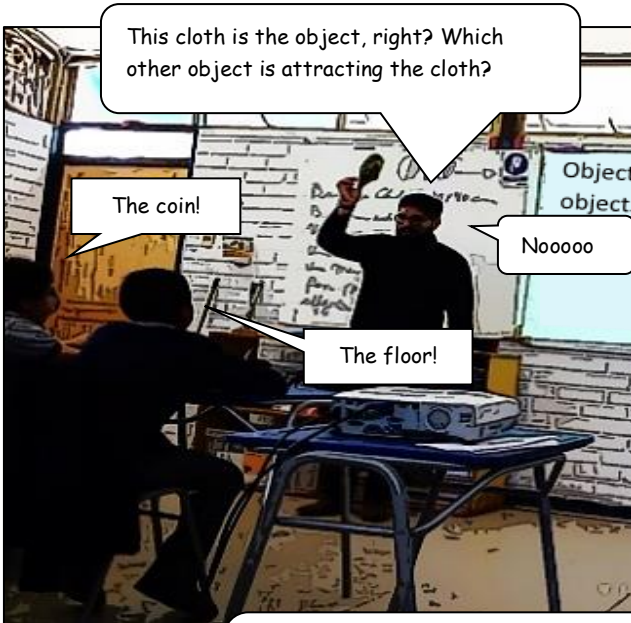
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6.2.2.1.2.2 Self-appropriation of the approach

Ricardo's lesson teaching big ideas is one of the big ideas which, according to the new curriculum, should not be taught to students at any level. However, he believes this big idea to be valuable for his aim and the students' learning.

Big ideas can be a way to organise scientific knowledge, and for Ricardo also a way for making connections with other content. When I asked why he decided to put the big idea "objects can affect other objects at a distance" on the whiteboard, he commented on the possibilities that the phrase gave to his lesson rather than just one concept:

> If I have started the lesson with the word 'electromagnetism' I should have been explaining other things of force and its relation; however, with this phrase I was able to encompass more things, for example gravity. That was the base for talking of electromagnetism as well, but other things related too; so, in a way, if I had started just with one word I would be pigeon-holed. (Interview 2)

It seems that for Ricardo big ideas as phrases encompass more content rather than single words. That could be related to more possibilities for the emergence of thoughts regarding the phrase and to connect with other content. As this big idea is not in the curriculum, he seems to be dialoguing directly with the literature, avoiding the curriculum. He is appropriating for himself the new approach in science. This is the opposite to the 'levelling down' associated with the assumption that schoolteachers lack knowledge (this is referred to in detail in the policy context and in Chapter 4 related to the assumptions by the university team). In terms of his pedagogy, Ricardo also connects with the students' daily lives by using everyday things. This, he argues, makes the learning more situated.

6.2.2.1.2.3 Situatedness by teaching with daily things

Ricardo's pedagogy includes the big idea explicitly, daily artefacts to explain it and analogies to understand it. In doing so, he acknowledges the science curriculum's problems regarding progression and situatedness:

> I see that the curriculum is not appropriate to the reality of the students nor the schools, and it tries to exemplify with things that the kids don't know, or I don't know. Besides, it assumes that students have the previous content from previous levels of schooling, but the students forgot. Hence, I prefer to start by giving them the foundations and then continue with other more complicated things. (Interview 1)

The curriculum does not understand the reality of the subjects involved in the teaching and learning process – not dialoguing with the daily life of the students or teachers. Furthermore, it assumes progression between levels of schooling. The way he suggests resolving this problem is by using everyday things. In the lesson, Ricardo showed a coin from his pocket to the students and asked them what would happen if he threw it. With that simple example, the law of gravity came up. The same occurs with the cloth and the thread which was spontaneous for Ricardo: *"the demonstration with the cloth and the thread occurred to me right there"*

(Interview 2). It seems that for him it is not just the connection to the daily life of the students that is important, but also teaching the big ideas using everyday things:

> As a teacher we should be prepared to teach without a recipe, you should know while having open mind to incorporate some examples, like improvising but with the knowledge; hence, I like to have available a lot of things. (Interview 2)

In his school, the students move between classrooms while the teachers have a fixed room. Ricardo's classroom is very busy with *"a lot of things"* which may help him to think of and use different examples, using what is available in the room. In his account, he spoke of the difference between knowing and improvising in a performative way. He stated *"as a teacher, we should teach without a recipe"*, meaning that a teacher does not necessarily need a daily plan, but they need the knowledge with which to improvise.

For Ricardo, it is crucial to show the students multiple examples: *"If I exemplify with a lot of things, they will understand better rather if I show just one thing"* (Interview 2). In doing so, the coin, the cloth, and the thread are used for the same purpose of using daily examples to promote the understanding of the big idea. This is related to how he defined big ideas: *"I took them as the basic idea that can help you to build the rest of the knowledge if you do not have these basic ideas crystal clear you cannot understand other things"* (Interview 1).

After those first five minutes shown in the vignette, Ricardo gave the students different materials to 'see' the big idea in action and experience it using their own hands:

> I always use PowerPoint presentation first and then I had a box with stuff, so I reorganise their chairs to work in groups, and I gave them things like magnets, compass, metal cars, metal powder and so on, with that they started to play, some of them remembered concepts of gravity. I think they understood that objects are affected at a distance without just me saying it but discovering it. In the end, they know that there are some things that I cannot see but exist. (Interview 2)

Ricardo's approach is based on concrete examples that he can demonstrate or the ones that the students can experience by themselves. It is by playing with things that students can discover the concepts associated with the materials. It seems that for Ricardo manipulating those materials is the starting point because *"some of them remembered concepts"* as the same as the big idea written on the whiteboard.

The concept of force that you cannot see but exists is a mystery, but it is used by him to emphasise the idea of the effect. He makes an analogy with magic. He is making explicit the force *"imagine that I attach a magic thread to the cloth"* to what the student can recognise the other object that is attracting, namely, *"the floor"* as the centre of the Earth. The use of the *"magic thread"* reinforces the concept of a force that it is not possible to see with the eyes, but it is 'felt' as an effect. He is starting with magic, which may be closer to the students, to depict the scientific explanation that is more abstract.

6.2.2.1.2.4 Ricardo's teacher-father role: the answer giver

As developed in Chapter 5, questions are generative, generative of more content in the domain of science but also generative of attitudes such as trust between the teacher and the student. According to Ricardo, the trust between the one who asks and the one who answers, with whatever response, is something that resonates for him to a familiar relationship like the one that exists between a father and a child which is going beyond the curriculum:

> I'm super open to talking about certain things, and I'm always mixing the role of teacher and dad. Because I'm a dad and I liked it a lot when my teacher at school explained to me certain things, and he had the same role of being this teacher-dad. He opened my mind and said, 'you are going to do this', showing me a world that was unknown to me. In the same sense, I explain to them [his students] that this [the school] is a world, but if you go outside or leave your city to go elsewhere, it will be completely different. I want to explain many more things, work many more issues with them, however, there is no time, and I do not have much training to explain issues that maybe I do not handle properly. (Interview 1)

In Ricardo's account, it seems that to a parent, children do not ask for accuracy in the answers but rather attention. His approach is similar to building a relationship like teacher-dad and he remembers the way a teacher was with him. He acknowledges that maybe he does not have the proper answers because he has no specific scientific training, but it seems that is not what he perceives the students want. Therefore, he seems to have an image where he can answer most of the students' questions regardless of the 'correct' answer because he establishes this relationship to give absolute attention.

As pointed out in interview 1, Ricardo's image moves between thinking that the students think that he knows – *"I think they have seen that I can answer most of their doubts"* – which is also the leading team's image of him – *"they recognise that I know a lot; I am messy, yes, but I know a lot"* – and, conversely, not knowing, because *"I do not have much training to explain issues that maybe I do not handle properly"*. In that sense, he moves between the idea that he is knowledgeable at the same time as not being an expert on some topics.

Alongside the position of being an answer giver, Ricardo suggests the role of the questions to democratise the knowledge because for him it is important to answer every question of his students, above all in the setting where he develops his practice:

> Look, one of the reasons of why I like to be a teacher is because, in one way or another, you are the one that opens the possibility for them to enter another world; not everyone is lucky that their parents have been teachers and the knowledge is floating in your house with books or have the possibility to travel. I have not travelled much either, although I can see or read things and I'm able to show them things to open their eyes. When I was a child, I break up things; I still take them apart, but it's because I like to know what happens or how something works, but maybe they [the students] don't have that possibility or they don't have anyone in the house next to them that gives them time and answers. (Interview 2)

Building on the familiar relationship, Ricardo's account sees the role of the family as crucial in the process of learning. When he recognises that in the families of his school, the knowledge is not *"floating in* [their] *house",* he can be the one to replace that lack, giving *"time and answers".* It seems that he moves between a paternalistic approach to the students – *"I'm able … to open their eyes"* – but instead of focusing just on pastoral care he opted by shifting his role to develop their curiosity, allowing them to break things, asking questions and be loud in his messy classroom.

In Ricardo's pedagogy it seems that there is a relation to the knowledge as something external, *"floating"* not constructed in the interaction. Knowledge is an 'object' that is in the air, something that is received like answers or resources. In the format of answers, his role shifts to a teacher-dad, as if his role is pastoral care which is related to the view of the school, however, at the same time, focusing on the big idea and the connection with other content. In relation to the big idea, Ricardo used daily life things in his classroom to overcome the lack of resources of the school. His pedagogy could be related to the lack of knowledge and resources from which he develops his practice using daily life things, daily life examples situated to the reality of the students, and as giving answers and time.

Now I turn to explore how Dora and Ricardo's subjectivities are produced in relation to the NIPDE's discourse.

6.2.2.2 An account of Dora's and Ricardo's experience, dialoguing with the NIPDE's discourse

NIPDE's definition of big ideas as empty conceptualisations might be related to Dora's fluidity between domains of science and in her pedagogy. It might also be related to Ricardo's self-appropriation of the curriculum, how to use it, and acknowledging the role of questions in his practice.

6.2.2.2.1 Pedagogy based on fluidity: Dora's positionalities

6.2.2.2.1.1 As facilitator, learner, and teacher

Dora is translating her pedagogy from the school to the CPD programme and vice versa. Dora's approach in her classroom and in NIPDE is to avoid delivering a 'correct' answer. Dora's fluid pedagogy allows her to deliver a teaching-learning process with some similarities in both contexts. The students of level 4 and the schoolteachers in the CPD course receive the same 'treatment'. Dora sees herself as facilitator, learner, and teacher which is summarised in this quote:

> I'm learning a lot while working on the research question. It's great because in the role of facilitator I cannot tell you the answer because oneself should realise the answer. The same with my students in fourth grade, I cannot tell them the answer at the same time as empowering them to realise how scientists work. In this other case with the schoolteachers, I found it great how we have been working defining the question because one could give them all the guidelines or the answer right away, but it is not like that. In this programme we have something that has nothing to do with other types of CPD training, and I have been in a lot of them because in here there is

nothing like theory, theory, theory. These schoolteachers have the theory, but they lack the reflection, and I realise that because I can see that there is a difference in me before and after my reflective process. That reflective practice that I have been developing for a while is not always there, so here they [the schoolteachers in the CPD] are gaining reflective tools. That is professionalism itself. (Interview 2)

As a facilitator in NIPDE, Dora oversaw the dimension of reflection of the schoolteachers; however, she also allows her teacher self to be part of the experience, moving from her role as facilitator to schoolteacher in different settings. In this quotation we see her experience designing the course – *"I found it great how we have been working"*; as a participant – *"I'm learning a lot working on the research question"*; as a schoolteacher – *"with my students in fourth grade"*; as a facilitator – *"one could give them all the guidelines"*; – and as a colleague of the schoolteachers – *"there is a difference in me before and after my reflective process"*.

Between those movements, she revealed that her fourth-grade students are like the NIPDE's schoolteachers in terms of learning by not saying the answer right away (as developed in Chapter 5 p. 131 in a conversation between Daniel and Ivan depicting the teacher-student role); the strategy in both groups is similar. In another parallelism, she refers to the lack of reflection by the schoolteachers which resonates with her own process of reflection by, for example, 'taking off the controlling suit', described before. As she has been in a reflective process for a while, she must feel that she is working on her professionalism as well.

Approaching the last session of the CPD course Dora wrote in her journal *"the first obstacle is us"*. However, her meaning is ambiguous. To which 'us' was she referring? Does 'us' refer to facilitators, schoolteachers or colleagues? In my interpretation, she was referring to every positionality together as if the first subject of reflection is oneself in its integrity, so maybe she is referring to 'us' as her joint positionings. In every role there is a sense of being an obstacle or the possibility to reflect on one's practice.

While engaging with Dora's account I asked myself why she moves freely between her positionings. It is my understanding that Dora is aware of her hybrid identity. This is related to the fluidity in her approach to big ideas as well. This could be explained by the different contexts in which she has been working that have shaped her positions. Why is she aware of these positionings? This could be related to the people with whom she has been talking, needing to make a statement, where she may be asked to stand for her experience considering her 34 years of teaching experience at the school or her recent experience teaching and researching at the university level.

6.2.2.2.1.2 The horizontal/vertical dilemma

In Chapter 4 (p. 102), the word 'horizontal' appeared in Dora's lapsus linguae which may be related to the vertical taboo of the work with the schoolteachers from the perspective of the university team. When Dora reflects on the ethical attitude that we should have as facilitators, the word 'horizontal' came up again:

I believe that everyone should give credit to the schoolteachers' work. We should empathise from a horizontal perspective with them. I said this because I find it inappropriate that two university teachers were laughing at the schoolteachers' works in the last activity. Of course, it was without the schoolteachers, but I would expect that what is done by the schoolteachers was recognised as important. (After the second session of NIPDE, Dora's journal)

Here, she is revealing that taboo with an example of facilitators feeling superior to the schoolteachers. That situation concerns Dora because her pedagogical position is to accept her students' opinions without mocking them. This can be seen in her approach towards the possible existence of the 'Garzapilen' when she said that *"it's essential to give credit to that discussion"* (Interview 2), while developing the big idea in the lesson. Despite this, she also used the word 'horizontal' to praise the work done as facilitators: *"This is brilliant! Because each facilitator did some insights into the reflection. It was a relaxed environment where teachers and facilitators discussed with 'horizontal language', all of us as teachers"* (after the fifth session of NIPDE, Dora's journal).

The first *horizontal* mentioned in her journal was near the beginning of the course, the second *horizontal* was in the middle of the course. The time when Dora had the Freudian slip described in Chapter 4 (p. 102) was after both sessions, meaning that the university team as perceived by Dora, had, at times, an attitude of superiority at the same time as considering themselves to be at the same level of the hierarchy as schoolteachers. That duality might be the reason why she had the slip of the tongue in the design meeting as her attempt to share the control with the students excluding hierarchies.

6.2.2.2.2 Following the curriculum or taking decisions: Ricardo's learning

6.2.2.2.2.1 Applying versus questioning the approach

There is a clash between applying and questioning the big ideas approach[55] in Ricardo's experience. In the second lesson observation I did, when Ricardo was teaching another big idea, he was dialoguing with the curriculum (fixed, concrete conceptualisation). However, when he was reflecting about that lesson in Interview 2, he seems to be dialoguing with the unfixed NIPDE's conceptualisation of big ideas.

In that second lesson, Ricardo introduced the big idea that is stated in the curriculum as "all material in the Universe is made of very small particles". In the middle of the lesson, he realised that he was making a conceptual mistake. He was explaining that all living organisms are formed by cells, and non-living things are formed by atoms making a parallelism of the smallest unit between what is alive and what is not. He asked me to stop the recording. I wrote in my journal *"I see that Ricardo is struggling with the big idea"*. I suggest that his desire to stop the recording might be because he had the curriculum in mind with the requirement of *applying*

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[55] Applying or questioning the approach is a discussion developed on p. 155 of this document. Applying the big ideas is related to the fixed conceptualisation of the curriculum while questioning the approach is related to the more fluid conceptualisation in NIPDE.

the approach as it is stated while also having in mind the many other tasks that are demanded from teachers in a school.

On the one hand, when applying the approach as it is in the curriculum, it is important to consider the context where the teachers develop their practice. In Chile, teachers face the problem of the time available to plan their teaching. The limited time available is usually filled by other tasks, such as meetings with parents, meetings between teachers, marking homework, administrative work, or substituting for absent teachers. Preparing the lessons is restricted to the free time of the professionals.

On the other hand, there is the question of the 'size' of the big idea and the time to incorporate the curriculum approach. If the big idea is too big or too broad it may confuse not only the teacher, as in this case, but also the students. Related to that, consideration must be given to how the big idea is written. In this case, the word 'Universe' may have given Ricardo the idea of non-living things rather than focusing on the part 'all the material' which involves living and non-living things. It may also have been presented as too abstract that it is difficult to grasp and provide concrete examples with daily things as Ricardo reports doing.

When questioning the approach, however, he seems to have the experience of the CPD course in his mind. He considers the moment as an opportunity to learn even though he was blocked because he could not prepare examples. He was rushing that day in the school, and he was insecure in his knowledge related to the topic:

> It is important the teacher handle the knowledge well, also the teacher should handle the broader aspects of the big ideas but in my case, I had doubts, I couldn't prepare the lesson as well as I wanted. Even though I can explain why I made that mistake it is also important for me that if I made a mistake, I acknowledge it and try to resolve it, the ugly thing would be to avoid talking about my errors because we are humans, we make mistakes. In the following lesson I recognised my mistake I showed them a video related to the topic of how all the material is made of atoms and we also discussed how we handle mistakes, and what can we learn from them. (Interview 2)

Ricardo's attitude is more confident. He recognises that he *"had doubts"*, meaning that he did not know the broader aspects of the big idea. This seems in contrast with his image of a teacher; he states that it *"is important the teacher handle the knowledge"*, giving a solution to his mistake.

During the course, Ricardo also referred to his confidence in his knowledge. In his reflective journal, he wrote *"what I'm feeling? That I still have a lot to learn and that is inspiring"* (following the second session of NIPDE). He also wrote *"I feel more energised; I can see that it* [the CPD] *is helping me to feel more secure in what I can do"* (following the fourth session of NIPDE). In both accounts, there appears to be recognition of his lack of knowledge but also his attitude towards the challenges associated with learning those things that he does not know, like what he did with his students in the following lesson by embracing the misconception.

Echoing Chapter 5 about pedagogical and epistemological positionalities because of the work around research questions, the following extracts of material gathered from Ricardo might unfold the role of the questions while commenting on his practice as a participant in the CPD course (through his reflective journal) and as a teacher in his school (through his interviews).

Ricardo, from his experience in NIPDE, acknowledges that creating a question is not an easy task: "*not everybody asked a question. If they knew that I spend two days making one question! Now I understand how the students can feel about that*" (Interview 2). Even though before the CPD course, he was aware of the difficult task to ask questions in a lesson, after NIPDE, he added the task to create questions as well. This resulted in his being empathetic to requests from the students and aware of the question itself. Related to this issue, Ricardo wrote in his journal:

> I feel that the question is not so lost. To know the question of my comrades helped me to see my question. I keep thinking and saying that it is difficult to make a research question. In my practice, to make the research question is interesting, and it would be good for other science teachers to make the same with the students. (After the eight session of NIPDE)

Ricardo's account acknowledges the importance of the questions to the science education domain, the intake that others can make to the own question, and the very task to create the question as difficult. Despite this last point, he suggests that the students should experience the creation of research questions. In a broader sense, not just research questions are difficult, but every question that is posed in the science lesson by the students has a level of complexity which, if taken into consideration, could generate closeness between the person who asks and the person who answers (similar of the familiar relationship explored before on p. 167):

> When someone asks you based on what you are showing 'what happens if I put this here?' and you have two options, to continue with what you were showing, answering your questions or engaging with the question with more flexibility and maybe you can retake the path of the lesson. Maybe, not the same path but you already answered what he was asking something that he thought by himself. In this case, for a child in the school being able to ask a question, whether it is part of the topic or not or whatever the complexity of the question, it must be difficult. So, I must have the ability to answer it because if I do not answer his question, I will limit him from asking me more questions, but if I answer it, although my answer may be very basic, I will lead him to have the trust to generate more questions. (Interview 2)

Ricardo posed the generative quality of asking questions by receiving an answer even though the answer is not the most sophisticated. Regarding what he said about the *"path of the lesson"*, it could happen that the question changes the topic of what is discussed which is the way he addresses his approach to big ideas, let the students ask their questions because that could bring up other connected contents. Sometimes that approach to letting the students ask all their questions changes the direction of the lesson, but it also helps to develop fluidity between the teacher, the content, and the students. As explored in Chapter 5, Ricardo's

position was that the teacher was the ultimate guide; in this sense, the questions or opinions of the students can change the topic of the lesson, but the teacher is the one with the clarity of where to go.

In the first interview, Ricardo stated that his *"classroom is always messy"* because the students are not silent such as the case of the vignette with the big idea where the students were giving their opinions. He also recognised his messy classroom related to giving the space to the students to ask every question they want – *"Sometimes I am developing one topic, and they ask me something, and I take that and go to another topic. When those things happen, I feel that I can fly, you know?"* (Interview 1) – which for him is also related to develop the curiosity of the students, because asking question is generative, so if the students see that the teacher answers their questions, they *"begin to ask and ask, and ask you again and they are always like that"* (Interview 1). In his words uttered in the first interview, that woken curiosity is the *"fuse"* that can be *"lit"*, answering everything they want because then they can *"question everything"*. That fluidity in his pedagogy may be incompatible with the administrative requirements of the school – *"I like that flexibility, and I dislike when you must plan every detail of the lesson and deliver your plan to the school; I don't get along well with that requirement"* (Interview 1) – which is related to what Ricardo's UTP said about his good ideas in the lessons but not meeting the administrative requirements.

Finally, I turn to explore how Dora and Ricardo's subjectivities are produced in relation to their schools' discourses.

6.2.2.3 An account of Dora's and Ricardo's experiences, dialoguing with their schools' discourses

The schools of Dora and Ricardo also have discourses influencing their practices. These discourses include the pressure of standardised testing and each school's image of its students.

6.2.2.3.1 The shadow of standardised tests

It is very common that schools require teachers to focus on the curriculum for their students to perform well on the standardised national test. For Dora, the pressure of the standardised test muted her in front of the headteacher's team. Dora realised that the conversations with the leading team during the one-to-one meeting, or the weekly meeting of the whole teaching body, are similar to those that occur with students in some classrooms; the teachers are muted, without the opportunity to give their opinions:

> The other day a student came to me saying that the replacement teacher [when she was out for two weeks] did not let the student explain his opinion. That feeling reminded me when I'm talking to the deputy headteacher she would call me out to show her my evidence that the approach I'm using is working or she would say 'if your lesson is that good why the SIMCE [National Standardised test] is not good?' that would crush me. I would be hushed like the student. (Dora's Interview 1)

The standardised test is a constant concern in many schools in Chile. Teaching something that would be 'useful' for the national test is more important than other ideas that do not feature on the test. This happened in Dora's school where the question by the deputy headteacher is not pedagogical, but rather is related to "*evidence*" concerning a good SIMCE (the national standardised test in Chile). It bears noting that Dora's school is a Catholic, semi-private institution. In Chile, being semi-private means that part of the school's income comes from the families and part from the state related to the number of enrolled students. Because of that, this type of school 'fights' to attract a certain number of students every year from other semi-private schools in the zone. As part private, these schools are also businesses – a policy inherited from the Chilean dictatorship – and funding is a permanent concern. The results of standardised tests are public now to separate the *"good"* schools from the *"bad"* ones, according to the Ministry. So, if the school does not want to lose enrolment, they need a *"good SIMCE"*.

In the interview with the deputy headteacher she refers to Dora saying that she *"is a good teacher, but the focus of the school should be improving the SIMCE, she is always innovating, and her master's degree seems useful, but the lessons should be curriculum-based"* (Paulina's journal). In the same regard, Dora had faced the opinion of the headteacher related to the curriculum saying that if *"she is not 'passing' the content she is wasting time asking the students' views"* (Dora's Interview 1). Both comments are asking Dora to follow the curriculum which, as explored above, could be less than what she does. In that vein, her approach using the mix of big ideas is neither dialoguing with the purpose of the team of headteachers nor with the National Curriculum. When I asked Dora if she thinks that the UTP knew about her approach using big ideas, she only said: *"No"* (Interview 1). In her school, the teaching focus of the leading team is to perform well in SIMCE. At the same time, Dora wants *"my students to be scientifically literate"* (Dora's Interview 1). Those two efforts might be mismatched because the dialogue is serving two different purposes.

Similar to what happened in Dora's school, Ricardo also feels the pressure of SIMCE in his school: *"because we have a goal which is SIMCE, in my other school I had good results but here the results are really bad"* (Ricardo's UTP interview). In Ricardo's UTP words, Ricardo is a good teacher. Still, he does not answer appropriately on administrative matters: *"he is filled with memos on my part, he has a lot of ideas to do impressive things, but he will never transfer it to a paper, and that is a problem for me"* (Ricardo's UTP interview). Ricardo experienced the requirements of the school as a pressure to have grades or respond to too many bureaucratic requirements that did not necessarily connect with his teaching: "*the school ask for grades so I must do things for it if I lose time with these activities* [talking about out-of-school activities] *they are going to say 'hey, why don't you have grades?'"*. As with Dora, Ricardo's aims as a teacher – creating out-of-school activities, using daily things to teach big ideas, connecting with the daily life of the students – were at odds with those of the school which was asking him to focus on SIMCE and the administrative requirements.

6.2.2.3.2 Assumptions of lack of knowledge and success

In public school there is an image of 'vulnerable' students who are assumed to be underachievers. Ricardo seems to 'fight' with this image by teaching big ideas with daily things.

The school where Ricardo teaches is a public school in a semi-rural zone in Chile. The prevailing discourse in public schools is related to the lack of success of the students. In Chile, there is an index to refer to the students' degree of deprivation which is called the index of vulnerability. The students at a school with a high level of vulnerability are called 'vulnerable children' or a 'vulnerable population'. In Ricardo's school, that discourse is strongly present. The headteacher and the UTP referred to this argument at the beginning of the interview saying that the school has a high level of vulnerability:

> We are a school of 97% vulnerability. With students like Jason [pseudonym] who is always breaking things. His parents are drug addicts, parents in jail, etc. that is ordinary reality. We ask these students to have the performance but mostly the behaviour. Sometimes if there are some activities outside the school, we must leave him here because there is the risk that something happens to him, something happens to the aunt [the teacher] or something happens to a classmate. That is the ultimate reality that you must know how to control it. At least the teachers here have a tolerance to deal with this. (Ricardo's UTP's interview)

In the UTP's account, it seems that the problem of deprivation of the students is related to the performance of the school but mostly to the students' behaviour which should be acknowledged by the teachers. The inequalities in Chile are a national complex problem; however, it seems that the ones called to take over the situation are the teachers rather than the state. Under this discourse, there is the assumption of a lack in terms of the resources available in the school, but also the lack of success of the students. They stated, *"we ask these students to have the performance but mostly the behaviour"* because the school seems to focus on pastoral care rather than academic achievement: *"what else am I going to ask of him* [talking about Jason] *with the family he has?"* (Ricardo's UTP's interview). Of course, the context of the students should be a concern of the teachers and the school. Still, if the aim of the school is focused only on pastoral care, the knowledge of the students seems underappreciated while the role of the teachers seems to have shifted.

Ricardo's headteacher seems to be against this discourse and explicitly states her view on pastoral care:

> For the government it is convenient to have people that do not rise from their situations, maybe they want the people not to study. I think they like the pastoral care and do not want the people to be critical and have thinking heads that question the system, so it is better if we focus on pastoral care. (Ricardo's headteacher's interview)

Even though the headteacher's account is against too an emphasis on pastoral care, in other utterances, the practice that she described underappreciates the academic achievement of the students. In that sense, the students and their culture are understood as deficient, meaning

that the school has a pathologising discourse. That duality in the discourse – rejecting the pastoral care but promoting it – pervades the decisions and practice inside the school.

The assumption that students lack success because of their vulnerability is present in the context where Ricardo works. Faced with this discourse, Ricardo articulates the same idea of lack of resources; however, he focuses on making connections between his teaching and the reality of the students' lives. This is not only pastoral care, but he teaches the students the big ideas of science in a way that is situated within their reality:

> You realise that it's a shame' in their homes there are no books; the government gave them a computer in seventh grade, but the only thing they do is play or be stuck on Facebook. (Ricardo's Interview 1)

Ricardo's account assumes that the students will not behave as academically as expected if they have new resources like a laptop. A different sentiment is expressed in his second interview:

> That was also something that I said to them that they had to take advantage of and be demanding of the teachers. They do not have to allow the teachers to underappreciate them. The students compare the teachers saying that these teachers are good because they 'didn't ask too much' but, in my case, I have more recollections of the teacher who asked me more or who were stricter with me rather than the nicer one. Therefore, I also try to be more demanding because I consider as a starting point that everyone is intelligent, maybe different learning rhythms, and I should know how to teach to them. (Interview 2)

As mentioned by Ricardo's headteacher, in these accounts Ricardo seems to experience the same duality. This is not surprising because the discourse of public education in the neoliberal context of Chile is full of the assumption that, due to socio-economic background, the vulnerable will experience a lack of success. The difference seems to be that in the second account during which Ricardo asks the students to request more from their teachers and himself, he is not assuming the students, because of their context, will be already disadvantaged. Related to this is the way he understands big ideas where the approach is used to generate students' opinion in other spaces outside the classroom:

> Take what I try to teach you and move it into your house, because if someone ever asks them 'hey what's wrong with this?' they will have an explanation of what is happening. With big ideas, if we allow them to have their opinions, to ask questions, we are giving them the job of generating ideas, of making certain definitions that can help them to do this mental work. (Interview 2)

Ricardo recognised the problem with placing pastoral care above academic achievement. He also recognises the assumption that some of his colleagues make when they say, "*we have students that simply cannot learn*" (Interview 2). To address this pathologising discourse, partly in himself, his pedagogy includes allowing every question that students have and making connections with their daily life through daily things.

6.3 Discussion

The purpose of this chapter was to explore teachers' subjectivities when teaching big ideas of science education that are produced in a scenario where discourses of the science curriculum, the university, and the schools are at play. In these contexts, there are contested understandings of what big ideas are, their role in the curriculum, and in science. These contested discourses enter the classroom where teachers' conceptualisations about big ideas influences their practice. The contested and multiple understandings of what big ideas are may open the possibility to problematise the very approach of big ideas. Thus, by giving more time and space to the subjectivities of teachers who propose their own ways (i.e. Dora's and Ricardo's subjectivities), big ideas could be more closely related to content, pedagogy, and epistemology, while understanding the transformations that take place when a curricular policy, as in this case the big ideas approach, is implemented.

As shown in my findings, a first level of debate is in the **policy-level enactment** and **CPD-level enactment** (see *6.2.1 Different contexts: Problematising the big ideas approach in science education*). Between the Chilean science curriculum and the NIPDE course there are contested understandings of big ideas which I came to illustrate as a discourse of 'Big Ideas' in capital letters related to the policy level and a discourse of 'big ideas' in lowercase letters related to the CPD programme. On the one hand, *Big Ideas* at the policy level is shown as fixed and concrete; besides, it is very similar to Harlen's (2010) big ideas in science education report. In fact, in the new Chilean science curriculum there are eight out of ten big ideas of science and the four big ideas about science. On the basis of my analysis of the curriculum, the incorporation of the approach was externally informed, considering world trends on science education, and without the schoolteachers' participation. Besides, the omissions of big ideas from Harlen's report seemed to be related to personal viewpoints of particular people rather than informed by the schoolteachers' practice. On the other hand, in NIPDE course the *big ideas* approach was shown as unfixed, becoming an empty signifier where any of the schoolteachers and teacher educators' conceptualisations fitted. Nevertheless, that emptiness brought the problem of some misrecognition of what is agreed as scientific knowledge opening the discussion of the tension between questioning/generating a proposal of big ideas or applying what is written in the curriculum, becoming a problem of professionalisation, meaning, if the schoolteachers are considered implementers or developers of curriculum.

Even though in the NIPDE course there was an attempt to incorporate the schoolteachers' understandings of big ideas, it seems that at this level – mostly in policy yet also with the CPD course – schoolteachers are treated as implementers because the discussion is outside the classroom. Although research wonders how the curricular changes are meaningful for teachers who have the ultimate responsibility for using them in their classrooms (Bell et al., 2018; Bradley & Moodie, 2017; Bravo et al., 2019; Houseal & Ellsworth, 2014; Mitchell et al., 2017), this apparently is not translated into practice. Then, how are the changes in the curriculum – like the incorporation of big ideas – made and addressed by the schoolteachers in their classrooms? The answer is usually sought in CPD programmes where the role of teacher educators is conceptualised as giving schoolteachers the necessary support to guarantee that the curriculum and its changes are "implemented adequately" (Couso, 2016, p. 49). According

to Ryder and Banner (2013), a very common policy concerning curricular changes consists in using professional development instances to develop the teachers' knowledge of the reform and how to implement it, which was what the policymakers described as the aim of NIPDE. However, I argue that NIPDE course went in a opposite direction regarding the curricular development discussion by starting to treat the schoolteachers as developers and not just implementers (see *6.2.1.2.3 Applying or questioning the approach*).

Considering this first level of debate, the way that the policy conducted the curricular development incorporating the big ideas approach was in line with what Bencze and Hodson (1999) described as a strand of curricular development where teachers have been excluded, related to a sense of ownership of the curriculum (Ogborn, 2002). Curricular developers are positioned as the thinkers outside the school who 'wish' to improve the quality of science learning in schools with their ideas (Giroux, 1990); the schoolteachers are the implementers/doers without their agency as reflexive intellectuals (Giroux, 1990). As posed in the literature review, another strand discusses the process of curricular development with power-sensitive questions (e.g. colonisation in the curriculum, Gandolfi, 2021) and how the curriculum is enacting cultural assumptions (Tobin & McRobbie, 1996) which could be more in line with what happened during the NIPDE course, when big ideas were conceptualised as an empty signifier trying to unpack what the schoolteachers understood by them. In doing so, because of this power-sensitive question and other ones – such as Who made the changes to the curriculum? Whose practice and knowledge are legitimised in that development? – the origin/context in which the curriculum is changed became a sociopolitical question, entailing discussions about control and colonisation of curricular developments. The approach of 'big' may trouble the hermeticism in science education (Bazzul, 2012). Troubling the hermeticism means recognising other ways of knowing as valid and disrupting rigid borders around the science classroom where there is a supposition that science is a core subject while others are not (Billingsley et al., 2018) as well as the idea that science as a body of knowledge is unquestioned and unequivocal (Eleftheria et al., 2016).

Now if we consider a second level of debate, there is **classroom-level enactment** described by Golding (2017) as the "core intended site of much education policy" (p. 924). In this level features of the schoolteachers' practices are highlighted when enacting a change that was imposed such as the big ideas incorporation into the Chilean science curriculum. This classroom-level enactment is illustrated with Dora's and Ricardo's subjectivities produced while teaching big ideas in their classrooms with particular salient features.

Dora´s subjectivity dialoguing with the curriculum is beyond what it is expected in terms of the scientific content taught to level 4 students. This could be related to what Ball (2003) describes, as policy as discourse is acting as both enabling and constraining teachers as subjects while policy as text shifts teachers from being agents of that policy. In that light, Dora understands what is asked in the curriculum regarding big ideas, yet she goes further in terms of content and level of the students. She also seems to be shaping the aim of the lesson with the students, building with them the big idea, regardless of what the curriculum states. In terms of Dora's

experience dialoguing with the NIPDE's discourse she posed herself as occupying multiple positionalities, such as, facilitator, learner, and teacher, which is developed in her practice with the level 4 students as well as with the schoolteachers in NIPDE. These multiple positionalities, could have implications for teacher education when the big ideas are understood as "generative and pedagogically powerful" (Mitchell et al., 2016, p. 12), offering the possibility to reflect on broader aspects of science education rather than just content knowledge. This is in line with what Dora defined as big ideas (*"the basic issues that all of us as Earthlings should know, the essential things that one should understand. We can improve both the quality of our life and other species as well"*), where there are fundamental and profound issues, similar to the framework of big questions with cornerstone questions about cosmos, nature and culture in a changing world (Stvinschi, 2009).

Ricardo's subjectivity is related to questioning the approach incorporated into the curriculum (following the discussion made in NIPDE), because he taught precisely the big idea that was not incorporated in the official Chilean curriculum, meaning that he is dialoguing directly with the literature on big ideas rather than with the curriculum as it is. For Ricardo, big ideas are phrases than encompass more content rather than single words which can explain broader phenomena. This understanding is similar to the conceptualisation of big questions that attempts to connect and answer the questions through the lenses of multiple disciplines, understanding that complex real-world problems can rarely be addressed through science alone (Billingsley & Hazeldine, 2020). Ricardo's pedagogy is related to the use of daily things, understanding everyday phenomena towards making the teaching situated through the use of questions by the students, highlighting that "what makes the question important is the specific context in which it is asked" (Gamoran, 2016, p. 87). The importance that Ricardo attributes to situatedness is related to answering 'real world' problems, the questions related to the daily lives and contexts of the students. Similarly to the framework of big questions that is also focused on real-world context (Lawson, 2020). The role of the daily lives of students involved in the big ideas approach was highlighted as a feature of Chilean science teachers by Bravo and Reiss (2021); teaching in this way can be particularly transformative, as shown by Ricardo.

At this classroom-level enactment, the school discourses are influencing Dora's and Ricardo's practices. These discourses include the pressure of standardised testing and the schools' perceptions of their students as lacking knowledge and being underachievers. On the one hand, Dora is underappreciated for going beyond the science curriculum because the focus should be on students performing well in the test, resulting on a Dora that is hushed (see *6.2.2.3.1 The shadow of standardised tests*), which relates to a Chilean culture of silence where teachers learn to be quiet, and avoid sharing their practice (Montecinos & Cortez, 2015). On the other hand, the discourse of underappreciation of the students limits Ricardo's use of daily things connected to the everyday situations of the students. This pastoral care/vulnerable discourse placed on the students troubled Ricardo, moving between pastoral care and teaching of big ideas as described by Day and Sachs (2004), who pointed out the importance of the school culture for teachers' practice. Based on my findings, what Dora and Ricardo enacted at the classroom level opened the space to unveil the sociocultural and political setting where teachers, such as these two, enact their professional lives (Tobin & McRobbie, 1996; 1997),

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without obliviating the institutional factors surrounding their practice (Benson, 1989), like the pathologising or standardised test discourse at the school.

Finally, this chapter aims to contribute to science education by adding other perspectives to the conceptualisation of big ideas; it provides evidence of the use of Harlen's big ideas and the way they shift, ultimately contributing with more context-based conceptualisations of them. This chapter also aims to show the use of the analytical tool of dialogue – as in previous chapters – by depicting the discourses surrounding big ideas in different contexts. As a result, the diagram presented first in Chapter 4 on the accounts of the subjectivities of the university teachers designing NIPDE and in Chapter 5 focused mostly on the accounts of the schoolteachers' subjectivities during NIPDE with a non-planned content can be completed. Figure 6.1 shows the completed diagram based on the previous two chapters and this chapter with the two cases of Dora and Ricardo incorporated as lines with alternating dots and dashes.
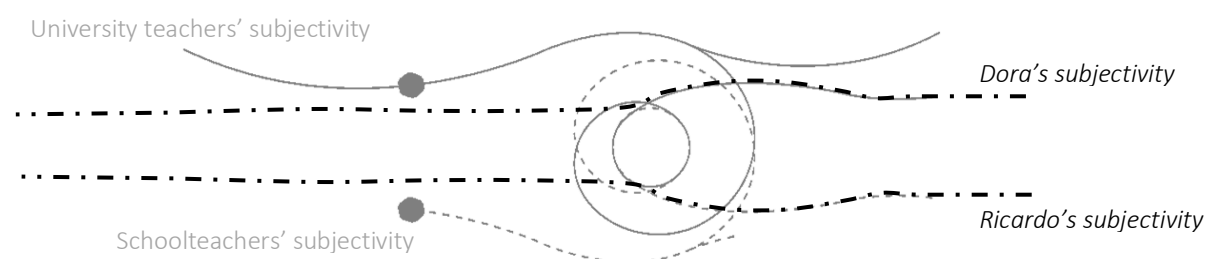
Figure 6.1 A map of the different subjectivities developed throughout the analytical chapters. The lines in grey symbolise NIPDE. The lines of Dora and Ricardo symbolise their practices.

The purpose of showing these discontinued lines crossing the grey ones is to acknowledge that the practices of Dora and Ricardo go beyond NIPDE and other bigger contexts such as the National Curriculum. However, as Dora and Ricardo were part of the course, it was possible to draw some connections to understand how NIPDE's big ideas discourse is influencing the experience of teachers teaching big ideas in their schools. To some extent, the subjectivity of teachers teaching big ideas exists regardless of those discourses. After closing the door[56] of the classroom, these teachers teach big ideas under their own conceptualisation. They go beyond both the contested understandings of big ideas in the curriculum and the shadow of the standardised test or the pathologised understanding of the students. However, it is not just teachers who close the door. Policymakers close the door to teachers by not dialoguing with them to create the curriculum. Schools also close the door to teachers by expecting them to focus on the curriculum or not 'lose time' getting distracted from the standardised test. The university might be opening the door a little – maybe via a window – by trying to build with the teachers a conceptualisation of big ideas or at least the possibility to question the approach. In the end, by closing doors or opening windows, there exists a chain of needful exclusions.

Finally, I present the last short pause in Appendix 11, namely, my third Interlude, which resonates with an iterative process of thinking with theory that was evoked in this chapter.

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[56] 'Closing the door' was a term discussed with my friend Felipe of the collaborative analysis group who used the notion in his thesis uttered by one of his participants.

CHAPTER 7: Conclusion

This thesis sits within a body of sociopolitical questioning as a lens to explore the subjectivities produced in and around a CPD programme as a way to provide an illustration of the turn that has been mostly theoretically based. In doing so, I am positioned in relation to the sociopolitical turn both by my role as a teacher educator working in a university and by my use of subjectivity. Even though this illustration is situated within the Chilean context, the conclusions that I draw are applicable to a broader literature on science education. In doing so, this research contributes to problematising the way we think about teacher educators and schoolteachers within CPD programmes both in general and in the social and political context of Chile. Specifically, I contribute with an account of the science schoolteachers' and teacher educators' subjectivities produced in and around a CPD programme focused on big ideas of science education, a recent change of the Chilean science curriculum. It has been suggested (Ryder & Banner, 2013; Bencze & Hodson, 1999) that curriculum developers design the curriculum, schoolteachers implement it, and teacher educators facilitate it through CPD programmes. However, there is a gap between how the curriculum is designed and how schoolteachers and teacher educators understand it and teach it. This subjective engagement with the curriculum is noteworthy, especially for teacher educators whose practice is less problematised in the science education literature. The question of subjectivity in science education is related to the recent 'call' to pay attention to the sociopolitical discourses rarely studied within the field. I have argued that data from the CPD provide an opportunity to explore the way schoolteachers' and teacher educators' subjectivities are produced, which ultimately contributes to this sociopolitical call.

Thus, this thesis is developed in the science education field, exploring issues related to centralised control and colonisation of curricular development, the role and aims of CPD programmes, and science schoolteachers' and teacher educators' subjectivities on those programmes. In conditions of centralised control, schoolteachers are positioned as 'teachers-as-problem' (Thompson & Cook, 2014), which in Chile could be related to teachers historically and persistently being considered as technicians (implementers) with a sense of incomplete professionalisation (Núñez, 2007). In this context, the aims of CPD programmes are restricted mainly to giving the necessary support to guarantee that the curriculum and its changes are 'implemented appropriately' (Couso, 2016), which also narrows down the position of teacher educators while their professional development is not considered. The specific questions asked in this thesis were: How did the university team members experience their interactions in and around the CPD programme? (Chapter 4); How did the work on the CPD programme, using the example of the activities on creating research questions, shift teachers' pedagogical and epistemological positions? (Chapter 5); and How did the participating schoolteachers and teacher educators conceptualise the purposes and practices of science education and specifically the big ideas of science education approach? (Chapter 6).

In what follows, I draw together three arguments which constitute the conceptual and methodological contributions of this thesis; I also discuss limitations and provide

recommendations for areas worthy of exploration through further research. I end this chapter with some final remarks and reflections.

7.1 Three arguments constituting conceptual and methodological contributions

University teachers' (including myself) and school teachers' subjectivities can shift during a CPD programme. The exploration of these shifting subjectivities in relation to a CPD course contributes to an empirical illustration of the sociopolitical aspect of the science education call. I made use of dialogue to materialise this sociopolitical turn *into* the science education field, meaning that throughout this thesis, dialogue became a sort of empirical methodology for building a connection (the italics *into*) between the two.

The above-mentioned is presented in the following three arguments. This thesis:

- Demonstrates that subjectivities can shift during a CPD course. Teacher educators, schoolteachers and I (researcher) all experienced subjective changes due to the CPD programme in the social and political context of Chile.
- Illustrates and articulates a particular version of the sociopolitical turn that has, to date, predominantly been theory-based, by providing empirical data on the experience in and around a CPD course in the science education field.
- Employs a productive and provocative use of dialogue which contributes to illustrating the sociopolitical turn in the science education field.

These three arguments constitute conceptual and methodological contributions that are intertwined. For instance, exploring the notion of subjectivity is related to the sociopolitical call which in turn contributed to both a change in my subjectivity as a researcher and to an initial conceptualisation of shifting subjectivities. The use of dialogue at different levels contributing to my analysis and my own learning process was (is) also conducive to a conceptualisation of dialogue as a contribution to the field of science education in this thesis. That provocative way of using and experiencing dialogue (through dialoguing with different voices and bodies of knowledge) has also contributed to the sociopolitical call in the sense of transgressing boundaries of the science education field, and also to my subjective change as a researcher reflecting on unfamiliar questions, using different lenses, and making new interpretations. Even though this intertwined circularity, I separated it into the above-mentioned three arguments to explore them in depth, revealing the conceptual and methodological contributions of this thesis as well as its limits and projections.

7.1.1 Shifting schoolteachers' and teacher educators' subjectivities

On the basis of my analysis, the subjectivities of schoolteachers, teacher educators and myself (as researcher and teacher educator) experienced changes in and around the CPD course. These distinctive and changing professional identities are produced in the encounter with *others* in and during the CPD space (including the analysis process). At the same time, these subjective changes are a response to the discursive context (i.e. institutions such as the Ministry, university, or school) in which the encounter occurs. In that sense, subjectivity in this thesis is understood as everyday relations that articulate how the experience lived in relation

to a specific institutional context. I argue that uncovering the complexity of these shifting subjectivities contributes to changing the assumption of teacher-as-problem/facilitator-as-expert because in both subjectivities something is being unfixed. The following is a conceptualisation of the salient features of these shifting subjectivities.

Teacher educators positioned them(our)selves as experts due to preconceived knowledge imbalances between teacher educators and schoolteachers. These subjectivities shifted during the CPD course, resulting in different forms of engagement inside it. There was a disruption (in the form of agreement/antagonism) of the supposedly unified university team with different identifications within the group related to institutional requirements and practices (i.e. the Ministry, university). This destabilisation of the 'we'/university team disclosed an emergence of a new 'we' which attempts to position similarly with the schoolteachers in relation to knowledge. I had the opportunity to unpack this shifting subjectivities because of both the number of people (12 colleagues including myself) and the time involved in the experience (seven months from its design to its final meeting). This kind of long-term experience is a methodological contribution to studies that attempt to understand the context in which a subjectivity can change, as opposed to what can happen in CPD courses that take place as one-shot interventions. A conceptual contribution to the CPD literature is the attentiveness to the emergence of crucial moments during a course such as giving opportunities for non-planned content.

Science schoolteacher subjectivities were characterised by fixed positions of who is the student and who is the teacher in the science classroom. That positionality shifted because of experiencing the position of the *other* (in this case, a student's role) while reflecting on questions such as *'who teaches?/who learns?'*, challenging the position of the teacher as only teaching and the student as only learning. As a result, the schoolteachers' pedagogical and epistemological positionalities were also shifted. For instance, pedagogically, there was the acknowledgement that a teacher should first learn (i.e. the process of creating research questions) in order to then teach the students; while epistemologically, there was the destabilisation of some narrowing assumptions (i.e. creating research questions as a simple process). In doing so, affective responses including disappointment, frustration and embarrassment were prompted by these shifting pedagogical, and epistemological positionalities. The encounter and involvement with the *other* (colleague, student, university lecturer or even theory) became generative, understanding that the learning cannot be conducted alone.

In my case, I have been experiencing a troubled identity as researcher and teacher educator (which I also tried to make explicit in the Interludes) by re-reading the literature of my initial training, finding new meanings; I have questioned assumptions such as who learns and who is considered the expert in relation to knowledge in a CPD, and focused on group formations when different identities combine and differentiate at different moments between the participants, or considering the influence of institutional practices and conditions that shape the engagement with a CPD course. My contribution, on one side, is related to questioning the nature of this subject formation through *asking after* the conditions of the subjectivation

processes social, political, and culturally important questions (mapped through markers in Chapters 5 and 6). On the other side, there is a contribution by making explicit how this subverted role had occurred (from being a biologist to also being a social scientist), attempting to acknowledge a *new scientific subjectivity* (following Lather, 2012) in science education. Lather posed this as an invitation to rethink the concept, the unconscious and body in science, asking, for example, what kind of politics are involved in what kind of science? In my thesis, this re-thinking took place through my dual position in both the CPD team and in my doctoral research, which opened up many possibilities of being and reimagining my work as teacher educator.

This initial theorisation of subjectivity has been influenced by science educators who have worked with this concept (e.g. Jesse Bazzul). So I have been looking 'from within' the field of science education, particularly drawing on authors who are already bringing in theory from other fields. Now, as further exploration this thesis might lead me to explore more in-depth in other areas with other authors (e.g. Michel Foucault) to keep theorising using other tools from cultural studies, sociology of education or philosophy to add to theories of subjectivity. Thus, I have drawn on research in science education that already draws on theorists from sociology and philosophy; and there is further work to be done, playing with different ways these ideas can contribute to the field and to the sociopolitical turn. In this vein, a possible limitation of this work could be a sense of incommensurability because of the same exercise of using different perspectives, trying to dialogue amongst different epistemes which could lead me to sometimes being mistaken. I ventured to bring together conceptualisations from different authors and sometimes some of them had opposite understandings (such as Freire and Butler around the notion of consciousness), which could be seen as an error. However, and here I connect to the sociopolitical turn, I was attracted by an understanding of the turn that meant an invitation to play with different notions to explore their productiveness in my analysis towards shaping my interpretations in this thesis and my future work. Now I turn to the second argument around the empirical contribution to the sociopolitical call.

7.1.2 Illustrating and articulating a particular version of the sociopolitical turn in the science education field

On the premise of my analysis, to research the sociopolitical turn in science education in this thesis meant three main concrete ideas: incorporating political issues of control and power relationships (e.g. in curriculum policy and development or hierarchies between schoolteachers and university teachers); transgressing boundaries (conceptually and in the way that the thesis is written); and tracing the absent/excluded regarding the topics of interest of this research.

Regarding control and power relationships, on one side, this thesis contributes to the analysis of both centralised control and colonisation of curricular development. Usually, teachers are treated as implementers or information providers, and less often as curriculum developers; however, schoolteachers are enacting their own understanding of, in this case, big ideas and how to teach them (e.g. Dora with going beyond the Chilean science curriculum and Ricardo teaching a big idea that was not incorporated on it). In this sense, schoolteachers are occupying

a classroom role that is not just about implementation of the curriculum, but rather having a response that is particular to their experience. When a language (such as the big ideas approach) enters the Chilean experience for schoolteachers, students, and those providing CPD courses, it generates a response from these groups (such as different conceptualisations of the approach) which can lead to an effect on science education itself because, for instance, the language of classifications previously separated by topics (in biology, physics, and chemistry) does not operate any longer. Thus, my thesis contributes conceptually with a map of contested understandings of big ideas of science education opening the possibility to problematise this very approach, and its understanding of where the curriculum is made. Besides, by giving more time and space to subjectivities of the schoolteachers who propose their own ways, big ideas could be more closely related to content, pedagogy and epistemology. In a broader sense, understanding the transformations that take place when curricular policy is implemented opened the opportunity to also question when aims and curricular changes in science education are presumed to hold globally, raising the question of its situatedness.

On the other side, there was also an exploration of preconceived hierarchical power imbalances between teacher educators and schoolteachers. At the beginning, university teachers were reproducing that there is a knowledge that is accepted as legitimate and assuming that there is another one that is considered as not so legitimate. On the basis of my analysis, I can add to the literature that this kind of colonising hierarchical relationship can be shifted (as previously illustrated) in the encounter with the other/knowing the other. My analysis suggests that questions such as *'How do the power relationships between the university and the school operate in schools and Academia?'* are worth continually bearing in mind. In here the contribution is related to framing this kind of questions, constituting a new approach to research the sociopolitical in science education.

This critical understanding of legitimate knowledge transgresses an established institutional boundary in understandings of knowledge. The transgression of boundaries in the development of the thesis was also related to using concepts from other fields contributing to problematise the professional development. The very use of subjectivity in science education is a contribution to the sociopolitical turn because it has not been commonly used in the field. The particular input into the field is related to exploring, for example, how the subjectivities of teacher educators, which is less problematised in the science education literature, are produced and shifted. To understand that the subjectivity of a teacher educator during the CPD course is also changing means that this group is also experiencing professional learning; this opened up the opportunity to problematise the teacher educators' identity, learning, and practices in a CPD programme which is normally focused on schoolteachers (as target).

Another example of transgression of boundaries is related to the way that this thesis is written. I made use of a variety of forms such as Interludes (reflecting an *inner dialogue* between the data and the readings shaping my learning and used to revisit some aspects of the analysis that I found more significant), comic strips (as a form of transcription of non-verbal language and classroom observations) and developing diagrams (illustrating the shifting subjectivities

alongside the chapters). Altogether, I tried to show an intimate mode in the process of writing which is also contributing to broader moves towards a new modality of researching in science education.

A third concrete contribution of researching the sociopolitical in science education was related to tracing the absent/excluded. A way of doing that was by recognising the absent, such as the professional development of teacher educators in the science education literature or the big ideas' conceptualisations of the schoolteachers, a voice that was not considered in the incorporation of the big ideas approach into the Chilean science curriculum. The exercise of bringing under the spotlight the institutional conditions, the differed meanings of words (e.g. 'development'), or the questions related to curricular development are worth (keeping on) tracing. Those examples had the spirit of uncovering situations (or avoided topics) that are hidden in science education, attempting to reimagine what is not there under the logic of presence. In doing so, this contributes to the sociopolitical turn which includes a call to explore silenced or excluded perspectives in the field.

Regarding the absent/excluded, I can see a further exploration using Derridian mobilisations of *trace* and *différance* which may productively inform how I can keep reflecting on subjectivities produced in CPD programmes. Derrida posed the concept of *différance* as follows:

> If the deviant presentation continues to be definitively and relentlessly rejected, it is only a certain present that remains hidden or absent; but the différance keeps us in relation to what we necessarily ignore that exceeds the alternative of presence and absence. (Derrida, 1998, p. 15)

As I understand it, *différance* is a playful movement that 'produces' acts of differing from a starting point; this does not mean that *différance* is before the difference in the present tense at the same time as being unmodified because it is not related to time nor space. In Spanish, as in French, the word 'differing' has two distinctive meanings, the first one is related to the action of leaving for later (deferring), make a detour or a delay, so is related to time; the other meaning of differing is related to being other, being non-identical, distinctive. By replacing the second 'e' in 'difference' with an 'a', this double meaning is not only merged, but constitutes something more. In that sense, *différance* is more than the dichotomy present/absent. As a result of further exploration, linked with subjectivation processes, by acts of differing from a specific state, different subjectivities are produced, so I could keep understanding the complexity of shifting subjectivities that are revealed in my thesis. *Différance* connects us with what is hidden or excluded. In this sense, if differences are 'produced' – differed – by *différance*, what is it that differs or who differs? The 'solution' to that conundrum is arrived at through 'trace', another Derridian concept.

Trace recognises the non-present, the excluded in the presence, expressing the "the mark of the absence of a presence" (Spivak, 1976, p. xvii). There is a problem in bringing into presence the trace because we would be naming the non-present, making it present. However, the exercise to imagine what is and is not there can make us think on how the mindset of presence closes down the possibilities of differed meanings. That logic of presence makes a defensive barrier, defending it in a way that is totalising. In here I can see a projection, thinking, for

example, the way that the curricular development or professional development are understood in the logic of presence – hegemonic understandings of certainty – what/who is absent is positioned outside that defensive barrier; therefore, it is/they are 'relentlessly rejected'. The exercise to imagine what is and is not there allows me to reflect on the possibilities of differed meanings by tracing the non-present, that is, thinking on what is relentlessly rejected makes me turn to what is absent in different dimensions of science education. This further exploration could be connected with the way I understood and used dialogue in this research, which is explained below as the final argument of the contributions of my thesis.

7.1.3 Productive and provocative use of dialogue

Dialogue increased in importance throughout this research, to the extent that I eventually incorporated it within the title from the very first page of this thesis to being a key contribution in this final chapter. One could understand dialogue as being used on different levels in my research. At one level, the dialogue between individuals was used in my analysis, as I paid attention to key episodes of utterances between the participants in the CPD programme. At a second level, there was a dialogue that contributed to my subjective change – a dialogue on dialogue – towards incorporating other perspectives. That second level was between the discourses of science education and the sociopolitical dimension, between my supervisors and myself, and between the collaborative analysis group and myself. This second level of dialogue was crucial to how I selected the key moments and in the different ways in which I used dialogue which, ultimately, became a sort of thread running through the whole process. In my thesis, dialogue contributed to the point of intersection between science education and its sociopolitical dimension; thus, I argue that by paying attention to dialogue one could understand the intricate interplay between science education and the sociopolitical sphere.

Regarding the analysis, I used dialogue to explore the different types of discourse that emerged in and around the CPD programme towards unpacking the subjectivities and the shift of those participating on it. Focusing on language through dialogue in my thesis provided a way to pay attention to the body and the material (language as a space where words and things meet and differentiate) towards unpacking aspects such as culture and power relations. In my analysis I made use of fairly long extracts from conversations between the participants of the CPD course, noting their speech, words uttered, silences, emphases or overlapped exchanges, as they occurred in conversations, whilst also depicting contextual elements by considering the institutional settings in which these interactions occurred. In so doing, a conceptualisation of dialogue emerged which is related to the recursive movement of interpretations between linguistic aspects of the participants' utterances, such as the spoken words, and the discursive context where those words were uttered. This conceptualisation constitutes a methodological contribution of the use of dialogue for researching subjectivities in science education.

In my analysis I sometimes paid special attention to words uttered (e.g. horizontal/vertical), while at other times I was focusing on how different voices moved around a theme (the use of chaos or the contested discourses of big ideas); I also depicted how different voices were at play within one person's speech (the case of Dora or me), each of them in relation to its

distinctive discursive context. The resulting three findings chapters overlap with regards to how I use dialogue with an overall conceptualisation and analytic approach, yet with nuances as a result of the different discursive contexts. For instance, around the discursive context of the university in Chapter 4, the focus was to reflect on words (e.g. levelling up, ambition) which illustrated the hierarchical relation to knowledge and the certainties of the university team regarding institutional practices, whereas in Chapter 5 around the discursive context of the school, the dialogue prompted a shift in the pedagogical and epistemological positionings of the schoolteachers. Thus, dialogue (participants' utterances + discursive context) was operating both to reflect and to constitute the positions of the participants, allowing me to unpack their (our) subjectivities.

Another contribution regarding dialogue is related to how I mapped some components as markers (e.g. social, institutional, scientific, affective) in the analysis. These different markers were also related to how I use dialogue differently. I did not use markers that were in the literature; rather, the data allowed me inductively to define the markers I was focusing on. Those markers associated with dialogue are a conceptual and methodological contribution as well.

There was also an issue of ethical engagement associated with my development of this approach to dialogue that I tried to acknowledge during the process of analysis, because I was analysing my own and my colleagues'/friends' utterances. There was a closeness to the data (e.g. my own utterances) and the very act of analysing those data (my own interpretations on them) which could mean that I was privileging some analysis that resonated with my own opinion or argument over other possible interpretations. I tried critically to keep an eye on this possibility by constantly questioning my own interpretations and discussing them with my supervisors and friends in the collaborative analysis group. In so doing, dialogue also contributed to reflection on my ethical engagement on the thesis.

A final limitation is that my thesis could have become too self-centred. I started thinking about how schoolteachers understand and put into practice a current curricular change in the science curriculum, but the final shape of the thesis, even though it considers the experience of two schoolteachers teaching big ideas in their classrooms, is more related to the whole experience of the CPD course in terms of the subjectivity of the teacher educators (including my own) and the schoolteachers, so big ideas were occupying another role while the initial aim was shifted. At the same time, I keep questioning if this becoming self-centred is also related to a sense of arrogance on my part. However, I can see some advantages to including myself in the analysis, such as unpacking my practice, which have implications for my current and future work as teacher educator.

7.1.4 A summary of the contributions to the existing literature on CPD programmes and curricular development

The three arguments described at the beginning of this chapter allow me to present the following summary of the contributions to knowledge with regards to the sociopolitical turn,

CPD programmes in science education, and schoolteachers' and teacher educators' professional identities and the science curriculum and its development.

There is an overall contribution of my thesis which is related to shifting subjectivities in a CPD programme. I argue that uncovering the complexity of these shifting subjectivities contributes to changing narrowing assumptions of teacher-as-problem and facilitator-as-expert – echoing Thompson and Cook (2014) – because in the teacher educators' and schoolteachers' subjectivities something is being unfixed. The possibility to disclose this complexity was related to experiencing a long-term CPD programme (seven months). This kind of long-term experience is a methodological contribution to studies that attempt to understand the context in which subjectivities can change, as opposed to one-shot interventions. In this case, the temporal horizon could serve as a reason to re-evaluate the length of such programmes as a means to explore how professional identities are (re)articulated. Similarly, in terms of a conceptual contribution the attentiveness to the emergence of crucial moments during a course – such as the commentaries and reflections around activities creating research questions – gives the opportunities for non-planned content to also contribute to the exploration of professional identities being rearticulated. For instance, I have illustrated how the schoolteachers questioned the initial position of the teacher as only teaching and the student as only learning in a classroom situation, shifting their pedagogical and epistemological positionalities.

Regarding curricular changes, the schoolteachers are treated as technicians/implementers which is more evident with their non-participation in curricular decisions, and the comprehensive curriculum that leaves very little space for their own ideas. A contribution of my study is the illustration of the way schools and schoolteachers enact such curricular changes, making adaptations or questioning/applying them, overcoming the exclusion of not being considered in the curricular development. This discloses, in a way, how policy speaks to schoolteachers and how schoolteachers speak to policy. Schoolteachers having a critical response to curricular change (e.g., the way Dora and Ricardo conceptualise and implement big ideas in their classrooms) allowed me to disrupt this discourse of the teachers as victims (technicians, colonised) even though the policy can be acting as a method of control. In this critical response to the curriculum, schoolteachers positioned themselves as reflective professionals in contact with others, basing their pedagogical decisions on their professional judgement and cooperation (Ball, 2003).

In terms of the sociopolitical call, on the one hand, as the turn is an invitation to play with different notions to explore their productiveness, I ventured to use notions such as subjectivity in my analysis. Subjectivity in this thesis is understood as everyday relations that articulate how the experience is lived in relation to a specific institutional context. Besides, the call is also an invitation to bring together conceptualisations from different authors even though sometimes some of them had very different understandings (such as Freire and Butler). On the other hand, I was able to incorporate political issues of control and power relationships regarding curricular development and interactions of those participating in the CPD programme. In terms of control, there is centralised control and colonisation of curricular development, which is related to the above-mentioned position of the schoolteachers as technicians. However, on

the basis of my analysis I have illustrated how schoolteachers are enacting their own understanding of big ideas and how to teach them which could be applied to a broader literature on schoolteachers' responses to curricular changes (*2.2.1.3 How do teachers respond to curricular changes?*) when they are positioned as implementers, executors or information providers. In doing so, this thesis also contributes with a map of contested understandings of big ideas in science education from my analysis problematising the curriculum (*6.2.1 Different contexts: Problematising the big ideas approach in science education*); the conceptualisations of the policy and the CPD programme on the big ideas approach; as well as the accounts of two schoolteachers teaching big ideas and dialoguing with the curriculum, the CPD programme and their schools (*6.2.2 Accounts of Dora and Ricardo's experiences teaching big ideas*), and the big ideas definition created during the course (*6.2.1.2.3 Applying or questioning the approach*). All in all, the contribution of this map is related to having an account of the big ideas in science education approach more closely related to content, pedagogy, and epistemology.

A final contribution to the sociopolitical turn is related to transgression of boundaries conceptually as explained above, yet also to how it is possible to communicate this kind of study. I made use of a variety of forms (e.g. Interludes, comic strips, and diagrams) trying to show an intimate mode in the process of writing which also helps contribute to a new modality of research in science education, specifically related to how to evaluate CPD programmes in a non pure descriptive way (Aldahmash et al., 2019), instead trying to explore more deeply changes in teachers' practices and learnings.

7.2 Limitations

There are some limitations mapped alongside the above three arguments. There is a sense of incommensurability because of the use of different perspectives, trying to dialogue amongst different epistemes. However, as my reading on the sociopolitical led me to use the notion of subjectivity, I consider that my use was a first exploration worthy of further development. Another limitation is related to the sociopolitical turn in the sense that my study could have been read as being outside the science education field. A further limitation is that my thesis could have become too self-centred. I started thinking about how schoolteachers understand and put into practice a current curricular change in the science curriculum, but the final shape of the thesis, even though it considers the experience of two schoolteachers teaching big ideas in their classrooms, includes the whole experience of the CPD course in terms of the subjectivity of the teacher educators (including my own). Aside from the above-mentioned limitations, I want to explain further limitations of this study more specifically.

7.2.1 How to spread this work in different contexts and with diverse stakeholders

Following the limitation that my work could have been read as sitting *outside* the science education field, I keep wondering how to discuss the results of my study with different stakeholders and voices 'inside' and 'outside' the science education field. For instance, how can I discuss my findings with policymakers who oversee curricular changes? As my questioning includes power-sensitive inquiries of centralised control and colonisation of curricular development, the very conversation that the curriculum is a form of control could make a defensive barrier between my findings and the people who are in charge of such changes. I

have had some experience in discussing parts of my findings with policymakers, specifically, the people who oversee the development of NIPD (the nationally funded project that includes the CPD programme), with whom I had productive conversations about the importance of generating questions and their role regarding scientific inquiry. In doing so, this limitation is becoming an invitation for me to gaze back to common points between my analysis and other voices, which is also a challenge considering how the thesis is written. Previously I said that I consider my writing as transgressing boundaries towards a new modality of researching in science education and I am committed to that idea; however, I also wonder how this very transgression can be received, which I also take as an invitation to look for ways and modes of discussing these findings with a larger audience while keeping the things that I value the most in my work. This limitation in particular is the one that is keeping me in a sense of constant struggle. A struggle that I want to embrace – although it can be painful – which makes me think of Haraway (2016), when she suggests staying with the trouble, imagining, in a provocative way, what is and is not there, as in my case, in a particular experience concerning the science education field.

7.2.2 Timing of the data production

The time of the year at which data was produced could have influenced the whole process of production. The CPD programme was held between November 2017 and January 2018 and some interviews and classrooms observations were conducted between October and December 2017 (see *3.2.2 Fieldwork*). As the school year in Chile traditionally runs from March to early December, the main part of the fieldwork was conducted at the end of the academic year when schoolteachers are more likely to be busy, stressed and, in many cases, dealing with the administrative part of closing the year.

7.2.3 My role as *insider* in the research and as teacher educator

In this study, my role as the researcher (designing, producing data, undertaking analysis, and writing about the process), while also being part of the teacher educators group, surely moderated my understanding of the schoolteachers and teacher educators' subjectivities. While the multiplicity of my presence in this study enabled me to resist fixed positions with some particular behaviours (of researcher, interviewer or observer) and instead permitted me to occupy somewhat opposed positions which influenced the analysis by coming back to those multiple positions and the contexts in which they were produced, it was still ethically challenging to deal with the insider role considering the ethics of interpretation (Lapping, 2008) when my own practice was also the one depicted.

Cochran-Smith and Lytle (1993) pointed out the dilemma of insider-outsider subjects when knowledge production of schoolteachers' experiences has usually been carried out by academics in the university. Cochran-Smith and Lytle posed the challenge to dispute the university's hegemony in the generation of knowledge, by considering teachers' voices in research through the dialogue between the 'outsiders' (academics) and the 'insiders' (teachers), closing the argument with the position of teachers understood as researchers of their own practice where there is no one better than them to speak about pedagogy and the

different challenges they face. The concept of researcher teacher was later developed by Cochran-Smith and Lytle (2009). Here, the teacher as researcher is reconceptualised as practitioner inquiry which implies the research process is carried out by practitioners (which includes not only teachers, but also other members of the educational community as in my case with teacher educators). Thus, inquiry becomes a collective effort and not an individual stance. I think this research stance resonates with how the potential limitation of depicting my own practice, my colleagues', and those of the schoolteachers was, if I may say so, overcome connected also with the reliability of my work.

7.3 Final remarks

I started conceptualising the CPD programme, perhaps in an idealised manner, as a *Hybrid Space of Learning*, as somewhere where schoolteachers and teacher educators could share their practice, developing a new understanding of how to teach big ideas. What I realised was that at the beginning and before the course started, I may have been obscuring the differences between the participants of the CPD programme, trying to blend in an unquestioned manner the interactions and relationships in a hybrid discourse. Now I think that my position as teacher educator is related to thinking from the different subjectivities (teacher educators and schoolteachers) that could be dialoguing with each other, recognising their different positionalities which could become an hybrid, meaning a space which it does not silence the differences or the power imbalances between the participants, but rather recognises them, building from them. That is for me a realisation as a teacher educator which I want to keep exploring.

As previously stated, while exploring the call to incorporate other perspectives and notions I have been experiencing a shifting researcher role (my subjective change from being a biologist to also being a social scientist) which I wanted to make explicit in this thesis. I argue that due to incorporating these perspectives, my epistemological positionality while researching science education was (is) changing. When I said that I am taking the turn personally I am referring to the fact that while producing this thesis over more than five years, I currently feel a mixture of emotions: troubled, challenged and also excited, and I can see that many reflections from this thesis are having a response in other areas of my life as well as in my position as a teacher educator who is still working on CPD programmes. In terms of my professional identity, I feel especially called to understand what it means to be a science educator in Chile, someone who is at the same time critical of dominant practices and discourses in science in my social and political context.

My final reflection, which is at the same time an invitation to myself and to others, is to continue exploring through the use of various notions (such as *différance* and *trace*), borrowed (or purloined) from different fields, as well as remembering the often dismissed fact that science educators (schoolteachers and teacher educators) are political subjects whose identities should inform the science education field (in this case science curriculum and professional development) as recursive attempts to reimagine absent possibilities of what it means to be a science person and what science education is and can be.

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Appendices

Appendix 1: Questionnaire big ideas in mind

Big ideas in mind

Dear teacher,

The aim of the following questionnaire is to explore the intentions and practices you have related to teaching with the big ideas of science education. In this sense, there are no such things as 'right' or 'wrong' answers; the intention of the questionnaire is to obtain your opinions and experience.

1. Professional and personal information

   a) Date of birth (dd/mm/yy)
   b) Which is your highest degree?
   c) How many years of teaching experience do you have?
   d) At which level do you teach?

Pre-primary	Primary	Secondary	University

   e) If you currently teach in a school, in which type of school do you teach? You can identify more than one school.

Public	Semi-private	Private

   f) How many hours do you work per week?
   g) How many students do you teach per week?

2. Teaching big ideas

Before the next part of the questionnaire, here are two definitions of a big idea and an example:

i. "A progression towards key ideas which together enable understanding of events and phenomena of relevance to students' lives during and beyond their school years" (Harlen, 2010, p. 2).

ii. Big idea is being a unifying principle that connects and organises a number of smaller ideas or concepts and multiple experiences. In other words, integrating is one role that makes big ideas pedagogically powerful in that they offer direction for teachers to make learning for students more connected (Mitchell et al., 2016, p. 3).

To illustrate, a big idea could be: "Organisms are organised on a cellular basis".

   a) Given these definitions, do you have experience in teaching with any big ideas?
   b) If so, which idea? At which level? How do you decided this is a big idea?
   c) Do you have your own definition of big idea? Could you please share it with me?
   d) Please give me one example of what happen when you taught with this/those big ideas.
   e) If you do not have experience teaching with big ideas, can you think of one idea which you would like to teach in this sense? If possible, describe which idea and level.
   f) Do you think teaching with big ideas in science could be helpful to the students? Why / Why not?
   g) What possibilities do you think big ideas have for teaching science? Why?

3. Working with big ideas

a) If you have experience teaching with big ideas, can I come and watch you teach one or more of your classes in the future? Please give me your contact details.
b) Are you interested in understanding more about this topic? Please explain your reasons.
c) Are you interested in creating and planning your own big ideas with other science teachers? Please explain your reasons.
d) Would you like to participate in a continuing professional development programme focused on big ideas? Please explain your reasons.

Appendix 2: SRI schedule

Extracts of the lessons	Themes	Observations
1	Big idea	Focus in which big idea the teacher is using and how they prepare that lessons with that big idea
2	Activity/strategies	How the teacher is teaching the big idea selected
3	Question/ instructions	What type of questions the teacher is using. What type of instructions
4	Resources	What type of materials the teachers is using
5	Teachers' role	Focus in what the teachers is doing during the lesson
6	Students' role	Focus in what the students are doing during the lesson

1° conceptualisation of big idea

Regarding the first interview, you told me that the definition you had of big idea is the following: "the basic issues that all of us as Earthlings should know, the essential things that one should understand. We can improve both the quality of our life and other species as well" how is that definition linked to this extract (video 002: 23_10 minute 4: 45-7: 46). First, describe to me what we saw. How does your definition of big idea connects to how the lesson gets started? What is the big idea that you wanted to work on in the whole unit? And if we move forward in the video (video 002: 23_10 minute 9: 20-11: 31) how did you come up with that? What is the big idea you wanted to work on here?

Could it be that you work on more than one big idea per lesson or does a big idea allow you to connect with other topics (such as working on different topics simultaneously) or the possibility of promoting different skills? Then you ask them to say their location by raising images of birds and you tell them that what we have defined is classifying based on some criteria. With the field trip the unit is completed, let's look at the following extract with the aim of the field trip (video 0022 13_11 all the video of 2:39 minute).

6° link with daily life

In the first interview you told me that "at this point in my life, I understood that everything is as fragmented as I told you, this question has to be put together, I think that putting it together is like, is to understand it with life, if I don't know why Scientific knowledge is built, if they are ... we are science, the fact that if I want them to understand something and I think it is also because of socio-scientific issues or involved with environmental or non-environmental issues, the sugar that you consume…"Let's see the following excerpt (video above between 10: 00-14: 00 that the girl went to the wetland) what do you see there? Can you see the connection to daily life? Why is it important for them to see that?

Appendix 3: Schedule's interview of the conditions at schools

Table: Schedule of the interview aiming to describe and understand the context – in terms of local policy and school level – that is at play.

Theme	Description
Big ideas	Questions about their definition of big ideas
	Questions about the curriculum with big ideas
	Questions of their knowledge of the use of big ideas by science teachers
Time	Questions about conditions of time the teachers have to implement lessons
Resources	Questions about the materials that are offered to the teachers and the ones that teachers ask for implement lesson using big ideas
Specific to the Ministry deputies	
Aims of the Ministry	Questions about the relationship between the aims of the Ministry and the teaching based on big ideas
The National Curriculum and its changes	Questions about the relationship between the National Curriculum and the implementation of the big ideas by teachers
	Questions about how teachers implement the current National Curriculum
	Questions about what conditions teachers have to implement the curriculum
	Questions about what conditions the Ministry offer to implement that changes
Assessment	Questions about how the Ministry assess the teachers' practice in terms of how they implement the new curriculum

Appendix 4: Summary of each session of NIPDE
Session 1: 11/11/2017

Morning

We started the morning of November 11 with a nice breakfast followed by a presentation by Karen and Paulina on the administrative issues of the course such as schedule of the lessons, facilitators, aims of the course and the type of CPD we thought we are. We ended up asking about the expectations of the schoolteachers on the course.

Contextualisation to the local territory: mapping activity
The main activity in the morning was related to conduct a mapping locating the districts of the schoolteachers. We used printed maps of each sector: D1, D2, D3, D4, D5, D6, D7, D8 and D9. The activity was organized around moments with the following aims:

MOMENT I. Brief introduction
We described what does it mean geography and its aim of study in relation to science education. We made use of the concept of the geographical space. Besides, we discussed the relationship between geography and science education. We ended this moment explaining the aim of the activity and showing the maps per district.

MOMENT II. Introduction of the activity
Groups of teachers were formed by district, we explained what participatory mapping meant and provocative questions about the mapping were presented.

MOMENT III. Development of the activity
Part 1: The characteristics of heritage of the environment were recognised: What are the main places (home, work, leisure, etc.) and the main territorial dynamics that characterised my environment? alluding to the heritage characteristics of the districts.
Part 2: The problems of schoolteachers´ environment were recognised: What are the main territorial issues that affect our environment? Alluding to socio-environmental issues.
Part 3: It was discussed how this activity can be used as practical work of teaching-learning of the geographical environment with students in relation to science education.

MOMENT IV: Plenary
The groups by district presented what they have worked during the morning, and the facilitators contributed by relating the previous work with the socio-scientific issues and the definitions of geographic space, territory, and environment. All the above linked with scientific inquiry.

Afternoon

Scientific Inquiry
The question that guided this work was *What is inquiry?* The idea was to make it clear that, in such a diverse group, and based on the different experiences they may have had in the previous version of NIPD, there are various conceptualisations of Scientific Inquiry. So, the aim was to explore these conceptualisations, in order to share certain common criteria. As a first activity, we showed a video of a colleague who carried out a series of activities with 1st year students, to then answer the following questions:

- Is it possible to conduct scientific inquiry with young children? Why?
- Can you recognize the use of scientific inquiry on the activities made by the children? Which ones?
- Do you have experience working with scientific inquiry with your students?

After discussing the answers, we carried out a practical work to explore the diverse conceptualisations of scientific inquiry . The activity had the following steps :

1. Each schoolteacher received a candy and a post-it
2. They were instructed to eat the candy at the same time and notify when it is no longer in their mouths, providing the time on their post-it.
3. A vertical axis (number of participants) and horizontal axis (time in minutes) were drawn on the whiteboard.

4. When the last schoolteacher finished, they were asked to come to the blackboard and put their post-it in the corresponding time.

5. We described the graph formed.

6. The following question was asked: What question could we ask ourselves in relation to these results?

7. The consensual answer that resulted was: The most obvious question was, why we have these differences in time?

8. A list of responses classified into physical, chemical, or biological factors was formed.

9. Then we asked, what could we do to find out if these variables actually explains the differences?

10. Work was done again in groups where each one created a different design to test the explanations

11. The idea that was the most convergent was written on the whiteboard, highlighting those decisions that were effectively aimed at isolating the variable to be studied.

At the end of the activity, the schoolteachers discussed how to continue the activity with their own group of students, and they were asked if what they had just collaboratively constructed is scientific inquiry. To end the session, the schoolteachers were shown an experience of another colleagues from a previous version of NIPD where a scientific inquiry activity with primary students was worked based on the use of local territory, trying to establish a relationship between the morning activities and afternoon activities on contextualization to the local territory and scientific inquiry in science education.

Session 2: 18/11/2017

Morning

<u>Curricular Mapping</u>
Returning to the action of mapping in the first session, the teachers were asked individually to fill in five cardboard circles that were arranged as a flower. Each circle that made up the petals of this flower had one of the following five themes: the territory, the curriculum, the students, the objectives, and a research question in the centre. To complete each one of the petals the following questions were asked :

1st circle: Which elements of the territory (1 heritage and 1 socio-environmental problem) would you like to use to teach science? Why?
2nd circle: With what content /part of the curriculum can you associate it? What contents does it have associated with?
3rd circle: With what course will you do it? who are those students like? Which characteristics of them make it easier or difficult for me to teach those contents? What I think they know about that content?
4th circle: Which objectives are raised with this content, socio-scientific issues, and students?
5th circle: Which question or research questions can be asked when the above four topics are in relation ?

Afternoon

<u>Big ideas of Science Education</u>
Before understanding/creating the concept of big ideas of science education, we first worked on what does it mean the notion of "Big Idea". In so doing we carry out an activity divided into the following moments:

MOMENT I
We asked the schoolteachers form small groups (4-5 members) and then to choose a movie that they like as a group. Taking into account that movie we asked them:

- Which are the big ideas of the movie?
- Why are those the big ideas?
- How did the group come to define them?
- Which was the process like?

After discussing the questions, each group presented their responses in a plenary. From the plenary session, we built with the schoolteachers what elements from their answers they had in common. With that information we were able to establish *Which*, *How* and *Why* those are the big ideas from the films. In order to establish the link with science, we showed to the schoolteachers an excerpt from the movie "Jurassic Park" to ask what is the big idea of science behind that movie. At the end, we built together the big idea of Jurassic Park, which was linked to the next moment.

MOMENT II
With the definition and procedure of how to build big ideas, we ask them to take their "flower" and to establish what is the big idea of science that they will work with their students considering every petal of the flower. We were able to create our method of constructing big ideas, in addition to one definition. The definition that we created in this session was laminated and delivered to each teacher as a symbol of the joint conceptualisation. The definition of big ideas of science by NIPDE was: "A sentence that contains one or more scientific concepts that can be related to my personal or group interests, it can be interpreted personally, it synthesises the fundamental ideas, it is communicable, and it can be shared"

Session 3: 25/11/2017
Morning

Scientific Inquiry
In this session we focused on working the research questions that were central in the "flower". The work also was divided into stages:

MOMENT I
The objective of the activity was to establish a link between the activity of the candy and the activity of inquiry with respect to the requirements that one must considered to have a "researchable" question.

It was recalled the earlier activity with the candy and was discussed with the teachers the questions that they made, such as:
- Is the composition of the different candy's colours different?
- Does the taste of the candy influence the time it lasts in the mouth?
- Is it okay if despite being a child I don't like candies?

In relation to each one of the previous questions, we asked:
- Is it a question that can be answered within a research? Explain why
- Can it be addressed in the course of a 45-minute lesson? Explain why
- Could it be addressed with Scientific Inquiry? Explain why

Following to this activity we generated a discussion attempting to develop two criteria of quality: "researcheability" and viability, with which it was built one "pattern of evaluation of researcheable questions" that later also was laminated and delivered to the teachers as one of the products of the course.

MOMENT II
Each teacher received a question to the chance by another schoolteacher. They were asked to assess the colleagues' question according to the pattern newly built, leaving record of each assessment on one sheet. Having assessed the question, it was made a "face to face" between the evaluator and creator of the question.

MOMENT III
At this time, the teachers redesigned or rebuilt their question considering the suggestions of the pair. The new version was transcribed into one new circle of cardboard (petal 2.0) and it was stuck under the previous one.

Afternoon

Eightathlon (first part)

The Eightathlon, formed by eight stages, was an activity designed to *refine* the research question with the schoolteachers.

MOMENT I

The objective of the activity was to relate the thoughts of the activity above, feasibility and possibilities of research of the questions, with the process of construction of research questions and all what that means. To comply with this objective schoolteachers were asked to work with their flower and with the final questions produced in the morning after the face to face activity. The main instruction of this activity was to complete each sateg as part of the Eightathlon in a specific time, the topics of each stage were:

- Part 1: Central ideas, elements and key concepts
- Part 2: Elements, properties and relationships
- Part 3: Relationships and initial questions
- Part 4: Cause – Effect relationship

At the end of this part schoolteachers were able to establish their initial questions reformulated defining one relationship of causality between these key elements. There was an emphasis on the fact that this type of relationship (cause-effect) is not is the only one, but for this exercise was made in that sense.

Session 4: 02/12/2017

Morning

Eightathlon (second part)

On the morning of the fourth session the schoolteachers finished the Eightathlon, considering the following parts:

- Part 5: Initial question and final research questions with cause – effect relationship
- Part 6: Identifying variables in the research question of research
- Part 7: Predictions
- Part 8: Design General proposal

After completing Part 8 of the Eightathlon, the teachers were able to establish one question cause and effect, the dependent and independent variables of that question, predictions that could propose and finally one scheme illustrating the process by adding all the parts of the Eightathlon.

Afternoon

At the beginning of this afternoon, we showed that the questions are not only cause-effect, also at that time we talked about other types of research questions involving other methodological designs which are grounded in other paradigms. Then of that conversation, we gave way to the main activity of the day which consisted in two moments:

MOMENT I
We worked with the at least three versions of the research questions created by the schoolteachers, that is to say, with the one of the flower, the one refined in the face to face with the pair and the one at the end of the Eightathlon. Those three versions of the questions were written in three new circles and then pasted on a separate individual card so the schoolteachers were able to write between them. The aim of the above was to answer in the two provided the following questions:

- What changed in each question?
- What made you change it?
- What cost you the most when changing it?

To end the activity and as a result of the schoolteachers' answers, we ask ourselves: What are the essentials if you want to do this activity with your students? As a result a list of "essentials to raise research questions" was built. This was another product that was laminated and deliver to the teachers as another of their products.

Session 5: 16/12/2017

Morning

We started this session (the final of the year) with the good news of the course appearing in a local newspaper where it was highlighted the work done with schoolteachers. We brought a newspaper for each schoolteachers and facilitators. To continue with the work in the morning, we returned to take our list of essentials built on the previous session to propose a teaching plan that was focused on raising research questions with their students.

Regarding the activity, we delivered to each one of the schoolteachers 15 slips of paper, each one with one "essential" and a space available to write. The instruction was that each schoolteacher should write in the space available one (or more) action(s) that they would perform to realise the "essential" in the classroom, considering the characteristics of their students (the petal in the flower). Then, each teacher, on one sheet paste the essentials+ action, in the order in which they thought they could teach them in the classroom. The schoolteachers designed one set of activities, ordered in a sequence. The idea was to make explicit that the actions are nested in activities, and these, in a sequence.
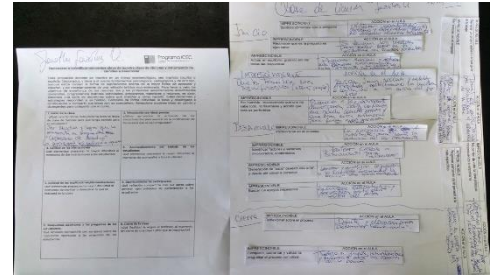
Afternoon

Reflection: reviewing the path

Trying to make a reflection of what was lived until that moment we conducted one activity of reflection. To comply with the above, a PPT was presented with the sessions held, marking the major milestones. We invited the schoolteachers to participate in a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis. The schoolteachers were separated into four tables, with the S, the W, the O and the T. In every one of them was present one or two facilitators, explaining the meaning of what they should do. All the participants had to pass to the four tables, in the order that they desired. Every 15 minutes schoolteachers were asked to move so everyone could participate in each table identifying the Strengths, Opportunities, Weaknesses and Threats.

Session 6: 04/01/2018

Morning

We started this session with one activity that had the learning community as focus. In this session a collaborative *Decalogue of Resistance* was created. The day was also marked by different moments:

MOMENT I

We showed a video of introduction to the topic of the day which was the collaboration aiming to show different contexts of collaboration. Then we asked what was common in the contexts?

MOMENT II

In this part we conducted an activity inspired by the Theatre of the Oppressed. In three groups we handed a situation that the group should represent in three minutes. The instruccion was that everyone should act, adding what they want to the situation provided. The aim was that the schoolteachers represent the situation once and then in the second time the public (facilitators also included) could stop the action with one applause trying to uncover an injustice situation that they thought that you could solve collaboratively. Who applauded take the place of the "victim" so that changed the history of the representation. After the whole experience of the Theatre of the Oppressed, with created a *Decalogue of Resistance* from the experience lived.

Afternoon

Considering that one of our goals was that the schoolteachers *experience* the scientific inquiry and made explicit the development of the skills in themselves, we planed two moments of out-of-university activities. The first of these was an out-of-university walk trough ground urban by the plan of Valparaíso that included the following points and intentions:

- Barrio La Matriz in Trole. Explanation of the path and direction of the work on land
- Tour of the Foundational Neighborhood of Valparaíso. The city as a synthesis of a physical-human space
- Valparaíso Patrimonial, value and devaluation in conflict
- Port Station, Metro to the Institute of Geography

- Terrace of the Institute of Geography. Landscape, Model of Valparaíso and Meteorological Station

Session 7: 05/01/2018

All day

Sticking with the aim above-mentioned we planed an out-of-univerity activity to the national park "La Campana" as part of the programme of scientific internship that was central in January. The purpose of the visit to La Camapana was to promote the creation of scientific questions in context of the environment, fostering socio-scientific projects and the use of the field trip as a methodology enriching of scientitic projects in motion.

The work done was around the following steps:

1. Initial questions that are transformed into research question. Identifying the dimensions worked (big ideas, who are your students, elements of the territory, as it relate to the curriculum objective learning and the research question)

2. Then the schoolteacher conducted a research design to answer their question.

3. The schoolteachers created strategies for data.

Session 8: 08/01/2018

Morning

From the out-of-university activity to La Campana, we reflected on the following questions:

- What possibilities of research did you see in the Campana?

We showed a summary of the information collected by each group as possible strategies of what the students will be doing in one out-of-school activity. Finally, we discussed the following questions keys:

- What elements of the curriculum can I address on a field trip?
- What should I consider to select a field trip?
- What facilitators have in my school to carry out an out-of-school activity?
- What obstacles I can experience in my school to conduct this type of activity?
- What can I do to overcome them?

Afternoon

After the work of the morning, we split up into groups of five schoolteachers to work with the four scientists associated with the scientific internship programme. The main aim of the first part of this work was to discuss with the scientists the problem and research questions, focusing on the design and analysis of data related to the project of science with the community. In this instance the invited scientists also were able to present their current research in terms of how they defined their research questions emulating what the NIPDE schoolteachers were developed during the course.

Session 9: 09/01/2018

Morning

We started this session asking was the process with the scientists in the session before. Then we asked that in pairs the schoolteachers revised the research design that was created the previous session. Finally, it was a plenary around the

questions: how was the process of discuss with each other (community)? How can we ensure that space (community) in the future? Then from that discussion, we asked the schoolteachers to generate, in groups, one poster, or other device, with which they can convince others to make lessons with scientific inquiry. To realises this, they kept in mind the following guiding questions: What is scientific inquiry? What benefits does it have for the school? What benefits does it have for the community? What benefits does it have for the students? What benefits does it have for you as teachers? What conditions facilitate the realisation of scientific inquiry lessons?
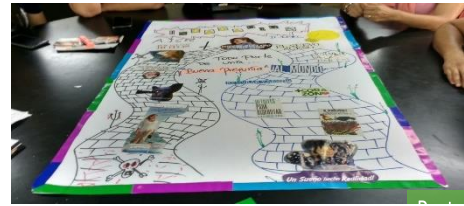
Afternoon

The aim of the afternoon was to resume the project of science and our definition of big ideas to refine even more the research questions and the other four elements of the flower. Each teacher was handed the five elements of the flower in an Excel sheet, definition of big ideas, and the procedure for defining one. With this information the teachers defined the big ideas of the science that were behind their projects. Examples of big ideas that the teachers defined were:

- People have large impacts on the environment such as the effect of the noise of the buildings in the poultry.
- The beings living are seen affected by the pollution
- The abundance of the wildlife aquatic Chile is seen affected by the intervention mining.
- The bodies need of one supply of energy and of materials from the which depend, surviving thanks to its range of resistance against to other organisms.

Then we discussed about the elements in common among the big ideas. Finally the schoolteachers worked in the presentation the day following in the "Seminar for presentation of NIPDE's projects" considering the following items:

- Context, who are they, their schools and their students
- Research problem and process to define it
- Methodology
- Big idea

Session 10: 10/01/2018

All day

In this session, we held the "Seminar for presentation of NIPDE's projects" in two rooms. The aim of the day was for the schoolteachers to present their projects in front of a panel that would give them feedback, as in a congress, and then they would also give feedback to the scientists who also presented their current work. 17 presentations were delivered.

Session 11: 11/01/2018

All day

Open space

On this last day we held an *Open Space* activity that consists of a space where everyone can openly discuss a topic. The initial call was to answer the question: *What are the obstacles and facilitators to transform ourselves and transform the school community into active inquirers?* all of us who participated in the space were able to respond on cards and propose their topics. When all the participants wrote their answers by card, thematic corners were organised and were stuck on the walls to enhance the conversation in each one of those corners.

Appendix 5: Overview of the design meetings

Table: Overview of the design meetings. The meeting of 22nd of September, 1st of December and 21st of December are the ones from which key episodes are depicted in chapter 5.

Date	Attendance/roles	Type of record	Short description
Before the course			
16th of June 2017	9: (1) administration team, (8) in total from the four focuses of the course.	Written record (308 words)	First meeting. Presentation of the project and aims of the course.
28th of July 2017	7: (1) administration team, (6) in total from the four focuses of the course.	Written record (466 words)	Possible start date. Definition of main aims of the course.
22nd of September 2017	8: (1) administration team; (7) in total from the four focuses of the course.	Written record (619 words) Audio record (time: 1.59.48)	The first draft of the 11 sessions; products for every session and assessment.
29th of September 2017	11: (2) administration team; (7) in total from three focuses of the course; (2) guests from geography.	Written record (1071 words) Audio record (time: 1.50.57)	Design: details of the 1st and 2nd session. Agreement of redesign after every session.
The first session of the CPD: 11th of November 2017			
During the course			
30th of November 2017	4: (1) administration team (me); (1) focus contextualization to the local territory; (2) scientific advisers	Audio record (time: 1.10.12)	Organization of the scientific internship which was held in January
1st of December 2017	6: (1) administration team (me); (4) in total from the four focuses of the course; (1) reflection and coaching.	Audio record (time: 1.00.03)	Final organization of session following day
14th of December 2017	6: (1) administration team (me); (1) focus contextualization to the local territory; (4) guest scientists	Audio record (time: 0.46.09)	Organization of the scientific internship which was held in January
2nd of January 2018	4: (4) in total from three focuses of the course.	Audio record (time: 1.29.48)	A general overview of sessions in January
3rd of January 2018	6: (1) administration team (me); (1) focus community of learning; (3) guest scientists; (1) reflection and coaching	Audio record (time: 1.48.26)	Organization of a seminar and science fair
21st of December 2018	9: (1) administration team; (8) in total from the four focuses of the course.	Audio record (time: 1.41.55) Transcription	A first focus group (after the fifth session).
The last session of the CPD: 11th of January 2018			
25th of January 2018	7: (1) administration team; (5) in total from three focuses of the course; (1) reflection and coaching	Audio record (time: 1.56.04) Transcription	A Second focus group.

Appendix 6: Example of coding process

The initial list of codes was

Name	Files	References
´dare´ to ask	1	1
armar y desarmar	4	10
Artifacts	3	10
Autority_valid knowledge_TS	5	13
Autority_valid knowledge_TU	8	43
challenge	5	18
children treatment	9	50
Clash of priorities	8	26
Collaboration_understanding	3	25
common understanding	2	13
completation by TU_traduction	5	17
Conceptualisation community of practice_TU	6	19
conceptualisation_Big ideas	4	43
conceptualisation_inquiry	5	27
Conditions constrains_TS	6	62
Confusion	1	1
Curricular constrains_TS	6	16
Curricular_conditions constrains_TU	5	14
Distinction	3	8
Doing science conceptualisation	8	39
Expectations_TU	3	8
Frustration_tension	6	64
General aim	3	7
Heritage_local knowledge	2	16
honest conversation_relax	4	4
ICEC_conceptualisation	4	24
insecurity	3	9
Instructions	8	40
Intervention_TS (amount of schoolteachers interventions)	9	1564
Intervention_TU (amount of university teachers interventions)	9	1665
Irony	6	10
Love first	6	18
Motivation	7	34
Naming things	5	7
Open space_organization	1	1
openess to change	4	17
Planning time_TU	4	7
Plenario	5	9
Practice_experience TS	7	19
Practice_experience_TU	7	13
Products	2	3
Quality disguised as inquiry	1	1
Questioning	4	15
Recapitulation	3	7
Requirements_consideration_TU	7	11
Resistance	4	40
Resources	2	5
Responsability_TS	5	23
selling inquiry	1	2
Socio-ambiental issues_local knowledge	2	14
Structure of the course	3	12
Table_TS	1	1
Table_TU	6	46
Territory as geography	4	12
Territory sociopolitico	3	11
Theatre of the oppressed	1	6
Time constrains_TS	6	20

Time constrains_TU	7	34
trabajo_cientificos	1	2
Transformation practice_be positive	7	50
Type_roles	7	25
Universal pluriversal	2	5
Use of humour	8	30
Use of the context_entorno_territory	5	17
we, they, WE	4	15
who is deciding	7	25

An example of one code: Frustration-tension

Name: Frustration_tension

<Files\\Transcripción_clase 3_25_Nov> - § 27 references coded [19.30% Coverage]

Reference 1 - 1.37% Coverage

Paola: Esperadme, dame un segundo. Acá donde estamos, Cris, esta segunda etapa va a tener un trabajo, cierto, consciente ahora teniendo en consideración la pauta de construcción que han realizado y la pregunta que surgió la semana pasada con las flores, sí, ahora ustedes se enfrentaron como profesor a evaluar las preguntas de sus estudiantes, primera etapa, ahora ustedes como profesores se van a enfrentar a evaluar las preguntas de sus colegas

X: Uh

pau: Chan chan

Paola: Ahora esas preguntas solamente usted se va a guiar en esta pauta que hemos construido, que va a decir tal cual como está aquí, con un ticket, si la tiene, no la tiene, si lo cumple, no lo cumple, nada de porque sí que la cosa, no, vamos a hacer eso, primera parte, sí, ¿se entiende?, Paulina nos va a entregar a quien le corresponde analizar cada pregunta con la pauta, Paulina

Pauli: Con la distribución al azar [risas], así que ahora voy a decir quiénes son las 2 clases, esto es muy importante, les voy a entregar, les vamos a decir quién es la inicial

Paola: Les va a decir a que se van a enfrentar

Pauli: A quien se van a enfrentar, con decirlo [risas] y además les vamos a dar 2 hojas para que ustedes puedan hacer lo que dijo Paola de ver los criterios de las preguntas que les tocó

Paola: Sin juntarse todavía

Pau: Sin juntarse todavía

Paola: Sin juntarse todavía

Pauli: pero digo las duplas sí po... chan chan chan... Víctor eres tú [bulla]

Reference 2 - 0.22% Coverage

[giselle dice que pasarán en esto por 10 minutos, en mi recuerdo, yo salí a hablar con Natalia que estaba muy mal porque pensó que les tratábamos como niñxs chicxs porque los pusimos a trabajar con gente que no habían trabajado antes]

Reference 3 - 1.16% Coverage

David: vamos a cerrar este último momento, primero vamos a estar en silencio después vamos a guardar el lápiz, ok, yo creo que conversando con ustedes van apareciendo dos ideas con fuerza, una es como ha cambiad la percepción respecto a preguntas de investigación, ese es tema que me interesa y es transversal, nos cuesta mucho escribir una pregunta, cierto? En la medida que vimos los criterios y han revisado su pregunta por segunda y tercera vez se van dando cuenta que era más complicado que al ppio,y eso es parte del proceso y a eso va la segunda idea en qué medida destinar un tiempo privilegiado a pensar en estas cosas que están en el marco de nuestro quehacer profesional, ie, dirigir a nuestros niños a investigaciones que sean del ámbito de la cs, bueno me doy cuenta que es más sofisticado de lo que pensamos al ppio, y como yo voy aprendiendo, nutriendo y complejizando mi aprendizaje. Les quiero pedir dado que ya la mayoría ha escrito su versión 2.0 de la pregunta, antes de ir a almorzar les queremos pedir que escriban en 3 minutitos en su bitácora este tipo de cosas aprendidas, las preguntas de la bitácora son, que estoy sintiendo, que estoy pensando y que cosas se relacionan con mi práctica.

Reference 4 - 1.09% Coverage

Delia: Dejemos un espacio para las sugerencias y las reflexiones, si, ya, por si quisieran hacer un comentario

Pauli: Sí, igual yo también pienso que...

Paola: Vamos a terminar con depresión en un día sábado o superar el sábado

Pauli: Es caleta... son caleta de actividades, son mucha información, pero y teníamos esta discusión hace rato también, pero no la hemos podido descomplejizar, porque también tenemos como ciertos objetivos por sesión que hay que...

Paola: Eso po, es que se... se topan o se juntan, cierto con el asunto de que tenemos distintos niveles, de comprensión de lo que estamos haciendo, todos trabajan de manera diferente, tienen sus tiempos para hacerse como, por ejemplo, hay algunos que necesitan más de 5 minutos para darse cuenta de lo que realmente quiero hacer ahora o de la instrucción que me dieron y entonces estamos con un curso que no está considerando sus necesidades educativas diferentes, sí po, no las estamos considerando porque todos chu, chu, chu, chu y no todos están trabajando a ese ritmo, entonces ponte tú, ahora hay muchos que se fueron verbalizados en la pregunta no registrada en ningún pétalo

Reference 5 - 1.59% Coverage

Paola: Cachai y solamente fue como sí, ésta es mi pregunta, pero ahora te decides, es que después lo voy a anotar, ya, okey, pero en este de aquí a más rato ya que paso con la pregunta, se transformó en otra cosa y el asunto de... de presionarlos en que saquen este producto del día de hoy, no todos están como... con las herramientas como para terminar el día de hoy, les falta, cachai, entonces...

Pauli: ¿Y qué hacemos?

Paola: No sé po, eso es lo que he estado pensando todo este rato, ¿Qué hago?

Pauli: Por eso te decía recién, es difícil

David: ¿Y José Luis?
Paola: Estaba pensando
Paola: Se fue a almorzar yo creo. No, se fue a dejar cosas del laboratorio móvil
Pauli: Pero yo creo que es difícil
Delia: Es difícil porque… puedo decir algo [1]
Pauli: Sí
Delia: Por lo que he escuchado de los profesores, que hay cosas que están siendo mucha información y que son… es muy valiosa, pero no nos sintamos, como retomo la clase anterior, pero retoma la clase anterior no es como di lo que hicimos, sino qué tanto de eso yo lo pude aplicar en mi práctica, porque igual puedo escribir en la bitácora, lo puedo hacer pero no necesariamente han tenido el tiempo para… degustarlo, porque hay cosas que no todos están habituados, el hacer una pregunta de investigación es complejo porque hay cosas como las que nos tocó a nosotros, el que lo vivió hace tiempo sabe lo importante, pero no sabe por qué es tan importante y a todos… a todos orden de investigación es difícil sacar una pregunta de investigación, tienes que estar harto rato in situ, tienes que ver cuáles son las vías posibles o qué es lo que tu realmente quieres
David: Tienes que leer la causa

Reference 6 - 0.77% Coverage
Paola: Y lo otro que les pasó, que yo bien varios grupos, es que me decían, es que a mí no me sirve esta pregunta de investigación que yo me hice la semana pasada y ¿Por qué?, la verdad es que o tengo que hacer un proyecto en mi colegio, entonces cuando dijeron haga una pregunta yo dije lo primero que pensé, a ver, las indicaciones de la semana pasada era, según tu mapa, según tu curriculum, según tu contexto, arma la pregunta, ah sí, es que yo tenía pensado hacer este proyecto, entonces era la instancia, entonces vio lo mismo, los 4 pétalos, era igual que su pregunta, entonces ahora recién, con esta evaluación se dio cuenta que no es
Delia: A lo mejor, es importante que se haya dado cuenta
Paola: Sí, pero ahora él me dice, tengo que volver a hacer esto para poder llegar a esto, porque no lo tengo

Reference 7 - 0.27% Coverage
David: Yo creo que hay que bajar, hay que desinflar esta presión un poquito en cuanto a que sientan la libertad, que no hay ninguna… no hay ningún requerimiento nuestro de que esto lo apliquen como un ladrillo, con la misma metodología
Paola: Presión
David: Con que se está usando

Reference 8 - 1.71% Coverage
natalia: Yo, acerca de lo que hablábamos de que el tema en realidad cómo nos sentimos el día de hoy… yo puedo hablar en lo personal, pero así como le pasó a mi compañero de allá, estábamos juntos en la sala, me pasó que yo falté la semana pasada a clases, entonces hoy día me sentí también como coja con la actividad de hoy, ya… no pude terminarla, me sentí con un poco de frustración igual, tampoco creo que si yo no tengo muy claro el tema puedo criticar a mi compañero, si tampoco voy a aceptar mi crítica si yo siento que mi trabajo no fue el mejor, en lo personal, no me gustan los trabajos asignados, así como tú tienes que trabajar con él, con él, no, porque yo tengo que trabajar cómoda,

10 minutos, 0 segundos

natalia: me tengo que sentir cómoda con la persona que yo estoy trabajando y estamos hablando de comunidad, perfecto yo te entiendo, pero igual nosotros en la escuela formamos comunidad con quienes tenemos alguna afinidad, ya, eso a mí me incomoda, me molesta y yo muestro mi molestia, o sea, yo no puedo ocultarla, es mi manera de ser, entonces lo hago notar de alguna manera u otra, la gente que me conoce ya sabe que es así, entonces eso me faltó, me sentí como coja en la actividad y… miré el correo que me mandó Paulina, pero no me puse a leerlo… para poder hacer la actividad en mi casa, porque no… porque no lo hice, no tuve tiempo, me siento cansada, pero sí me pasa que cuando llego acá se me olvida el entorno, lo paso bien, siempre he dicho eso, que es una lata oh mañana tengo que ir al ICEC de nuevo, el sábado levantarse temprano, pero llegamos acá y cambia, entonces me voy contenta, lo paso bien, estoy en un ambiente agradable, pero hoy me sentí así, eso es lo que me pasó hoy, me sentí coja en la clase, me faltó algo así como que lata, eso

Reference 9 - 1.64% Coverage
victor: Sí, pero sobre… yo creo que como muchos, como muchos, estamos en una etapa del año que ya no queremos más, si nuestros alumnos no quieren más y todavía nos queda bastante por hacer, aparte del ICEC, pero también yo personalmente puedo decir que vengo… cuando vengo en la mañana, me subo al auto, sé que vengo para acá, vengo contento, esperando que sea la velocidad y no me pillen los carabineros, pero vengo la verdad súper contento y tal como muchos han dicho, me siento bien, bueno, a ustedes los profesores ya nos conocemos hace tiempo, me siento muy agradado de ustedes, expectante de que quieran inventar una idea, qué iremos a hacer y agradecido también de que yo creo que el sentir de muchos era, aterrizar en esto, lo que ustedes están haciendo en este momento, ya, que estamos aquí en el ICEC cierto y yo tengo muchas experiencias muy buenas, pero también era mucho estudio, tanto, tanto que… no concordaba con esto la realidad del trabajo, entonces lo que yo anunciaba para este periodo es que fuera más práctico, muchas cosas prácticas que las fuéramos haciendo aquí, creo que en mi caso en particular, se están cumpliendo en estos momento y eso yo lo he sentido muy agradado y en lo que yo me he sentido muy desagradado ha sido lo de las alcas que ya hemos reclamado, pero no, en realidad profesor es que darnos cuenta como algunos dicen que… creo que no hay armonía, en el que dice que sabe mucho más que el otro, porque nos vamos dando cuenta nosotros dentro de muchas cosas, yo veía mi gran idea y me fui tan feliz con la gran idea, miraba mi gran idea y no hay… [Bulla], habían cosas que cambiar y a lo mejor cambia todo y me frustré y me sentí complicado, pero con ganas de seguir adelante

Reference 10 - 0.37% Coverage
José Luis Pérez: Bien, a mí me gustaría dejar la palabra a otro de los José Luis del programa [risas] y conversamos un poco también de esa frustración y bueno, desde la psicología entendemos el tema de la frustración, pero desde la ciencia es súper interesante lo que estuvimos hablando de… de lo que pasa que es como parte del quehacer, así que le dejo la palabra al colega José Luis

Reference 11 - 0.62% Coverage
JL Carvajal: Bueno, ahora en la sesión de la tarde vamos a trabajar con la pregunta de investigación, hoy día nos vamos a ir con su pregunta de investigación y vamos a ver casi con el proyecto delimitado y a lo mejor pensando en la estrategia base que yo puedo generar amparado en esta pregunta de investigación, algo que han sentido y algo que les pasó, sentirse en ese caos en algún momento es súper necesario para hacer ciencia, ya, se los dice un científico, ya o sea, ese caos es muy necesario por lo que me están bombardeand, por lo que yo mismo estoy reflexionando y frustrándome porque esto no lo sé, no lo manejo, lo tengo que manejar, etc.

Reference 12 - 1.42% Coverage
¿Qué vamos a hacer ahora?, vamos a trabajar en nuestra pregunta refinada de investigación , sí o no, y desde una pregunta inicial, desde una idea que está dentro de esa pregunta vamos a hacer todo el proceso hasta identificar variables, que lo hablábamos en la mañana, causa-efecto, sí o no, relaciones entre elementos que tengo en esa pregunta y eso lo vamos a ir destilando y lo vamos a ir paso a paso mirando qué se requiere en el proceso de construir una pregunta de investigación, eso es lo que vamos a hacer ahora, por lo tanto, hoy día van a salir con 2 productos, el de la mañana, su pregunta refinada, ya, que pasa por este escáner, que es investigable y si es viable y además ahora va a salir con todo lo que hay dentro de esa pregunta de investigación, cuáles son las variables que podemos manejar en esa pregunta de investigación, cuál es la variable independiente, cuál es la variable dependiente sí o no, cuáles son las causas, cuáles son los efectos, cuales son las propiedades medibles de esa variable, todo eso lo vamos a sacar y lo vamos a destilar en el proceso, por lo tanto, ahora van a salir con todo lo que se destila dentro de una pregunta de investigación, por lo tanto, van a poder salir con un producto, casi delimitando sus proyectos y dentro de esa delimitación qué van a poder utilizar para trabajar en el aula, habilidades científicas, habilidades no científicas, sí o no, etc.,– pero vinculados a su proyecto, a su flor. Siempre trabajando en la flor

Reference 13 - 0.10% Coverage
JL Carvajal: Ya, desde ahora corre el tiempo, 10 minutos para que resuelvan la primera parte de la guía…

Reference 14 - 0.20% Coverage
0057 tiempo 00.10.00 jlc: ya, escuchen, ahora vamos a ir a la tabla 3, escúchenme, esta es diferente, ahora vamos a la parte 3 y es más corta y simple porque es resumen de lo que ya hicieron, entonces escúchenme,

Reference 15 - 0.18% Coverage
por lo tanto ahora en la 3 les voy a pedir la relación y la pregunta original, pero por ahora van bien, van concentrados, van apurados, en realidad, pero escúchenme no se desconcentre

Reference 16 - 0.30% Coverage
ya identificamos algunos elementos claves de la investigación pero entonces no se angustien ni se frustren porque esto puede ser infinito, podemos encontrar miles de elementos en la pregunta, escúchenme las características de cada elemento que encontraron en la tabla tengan en la cabeza que son cuantificables

Reference 17 - 0.23% Coverage
cual es la relación? La cantidad de metales pesados tiene un efecto o influye sobre el numero de la vegetación asociada al río Aconcagua entonces por lo tanto hago la relación ente estos dos, solo les pido la relación más rato vemos más cosas.

Reference 18 - 0.60% Coverage
JLC: ya, escúchenme porfavor, vamos a llegar hasta acá hoy, la tabla 4, escúchenme, les recuerdo lo que estamos haciendo, era una maratón y e los dije de un ppio, desde una idea llegamos a identificar elementos claves de la idea, luego de eso identificamos características de cada una, luego dos elementos los relacionamos y lo que están haciendo ahora, ya están pensando en causa efecto, hay una causa que tiene un efecto en algo hay algo que si disminuye– o aumento o se usó una empresa algo, que va a tner un efecto en– número, diversidad, crecimiento por lo tanto desde este momento de caos están pensando en causa efecto,

Reference 19 - 0.73% Coverage
JLC: atención, por favor, atención, por favor, ya hasta acá llegaremos hoy en la actividad práctica vamos a continuar después para que no perdamos de vista que hoy se trabajó con las preguntas de investigación, fuimos desde una idea inicial, les voy a volver a repetir, desde una idea inicial, una pregunta cualquiera, nos fuimos a establecer características de los elementos claves, si o no? Relaciones entre estos elementos claves, causa efecto de los elementos claves por lo tanto ahora puedo cuantificar algunas características de cada elemento que componen esas preguntas de investigación, vale?, imagínense, no hemos hablado de hipótesis, no hemos hablado de predicciones, todavía, solo estamos construyendo la PI hoy pensaron un montón, estrujaron su cabeza.

Reference 20 - 0.28% Coverage
Una cosa que le decía a uno de sus colegas, que estas cosas no las enseñan en la formación inicial, nunca, son cuestiones que las tenemos que aprender por experiencia, si usted no vive la experiencia de todo este proceso para llegar a construir una PI, yo me pregunto, como puede enseñar eso?

Reference 21 - 0.85% Coverage
JL Carvajal: Vamos a hacer una breve, muy breve síntesis, les voy a pasar una guía de 9 partes [risas]… no, vamos a hacer una breve síntesis de lo que hicimos en el día, no quiero ser repetitivo pero hoy día trabajamos con preguntas de investigación, trabajamos pensando en la construcción en el hacer y en la mañana que es lo que definía un criterio que definen a una pregunta para que sea de investigación, ya, por lo tanto hoy día, trabajamos en el proceso, pensar en ese proceso, lo que hicieron durante el día fue reflexionar sobre su propia construcción de las preguntas científicas, esto es súper importante, hicieron preguntas científicas, o sea, trabajaron sus preguntas para poder hacer preguntas, para después poder enseñarlas, ya y por lo tanto, construimos en conjunto, de alguna manera, estas preguntas científicas dentro del proceso para que se den cuenta identificamos eso

Reference 22 - 0.53% Coverage
¿sí?, que pudiera cuantificar, observar y medir causa-efecto, multicausalidad, etc., o también me puede detonar este proceso de transformación de pregunta de investigación, una estrategia sencilla, simple, de enseñanza-aprendizaje en el aula o en terreno, ya, por lo tanto, tienen opciones después de poder construir esta pregunta de investigación, no es fácil, pero es válido. Hoy día, les estrujamos el cerebro (risas)… y se dieron cuenta de algunas cosas particulares, ya, tienen que empezar a reflexionar sobre eso y la Paulina les quería decir algo

Reference 23 - 0.46% Coverage
Pauli: ¿Qué les quería decir yo?, no, sólo quería preguntar ¿Qué aprendieron ustedes?, ¿Qué creen ustedes que aprendieron de esta actividad?
[risas]
JL Carvajal: Sin llorar
Pauli: A parte de estresarse o también como… y la pregunta que hacía antes el José de cómo se sintieron, pero quizás lo quiero cruzar como… ¿Qué aprendieron?, o sea, en ese caos que se formó igual salieron cosas… como que se llevan como un aprendizaje
JLP: Tú dices como el qué siento y en qué pienso [risas]

Reference 24 - 0.73% Coverage
Rodrigo: Yo primero dar las gracias a Paulina, dar las gracias a ustedes, porque al final es como que presentaron el desafío y tenemos que seguir trabajando, seguir elaborando cosas y al final realmente nos sirvió el desafío, una cosa que a mí me gusta, el hecho de que antes no sentía ese bicho de empezar a hacer trabajar más a mi cerebro, ahora yo lo siento que ya ahora tengo la necesidad de … y obviamente que a partir de esto yo me doy cuenta que lo que hago con los chiquillos o los proyectos que he trabajado en el aula no tienen mucho que ver con… con lo que me están enseñando ahora, era como una parte baja y esto es un paso para aumentar el desafío o el nivel de investigación que pueda tener con ellos, me ayuda bastante a eso y te doy las gracias por eso

Reference 25 - 1.28% Coverage
José Luis Pérez: En relación a esto de sentir, pensar y actuar, después pensando fíjense, esta tan arraigado el tema del pensamiento como el valor máximo dentro del círculo, lo que sentimos pasa inadvertido, lo que decidimos, lo que decimos, que legitima nuestros sentir, nuestro pensar, estaba… soy psicólogo clínico de formación inicial y no puedo dejar entonces de pensar también en la clínica de como esta sensación como de angustia que pude también experimentar hoy, puede frenar la posibilidad de mirarme y sentir, entonces sería súper importante que ahora en la bitácora pusieran también si alguna o alguno sintió frustración, tratar de pensarlo un poco, porque si no la experiencia que yo tuve como clínica y haciendo clínica, es que las personas que bloqueaban el sentir, después a la siguiente no llegaban y no queremos que pase eso, lo que queremos es que efectivamente podamos… podamos pensar eso que sentimos también y podamos tomar una decisión acorde a lo que hemos sentido, ya, quizás estoy siendo demasiado extremo pensando, pero bueno, lo experimente y eso lo comento, ya, así que ojala que se explayen quien necesita más el ámbito del sentir ahí, pero es el momento de tirar fuera y también, aprovechar el espacio que ahora el José Luis y Paulina, si Dios quiere, seguir comentando cómo se sintieron en el momento, ya, eso

Reference 26 - 0.11% Coverage
victor: Yo creo que esto amenaza el curso
[Pauli: Sí… pero yo creo que [bulla]
Pauli: Cómo se apaga esto [bulla]

Reference 27 - 0.48% Coverage
Pauli: O sea, tú la puedes cambiar, como que te metes a tu perfil y se cambia. Como que el perfil se puede cambiar. Pero eso, traigan esa información para la siguiente clase y si están en la semana, si tienen un tiempo y no saben que hacer miren esa flor
Risas
Pau: piénsenla, pueden poner la flor en su habitación la BI o en el baño, y pensemos en eso, sabemos que fue mucha pega, que fue un trabajo desafiante y sabemos que necesitan tiempo para digerir esa información, por eso mírenla en la semana

<Files\Transcripción_clase 4_2_dic> - § 3 references coded– [4.37% Coverage]
Reference 1 - 0.82% Coverage
X: Traiga todos los días el maletín [bulla] [murmullos 01:33 – 03:32]
Pauli: Ya, ya eso no más iba a decir. Vamos a retomar lo que estuvimos haciendo en la mañana
X: No
Pauli: Pero no con la prueba de tablas, para su tranquilidad no hay más tablas, ahora cambiamos a cartulinas
X: Muchas tablas por hoy

Reference 2 - 1.08% Coverage
Pauli: Bien y otra cosa que es súper importante y aquí viene la actividad que vamos a hacer ahora en la tarde es… ¿Qué paso? [bulla]
X: Se está persignando el Cristian
Pauli: No, esto va a estar mucho más relajado, cuando les he mentido [risas], cuándo les he mentido, va a estar mucho más relajado, amigable, como siempre… ah bueno, esa es la fuente y como les decía anteriormente se los voy a mandar

Reference 3 - 2.47% Coverage

Pauli: Sí, yo de hecho, apoyando lo que decía Silvia, pensaba primero el punto 3 y dice, entonces solicita que se reúnan los mismos grupos de 4 estudiantes y decidan una pregunta de investigación acerca de cualquiera de las especies del patio
X: Ya esa parte de la investigación es complicada
Pauli: Es complicada, o sea, ya vimos nuestra lista de imprescindible, podemos… cuánto tiempo hemos tardado, exactamente, si yo les hubiera dicho en la sesión 2, ya chiquillos, salgan al patio y decidan la pregunta de investigación de cualquiera de las especies que hay aquí en Curauma, hubiéramos tenido… resultados, el que está atrás
X: No
X: Piensa que este resultado está lleno de apreciaciones y acá te lo está pidiendo [10:46]
X: Para nosotros ya es difícil, si imagínate tercero básico como abordar el tema
X: Mejor clasificar las especies
X: Clasificar las especies, porque [10:55 – 11:00]
X: Por eso te digo

<Files\Transcripción_clase 5_16_dic> - § 21 references coded– [6.97% Coverage]
Reference 1 - 0.27% Coverage
 con eso van a haber generado su secuencia, su diseño de clases, si, ¿se entiende?, tienen cara de… preocupados [risas]… hagámoslo [risas]
Pauli: Podrías volver a la primera parte, lo que van a hacer ahora recién
Corina: Sí, entonces ahora… entonces, lo primero que se va a hacer es llevar los imprescindibles a la acción en el aula, ya, entonces ahí les vamos a repartir esos sobres adentro están cada imprescindibles y la idea es que puedan… puedan de alguna forma seleccionar de qué manera ese imprescindible se traduce en una acción concreta, que ustedes puedan hacer en el aula, ya…

Reference 2 - 0.23% Coverage
¿les costó mucho hacer este ejercicio?
X: Sí

X: Sí

Corina: Pero es interesante creo yo, porque hay cuestiones, o sea, estos imprescindibles que ustedes levantaron a partir de su propia experiencia, levantaron ustedes una pregunta de investigación… ahora, claro hay que hacer, como la otra traducción de cómo hacemos que nuestros alumnos pasen también por ese proceso, yo creo que es interesante el ejercicio, ahora tienen un montón de ideas concretas para hacer dentro de la sala de clases.

Reference 3 - 0.17% Coverage

Cristian A ver, el ejercicio de acá es, no normalmente estructura su clase con estos 3 elementos, pero el ejercicio real es darles a conocer que existen más cosas y abrir más el abanico de posibilidades, el abanico de alternativas, porque muchas veces esas cosas sirven y sí efectivamente las hacemos, pero no estamos conscientes de que las estamos haciendo, sí

Reference 4 - 0.13% Coverage

Corina: Sí, se acuerdan que habíamos escrito al principio, en la primera sesión que habían 2 clases de evaluación, la primera instancia es el trabajo en una secuencia, en este caso, va a ser esta secuencia que trabajaran hoy día, ustedes se van a ir prácticamente con la tarea hecha

Reference 5 - 0.48% Coverage

X: Pero ahí se desprende una incapacidad del propio colega o de la colega que no es… constante, que no quiere seguir haciendo, o sea, se dio por vencido… se ha convencido de esa misma frase, es imposible hacerlo, él ya se coartó, entonces no ha buscado quizás la estrategia, la forma, los métodos, todo lo que nosotros sabemos que hay que aplicar para poder introducir a los niños en un mundo de indagaciones, si hay varias cosas que uno puede inventar y hacer, para llamar la atención, con esa frase ya se está coartándose solo, no, es imposible con estos cabros

X: Si está planificando algo…

X: Siempre va a haber algo que se puede hacer po

X: Estaba pensando que a lo mejor el colega estaba pensando en que esta relacionando indagación con algo experimental y perfectamente podría hacerlo trabajando con datos, con gráficos, no sé trabajarlo con… [Bulla], puedes trabajar con temáticas, que eso, a lo mejor piensa que indagación tiene que ver con algo… con un trabajo experimental [bulla], no sé, pero también puede influenciar

Reference 6 - 0.27% Coverage

Delia: Entonces podría ser que ustedes tienen… tendrían como las bases para decirle a este profesor que dice que no se puede hacer indagación, oye, si se puede hacer indagación, sí se puede lograr, tenemos el convencimiento de que, sí y poder llevarlo a tener evidencia de que, sí se puede, sí

JLP: Sólo un pequeño detalle, esto no es una frase de la China, es una frase nuestra, de que todos la hemos sentido, yo también la he sentido, sin más, yo hago clases de psicología en vespertino también y ayer un estudiante de verdad le dije sabe que, si quieres te puede ir y…

Reference 7 - 0.47% Coverage

JLP: Como tú dices, porque es así, o sea, cuando yo escucho de repente relatos como, no, si es imposible hacer clases con esto, he estado en mi sala, me recuerdo a un curso, a un joven y entro y vi a un profe haciendo clase al vacío y comentando, yo dije a quien está mirando y me di cuenta que al vacío y a los lados habían unos cabros jugando, tirándose papeles y 3 o 4 escuchando su propia música en altoparlante al celular y el resto jugando, es como chuta, esa es la cuestión, esa es la realidad, entonces cómo, porque es re fácil pensar que uno… uno es súper poderoso y puede cautivar a los estudiantes, pensemos que la realidad excede, por eso que hemos compartido este espacio, para que efectivamente podamos pensar también qué hacer con eso, cómo hacernos cargo porque no basta solamente… pensar –[1:37:11] hacer que… hay cabros que lo pasan pésimo, tienen… tienen un cagazo social y que nos hagamos cargo nosotros para hacer, yo creo, que ahí sí que se acerca a lo imposible, no imposible pero ya cercano

Reference 8 - 0.22% CoverageDelia: Sí, qué pasa por ejemplo en el caso de que te dan octavo, nunca habías tenido octavo, primero, entonces vienen los estudiantes sentados ahí, que están acostumbrados al caso que decía José Luis recién, con la profesora que decía todo al punto fijo y que no estaba y que hacía todo como mecánicamente y hacia que repitieran textual del libro de texto, por ejemplo, entonces tú llegas ahí con tu mochila que dice ICEC y vienes con todo esto y promoviendo la indagación [risas]

Reference 9 - 0.21% Coverage

JLP: Súper bien, yo sí que entiendo perfectamente ese punto, pero creo que la sociedad o incluso con el apoyo de toda la… factores culturales de los profes y… los profes se sientes atacados como lo que no enseñaron, pero ellos no tienen la culpa, esos profes se van, perdonen la expresión, se van cagados sistemáticamente, son en algunos casos, como conversábamos con la profe, mano de obra, salen como de una misión súper complicada, no es un tema fácil

Reference 10 - 0.47% Coverage

X: Es que además es difícil abordar criterio o forma de enseñanza, esta carga que tenemos como gremio que lo mismo que dice la colega, trabajamos en contextos tan distintos, que… no sé po, comparando con un médico, la cirugía estética la hace de una manera aquí o en la China, pero nosotros si un alumno… que trabajamos con niños de distintos [1:40:58] no podemos enseñarles de la misma manera y es así de simple, es lo que todos ven que se va perdiendo con los años, porque uno se desmotiva también, porque lo que decía, lo mismo de la primera pregunta, es imposible hacerles clases a estos niños, yo también he tenido colegas y yo también he salido prohibiendo de la sala, así… no es tan maravilloso tampoco

X: No po

X: Pero si uno eligió esta carrera, es tu trabajo, tú lo elegiste, no te quejes

X: Claro

X: Sí po

X: Es lo que tú quieres, tú lo que quisiste hacer y si en la práctica o en tu trabajo te diste cuenta que dabas botes, busca una alternativa, así, así se responde

X: Sí po

X: Tal cual

Reference 11 - 0.39% Coverage

X: Ah entonces yo vi otra votación, no les preguntaron tampoco

X: Y a los profes no les preguntaron po, entonces ella designa todo

X: En mi colegio no estaban…

X: Y dijo ella puede ser la mejor [risas]

X: Y todos así…

X: Será po

X: No, pero igual es buena profe, si trabaja con el DUA la profe, pero el tema es eso, que ella nos miente, no, el tema no es eso, el tema es que nos miente

X: Claro

X: Por qué no dice la verdad, nos dijo que la evaluación docente, el trabajo colaborativo que a ella le iban a hacer un sumario si nosotros, el trabajo colaborativo no era real el que estábamos haciendo

X: Mentira

X: Pero eso es una mentira

X: O sea…

X: Se pone como el parche antes de la herida

X: Yo creo que va en uno, porque hay un cuestionario

X: Si uno no sabe que no es así, si uno sabe que no es así, decirlo de alguna manera

Reference 12 - 0.29% Coverage

X: Esto depende de uno, de cada uno

X: Sí

X: Ya

X: Ah sí, de todas maneras, sí, totalmente de acuerdo contigo, me cuesta un mundo

X: Sí

X: Lo otro es debido a la frustración, sí

X: Y en ese caso soy muy ansiosa

X: Sí

X: Me gustan las cosas rápidas

X: Por eso lo [22:02] acá

X: Por eso [risas], no sé si lo haré bien

X: Voy a ponerme a llorar

X: No me miren mi letra

X: En todo caso, esa es mi gran debilidad… aunque lo soporto, sí, de todas maneras, que no resulte, que los niños no puedan hacerlo, entonces… como ansiosa, no sé, eso es como que me

X: Yo lo catalogo como ansiedad

X: Sí, como ansiosa de repente

Reference 13 - 0.20% Coverage

X: Porque después del todo el proceso no resulte, se caiga el proyecto, se caiga

David: Ya, es distinta, no es exactamente así… mantener un…

X: O sea, me refiero a que uno llega con todo el ímpetu pero que choca con eso

X: Se estanca

X: Y al final

David: Te tiran el avión abajo

X: De repente falta esa… bueno…

X: Les voy a sacar fotos, por si acaso

X: Espérate, espérate, espérate

X: Inseguridad, terror, temor

Reference 14 - 0.79% Coverage

X: Sí, absolutamente, absolutamente la razón, creo que no hay memoria, ¿sabes por qué?, yo creo que se les han dado a niños que… yo creo que la sociedad ha dado tal cantidad de beneficios y derechos a los alumnos y sus apoderados que se olvidaron que también tenemos derechos, perdón, deberes para con la sociedad de lo que es una organización que hacemos como colegio, han olvidado la parte que nos corresponde, yo una vez, yo creo que [bulla], que claro, respeto, no miedo, que es distinto, ya, yo hago clases hace 10 años y les puedo comentar que la primera clase que yo tengo con los cursos nuevos, eso les pregunto, que entienden por respeto y que entienden por miedo, que me lo definan y después ahí ellos me indican [bulla], porque todos me conocen, yo soy muy estricto, entonces a mí no me interesa que ellos me sientan miedo, sabes porque, porque cuando yo estaba en el colegio de cura, una de [bulla] compañeros de las instituciones [37:47], pero rudos buenos para los combos, nos pegaban a todos [bulla], después cuando yo llego a mi clase, después se callan, no porque haya una regla [bulla], pero sí les digo y me cuestiono vale la pena, porque uno se desgasta, uno llega cansado, hay días que mi esposa, ya me conoce con los años, me conoce, entonces hay veces que yo llego, yo soy así cuando puedo los reto, pero muy estricto en mi trabajo y no hablo nada, me dice, día de perros, día de locos, no hablo nada, son esos días que llego amargado, porque lo he pasado como muy mal, muy mal, cuando hay alumnos que te echan garabatos, te insultan, cómo lo entiende mi profesor del ICEC, si tú tienes [bulla], entonces yo siempre me cuestiono, vale la pena, ¿vale la pena hacer esto?

Reference 15 - 0.42% Coverage

JLC: Claro, exacto, exactamente que estaba como las pelotas

Víctor: Eso me dio mucha vuelta, y yo lo hago, lo hago, hay veces que yo me voy para mi casa, esta clase vale callampa y bueno, que muchas también [18:20] porque te encuentras… claro, vas feliz y te encuentras con pasteles

JLC: Justo te pasa algo

Víctor: En serio, me paso hace poco

JLC: Y tú preparaste la cuestión y estabas como preocupado

Víctor: Estaba como en otra y cachai que ahí fome, el otro día me paso y para ellos yo me estoy perfeccionando, me estoy perfeccionando en el ICEC para ellos

JLC: ¿Qué haces en ese caso?, ahora, como que el Víctor de este año

Víctor: Mantengo el autocontrol punto 1, porque no te niego que me dan ganas de…

JLC: Pero que te lleva a autocontrolarte

Víctor: Porque tengo internamente la esperanza de que tiene que haber un cambio, estoy ahí… sigo esperando de que tiene que haber un cambio

JLC: Ya, lo otro, por ejemplo, qué les pasó a ustedes ahora con… con todos los procesos que hemos vivido en estos ratos… una de las cosas de qué les pasó… qué visualizaron, qué les pasó con el octatlón por ejemplo[2]

X: ¿Con que?

JLC: Con el octatlón, cuando hicieron el octatlón, ¿se frustraron?, ¿se sintieron así como agobiados?

X: No, es que al principio la palabra ciencia me da como… ciencia, nunca me ha gustado ciencia, o sea, nunca me gustó ciencia, o sea, siempre yo le hacia el quite, no tenía malas notas pero… nunca quise, por miedo que me sale matemáticas, esas cosas o física y no es lo que yo pensaba

JLC: ¿Y ahora?

X: No se me ha hecho como tan difícil

X: Ah no estuve en el octatlón

X: O de las preguntas, de la…

X: Fue un desastre, usted conoce mi realidad

JLC: Ya, pero quien vivió eso, quien vivió eso

X: Es que mira, yo falté una clase…

X: Yo también falté a una clase

X: Y en la clase que seguía se nos juntaron 2 clases en una

X: Horrible, horrible

JLC: Ya, que les pasó

X: A mí me pasó eso

X: A ver, yo primero me sentí frustrada, ya, ¿Por qué?, porque como no había venido la clase anterior, entonces para mí todo esto era como chino, ya y me costó un poco… enfocarme a lo que tú me estas pidiendo en cuanto a la… al octatlón, me costó mucho

JLC: Pero sabías cual era el objetivo final

X: Sí, sabía el objetivo final, porque averigüé y todo eso, pero al ver todo esto y al ver… al ver el trabajo de mis compañeros yo me sentí… yo me sentía frustrada, en serio, frustrada

JLC: y se está mirando mientras está frustrada con la cara de mierda de que, así como otra hoja más, etc. Y se está mirando, se está mirando todo el proceso, o sea, ustedes hace 5 años atrás si les ponen a hacer preguntas de investigación a los alumnos, en 5 minutos me la tienen, sino la tienen un 1 o tienen malito

X: Claro

X: O no

X: Nosotros pusimos en el lugar

JLC: Transformémoslo en fortaleza

X: Sí

JLC: O sea, ustedes ahora se adelantan un paso, el otro año cuando trabaje en alguna parte con la pregunta de investigación, ¿Qué pasó?, ustedes lo vivieron o no

X: Sí

X: Sí

JLC: ¿Se miraron?

X: Sí

X: O sea y ahora van a saber cómo va a reaccionar el alumno

X: Sí

JLC: Entonces si lo transformamos en fortaleza al final yo me adelanto un paso, respecto a que yo viví algo, lo estoy viviendo y ahora yo más encima vi el proceso, o sea, cuánto se puede demorar el proceso y cuáles son las frustraciones que pueden tener durante el proceso, por lo tanto, ahora mi estrategia de enseñanza de aprendizaje que yo voy a hacer el otro año, cuando haga preguntas de investigación

JLC: O sea, al final este cabro no le puedo pedir en 5 minutos que haga una pregunta de investigación si tiene que hacer una pregunta inicial, tiene…

X: Si yo me demoré…

X: Lo mismo…

X: Si yo me demoré como un mes [risas]

X: El colapso cerebral

X: No y lo más chistoso es que nos decía, pero entendieron chiquillas

JLC: No entendió

X: Sí, hasta que llegó el momento en que le dije sabe que profe no le entiendo nada, nada y el profe decía, pero si lo he explicado de la mejor manera, no le entiendo y ahí llegó, así como pum, chiquillos acá, acá, acá y ahí como que ya hay que armarlo…

JLC: No y yo después les voy a explicar, cuando yo me iba, era algo que era un caos y eso lo que les pasó es que el caos lo vivieron en un día y los otros lo habían vivido en 2 días

X: Yo también

JLC: Pero todo eso que habían vivido ustedes en un día lo habían vivido en 2 días

X: Yo ya venía como media preparada, porque ya me lo habían mandado y tuve que leer antes, entonces llegué acá y el Víctor me explicó, él me explico, entonces yo ya lo tenía, como la idea como lista

JLC: Como de aprendizaje y esa cuestión también [bulla] y yo lo vi, lo vi, lo vi [risas]… lo presencié, es que de verdad

X: Yo te juro, para mí era como así mirar al profe y me explicaba, me explicó de la mejor de las formas, así como y hasta con dibujitos al último y yo…

X: Todavía no entendías

X: No entiendo, hasta que le tuve que decir, sabe que profe no le entiendo y me quedo mirando, así como no vas a entender si yo lo entiendo y ahí llego yo, que les pasa chiquillas, que no entiendo, porque no sacas nada con decir sí, sí entiendo, maravilloso

X: Sí entiendo, claro

³

Víctor: Quiero hacer solo una acotación que me pasa a mí en forma particular que es la siguiente, yo llevo en el municipal, toda mi vida trabajé en el particular subvencionado y ahora llevo recién 4 años en el municipal que para ellos soy bebé, no tengo idea, pero me he encontrado desde que llegué con una colega que todo lo que he hecho ella lo deshecha, todo, todo, o sea, he propuesto algo y yo no estoy al día en el consejo, me toca en el otro colegio y siempre hay otros colegas que son súper fieles y te dicen oye, esta colega, te acuerdas lo que tú planteaste, dijo que no servía, que no, para que, churra y te saludas todos los días con ella y le caes pésimo y todo y eso lucho todos los días, nos hemos agarrado varias veces correctamente sí, soy muy cuadrado entonces, pero cómo luchas con eso si son personas que abiertamente no te permiten ni siquiera acercarte a ellas, o sea, yo tengo personas, esta persona en particular te doy un ejemplo, saludo de navidad, volvimos todos así, hola como estas saluda a todos y donde estoy yo, te salta y… oye, te estoy hablando en serio, no es juego y saludo de año nuevo es lo mismo

o sea, acá no se avanzó tan solo con los científicos, aquí hubo un grupo con los científicos y esa… cooperación , ya, respecto de mirar, de extraer lo que tengo en mi cabeza, ponerlo al servicio del otro y empezar a transformarlo con el otro, también es parte del proceso científico y eso lo hace dinámico, porque el otro tiene otras experiencias en la cabeza y mira lo mismo, pero con otro foco o con otro enfoque o con otras cosas que tiene en su constructo, por lo tanto, esa construcción y desconstrucción que es lo que nos frustra… y después empezar a construir de nuevo, es lo que va reflexionando y haciéndolo dinámico y vamos acotando y acotando y acotando esta situación posible de ese fenómeno que es multivariado a la final y que siempre voy a ir descubriendo que hay más variables o que mis prioridades de variables van cambiando, sí, o sea, y esos momentos de frustración y esos momentos de caos, se acuerdan que yo les hablaba en el octatlón, son súper necesarios y cuando le dicen al alumno haga una investigación en 5 minutos, no, ahora saben que no [risas], es dinámico eso

X: Ahí está el asunto, que nosotros pensábamos que teníamos como lista la pregunta de investigación [risas]

X: Sí [bulla]

X: Y la secuencia metodológica para llegar a una pregunta con los chiquillos, es enseñando que a lo mejor que los tiempos que coloqué o que podía colocar, si es que todavía no termino, no es el adecuado, si entiendo que ya tenía la pregunta y la había visto y se suponía que estaba bien y llega con la profesora y me dice no y… cambia o no cambia en su totalidad y los otros compañeros quedaban como descolocados, así como ya, no quiero más y yo con la cara así, como hay algunas cosas que tengo que cambiar, pero igual es un proceso que uno pensando que ya estaba listo,

JLP: Hoy día tenemos varias sorpresas, pero antes de comenzar con eso de la sorpresa, queríamos hacer un cierre a lo que fue lo de ayer, porque ayer terminando luego del café nos volvemos a reunir pero estamos todavía un poco… choqueados vivenciando digamos, lo que habíamos vivido con los científicos, así que queríamos preguntarles y abrir el diálogo a que nos pudieran comentar que les pareció el día de ayer, al menos hablo de lo que yo vi, vi rostros que daban cuenta de que habían reformulado sus problemas de forma muy esperanzada, un rostro de que ya se habían destruido sus problemas y no había tanta esperanza en los rostros, vi rostros variados, entonces sería bueno que con mucha confianza, con la confianza que tenemos, podamos escuchar todas esas voces, ya, así que éste es el momento en que la pelota está botando y va hacia ustedes, ¿Cómo fue el día de ayer?... Jessica

Jessica: A ver, yo ayer llegué contenta, emocionada, feliz y me fui derrotada, sin ganas, que yo no sirvo para hacer esto, Jessica qué te pasa, tu puedes hacer una pregunta de investigación, pero… tienes que hacer todo de nuevo

JLP: Ya

Jessica: Ya, entonces llegué feliz y me fui así como…

X: Lloró todo el camino

Jessica: Si me querían echar del auto por alaraca, pero… no, hoy día llego así como sí, puedo hacerlo, estuve conversando con mi almohada y me decía Jessica no te preocupes mañana vas a poder hacer una pregunta de investigación, olvídate de las aves, mándalas a la Antártica y con mi compañero estuvimos así haciendo, mira Jessica, tú tienes esto… enfócate en lo que tú tienes, enfócate en tú lugar geográfico, adiós problemas y echa a volar tus aves, así que hoy día estoy enfocada en eso, muy buena experiencia con Paula, que yo ya la conocía, es muy apasionada, pero siempre te da como… ya, pero… muy bien, pero y ese pero te da a decir ah ya, o sea, el paso que va adelante, voy a tener que dar un paso para atrás, así que entonces y también igual felicito a los científicos, porque es una tarea muy dura hacer una pregunta de investigación, no es una tarea fácil, es una tarea… más bien como desgarradora, así de fuerte el hacer una pregunta de investigación, porque viene de adentro, viene de tu ser, viene de la exploración, tomas tu conocimiento y empiezas a armar tu pregunta y ese proceso es pero agotador, realmente agotador

Karina: Por ejemplo, ella, cuando ella trataba de explicar o ayudar en nuestras investigaciones, nosotros nos dignamos a decir, mira, puedes hacer también esto otro, como era el momento de dar una idea y un poco reforzar lo que habíamos empezado y al final dijimos, mira lo pensé y no lo hice y ahí nos dimos cuenta de qué, en el fondo, a lo mejor tenemos como un poco de miedo tal vez de llevar nuestras ideas al aula, pensando en que va a estar mal

X: Yo creo que me volví el Grinch de las preguntas de investigación, las odio, todas las preguntas de investigación, odié a Paulina, odié a José Miguel, para mí ayer fue un día negro totalmente, porque me fui sin nada, se destruyó completamente todo el trabajo y todo lo que habíamos conversado acá y no veía por dónde agarrarme y el Rodrigo o las chiquillas también les pueden decir, yo me agarraba no tenía que hacer, que pienso, ahora que pienso, qué pregunta hago, me cambio de localidad, yo ayer viví un caos, completamente, cuando llegó Jonathan a hablar conmigo como que me emocionó un poquito, me dijo está bien, dale, piensa un poquito, mira podemos formular esto, podemos hacer esto, pero ayer yo viví el caos absoluto, yo me fui de aquí como con mi día negro, entré después al almuerzo, a la once, yo me quería solamente ir, ir, ir, ir, desmotivación total, o sea, por eso te digo como el Grinch, porque acá todos sacaban cosas positivas, pero yo ayer me fui con una sensación negativa

Reference 5 - 1.20% Coverage
Paola: Yo quisiera hacer una consulta así como general, si me pueden escuchar, sus vivencias como aparece ahí, ese caos que ustedes vivieron, esa decepción, frustración, como quieran llamarle se generó totalmente y quiero saber… ¿Por qué les destruyeron la pregunta o porque pensaron en cómo poder responder a esa pregunta?, pensaron en un plan, ustedes tenían en mente algo en cómo responder y resulta que los científicos les dijeron mira, para poder responder esa pregunta, lo que tú estás pensando no es lo más adecuado, ¿Dónde fue el punto de conflicto?, dónde sintieron que todo lo que habían hecho finalmente había que reestructurarlo, había que pensarlo nuevamente, Consuelo

Reference 6 - 0.34% Coverage

X: En mi caso, fue cómo aplicarlo, como llevarlo a, cómo hacerlo a prueba, tenía entre otra cosa, en realidad no concedía, no me daba cuenta la pregunta, entonces a mí me hizo clic en esa parte

Reference 7 - 2.60% Coverage
Paola: O sea, no era el problema que no supiesen construir una pregunta finalmente todos lograron en el nivel anterior o en las sesiones anteriores saber plantear preguntas de investigación, preguntas que podíamos pedirles que realizaran nuestros estudiantes, sino que ahora se enfrentaron a qué tan viable o que tan factible era poder…
X: Realizarla
Paola: Realizar la metodología, el plan de acción, cierto … Para dar respuesta a la pregunta
X: A esa pregunta
X: Como hacer
Paola: Y en base a eso, que se dieron cuenta después, que las preguntas ya estamos claros que todos hacemos preguntas ahora, ¿Qué otra cosa hay que considerar entonces?
X: ¿Cómo?
Paola: ¿Qué otra cosa deberíamos considerar cuando hacemos preguntas con los niños?
JLP: Rodrigo
Rodrigo: Lo más práctico que yo tengo para realizar la investigación, porque yo quiero ver no sé po… los hoyos negros, pero no tengo un microscopio, un telescopio avanzado o no tengo cosas que realmente me sirvan para la investigación, yo tengo que averiguar entre comillas lo que tengo a mi disposición y ayer nos decían, y cómo vas a analizar calidad de suelo, no lo podía demostrar, no tengo un microscopio, una lupa, ese tipo de cosas y ya, específicamente tú deberías hacer esto, peor yo te recomiendo que hagas eso que esta acá , un poco más acotado, de acuerdo a lo que yo tenía o lo que yo tengo en la casa yo puedo realizar una investigación, más acotado dependiendo de los recursos que yo pueda disponer

Reference 8 - 2.50% Coverage
X: No, lo que pasa es que iba como a reafirmar lo que decía el colega, porque ayer cuando estuvimos hablando con… cuando estuvimos con Francisco, con la colega Mariana, con la experiencia del profesor tierno… él también nos dijo que nosotros también teníamos que tener la capacidad de autocrítica y como estábamos entre profesionales, teníamos que tener… el sentido de que todo lo que se nos decía y se nos explicaba o que nosotros pensábamos que se nos estaban desarmando las investigaciones, el proyecto, teníamos que aceptarlo, porque todas las instancias de nuestra carrera hasta que nosotros salgaos del sistema va a ser así, por lo tanto como… todo eso va a llevar a un trabajo productivo y todo va a ser par mejor, no para peor, porque a veces uno se cierra como decías también, crees que es como el tremendo proyecto o que mientras más grande o extensa sea tu pregunta va a ser una investigación con mayor peso y no es así po, ayer nos dimos cuenta que menos es más y valoro también la experiencia como me lo recomendó bien simpático Francisco que tuvimos un buen docente que nos abrió el tercer ojo, si se podría decir y nos hizo una repasada como de 3 veces cada uno hasta que llegamos, hasta que todos quedamos satisfechos y claro, o sea, fue súper productivo para nosotros nuestra experiencia trabajar de esa manera y debemos aceptarlo así, el trabajo de ciencia es así, un trabajo en equipo, colaborativo

Reference 9 - 2.70% Coverage
Corina: A mí me llama la atención, yo no vi lo que pasó ayer, pero me llama la atención varias cosas, una lo necesario que parece ser el compartir la pregunta de uno con otros, sí, o sea, tanto colegas como científicos que tienen otro tipo de experiencias, pero pareciese ser que todas las otras opiniones son muy importantes, o sea, recién cuando uno expone o se expone, no cierto, uno expone la pregunta o lo que sea, ahí puede como dicen ustedes, abrir la cabeza, abrir un tercer ojo como decía él, entonces una cosa, lo otro lo que ustedes dicen que para la reconstrucción o lo que decía Rodrigo, de la reconstrucción, la construcción es necesaria la destrucción y eso claro, puede ser frustrante, yo estaba pensando en cómo es el trabajo científico, así como en general y ahí, o sea, estamos en la facultad de ciencia y podemos decir por ejemplo, que no sé, que la tasa de aprobación de proyectos de investigación es de un 40 %, o sea, tengo un colega que ha postulado 7 veces a un mismo proyecto y no se ha ganado nada, 7 años consecutivos y no se lo gana, las tasas de la aprobación de los artículos científicos también es súper baja, entonces uno… lo normal es que a uno le rechacen los artículos científicos y ahí de vuelta a escribir de nuevo, cosas así, entonces es una cuestión como de… no sé, yo creo que el trabajo científico de por sí, como que genera, o sea, o uno es muy resiliente entre comillas o mejor se cambia a hacer otra cosa, porque no es… porque muy pocas veces uno tiene como triunfo, entre comillas

Reference 10 - 1.52% Coverage
Corina: Yo creo que eso es súper importante, en lo que uno se sienta más bien cómodo con su pregunta de investigación y que también que uno, que sea algo que uno realmente… sienta que es factible de hacer, porque eso también me decía la señora de Explora, que muchas veces se plantean problemas o preguntas que claro, son muy ambiciosos y que se proponen, pero no hay por lo mismo, no hay una idea clara y que al final genera una frustración, tanto con el profe como en los estudiantes, entonces si uno hace algo mucho más concreto, que uno como tú dices lo que uno realmente conoce o tiene mayor posibilidad de conocer, que además tiene que ver con los recursos que decía Rodrigo, está acotado a los recursos que uno tiene también y que es factible de llevar a cabo, entonces es otra, o sea, es mucho más posible, es mucho más factible la posibilidad de éxito

Reference 11 - 0.88% Coverage
Pauli: No, además que van a ser ustedes mismos quienes escuchen, si les voy a explicar más adelante, pero van a estar casi todos los que estuvieron ayer y van a estar ustedes mismos mirando hacia el frente, sí, en distintos grupos
X: Los mismos
Pauli: Y nosotros, pero miren esas caras de amabilidad [risas y aplausos], miren a la Paola
X: Gracias profe Pao, gracias
Pauli: No teman, no teman nada de mañana, si va a estar… es solamente para que sigamos afianzando lo que hemos ido trabajando

Appendix 7: Interlude 1

Do you remember the cockroach? Since the beginning of this project, I thought, as an analogy, that NIPDE was a living creature. I would say not just alive as another organism, more like NIPDE is part of me while it also is another individual. I dissected the cockroach; similarly, with NIPDE I'm the one who is dissecting it when the course is external, or I am being dissected when it is part of me. When I started to think that NIPDE is alive, as the cockroach was, I did the analysis trying to understand its structure – meaning the participants of NIPDE – and functions – interactions that happened during the course – but without just 'opening it up' to take its parts out as in my undergraduate experience with the insect; rather, by incorporating other perspectives by thinking them through.

From this initial reflection on 'being alive', I went back to my background in biology. During my training I read a book called The tree of knowledge: The biological roots of human understanding *by two very well-known Chilean scientists (and, I would argue, philosophers) Humberto Maturana and Francisco Varela (1987). When I read the book around 2003, I was focused on the biological part of the text; these authors pointed out that knowing is rooted in the biological structure of the organism; in that sense, cognitive experiences involve the knower in a personal way where it is impossible to separate that particular way of being from the world that appears to us, forming a structural coupling between the organism/unit and the environment. There is another coupling which, according to Maturana and Valera, is a linguistic one – expressed as the innate capacity to communicate with symbols and signs – in social beings like humans. As I was concerned with the biological part of NIPDE I returned to this book. On rereading, I found my focus had shifted from the purely biological to arguments on linguistic coupling. When I realised that the book was also talking about language it gave me the idea to connect this with the analysis of the design meetings. At the beginning, these authors make a circular suggestion in a heading that reads "Knowing how we know", which made me narrow the analysis to questions around the action of knowing either the schoolteachers as participants of the experience or knowing the scientific content of the course in advance. In that sense, I asked myself, who is the knower? Which 'world' is the knower bringing with him/herself?*

Another thing that struck me this second time of reading was the original, and provocative, idea of the 'being of the human being' as a network that connects natural sciences, philosophical reflection, cultural evolution, social sciences, and cybernetics, where at the centre is the nature of the cognitive experience of the being. Thinking about 'coupling', I started to wonder about the nature of the linguistic coupling between the university teachers and the environments of the university and the school. And, on another layer, what is the linguistic coupling between different perspectives apart from the biological one in the questions that I'm posing? A central part of the book is the proposal of two aphorisms to understand the connections within an interconnected network in which the

centre is the cognitive experience of the self; the first is to do with a circularity between action and experience, summarised as 'all doing is knowing, and all knowing is doing' where every act of knowing brings forth a world; the second one is related to language and reads 'everything said is said by someone'. These two aphorisms were evocative for my analysis in a very practical sense because they led me to ask, if you know or do not know who is part of the experience, the CPD in this case, what are you going to do? There is an irretrievable connection between the action and the experience. That connection could be happening in a material sphere; however, there is also a more abstract sphere related to the reflections on the cognitive experience which is particular to someone who brings forward their world in a particular moment. Therefore, questions of, what are we doing? what do we know? and who are we? became important in this experience. This second time the book had a whole new meaning, I started to understand part of the purpose of these authors in conflating biology and human processes of thought, including language; perhaps this book has to do with my subjective shift from being a biologist to being a social scientist, too, with a journey that starts with language. This is a journey that I was not aware of before.

So, I started to focus on language, but what do I mean by language? At a certain point, I understood it as what was said by someone, as simple as the words uttered by a person. At some point, someone in NIPDE said that 'we are horizontal' as opposed to being vertical in relation to the schoolteachers; the use of horizontal was worth stopping and thinking about. Around July 2019, one of my supervisors commented that it seems that the university team, including myself and my colleagues, were using 'horizontal' to mean equality in a relationship whereas 'vertical' was used to indicate some sort of a hierarchy. My answer to that comment was 'yes' and I could say that being considered horizontal was our desire while being vertical in the relationship with the schoolteachers (i.e., 'above them') was not what we wanted. But is it that the people or the discourses are horizontal/vertical? I think we were considering that horizontal/vertical were attributes of a person rather than of the discourses operating on the individual. Besides, the notion of vertical was demonised, which could be related to a sense of imposition, like an aftertaste of the dictatorship in the Chilean context. Then I came to read Basil Bernstein (1999), a British sociologist, and his production of a language of description within research with his mobilization of horizontal and vertical discourses of knowledge structures. Perhaps a traditional understanding of vertical and horizontal is related to opposition, and I would say in the case of the university team that we understood these terms in relation to hierarchies or forms of oppression. In Bernstein's understanding horizontal discourses are embedded in practice, where its realisation varies according to culture and specialised practice. Vertical discourses take the form of coherent, explicit, 'systematically principled' structures, which are more abstracted from practice, or the form of specialised language, mode of interrogation, and production. In a way both are modes of

specialised knowledge. In my understanding, limited due to my unfamiliarity with this form of knowledge, these definitions may be complementary rather than exclusive, and productive in the sense of offering more possibilities and interpretations in this research. How did that understanding shift my interpretations? I think they shifted when I started to ask how those discourses circulate in the course. I think a key issue was to look, for example, at Dora who is a schoolteacher participating in both school and university settings at the same time. In this case, the experience of her being deeply ingrained in the school made me think that Dora, who has the specialised language of the school, produced a horizontal discourse within the mode of the school, while the group of us who do not have the experience of the school were producing a horizontal discourse between us but vertical in relation to Dora's school discourses. Considering this, my understanding of language was becoming more complex because it was not just the words uttered but also the context in which those words are uttered.

At that point, I came to think about the nature of our settings. Where are we developing our practice? And how does that context shape our experience? Then I turned to look at the institutional context that could be producing those vertical/horizontal discourses, and the differences within the university team, namely, a 'we' that was unified. Those differences came about because we are different members in this 'we' which also leads to the emergence of differences in context and activities. To unpack these differences between this 'we' makes the distinction more complex, going in depth on the social basis of the 'we' because in the homogenising and romanticised phrase 'we are horizontal' there is more to say rather than a pure 'we' that is indistinguishable in its parts. From here, I started to question the pedagogy and science education associated with these discourses, which is not totally part of my current questioning but is, perhaps, part of a projection of this thinking. I want to see the reverberation that this reflection can offer.

I would say that thinking of NIPDE as a living creature and the notion of horizontality with Maturana, Varela and Bernstein brought to my mind reflections and ways of thinking aimed at revealing the complexity of what I thought the course was and what was said in one design meeting. Perhaps I'm falling into an overinterpretation but thinking with these notions made me explore in depth the interpretative potential of each thought and each phrase. With Matura, Varela, and Bernstein, I started to explore more of the richness of the data. I enjoyed making them into a dialogue, playing with what I understood of their productions, even if I might sometimes be mistaken. However, is that not the point I´m trying to make here? That is, a specialised language such as the language of science education could benefit from other languages to imagine the potential of its realisation and vice versa.

Appendix 8: Lazarillo activity

29:38

Javier: Ok, dear fellows (.) I want to ask you <u>about the</u> <u>experience</u> (.) how was <u>your experience</u>? (.) <u>How did</u> <u>you feel</u> being blind? How did you feel not being able to talk? (.hhh) someone wants (xxxxxxx)

Eliseo: [*Good*

Javier: Go ahead ((noise))

Eliseo: With the colleague we realised that it <u>is better to be mute</u> than blind ((laughs)) yeah, because at least one can (3) one has more options to be able to communicate (.) lacking sight is complicated

Pedro: I want to talk about trust (.) because <u>I know Nicia from before</u> (.) we have <u>shared many things</u>, so I do not know if it is easier because I already (2) easier than people who do not know each other (.) that experience <u>that someone is guiding you</u>, or you are guiding someone could be more complicated

Ricardo: Well, the issue of <u>trust could be demonstrated</u>, for example, my partner was all the time with <u>her</u> <u>arms up</u>, maybe she didn't trust me (.) she didn't know me but, in my turn, I did not raise my arms because I was feeling <u>with my other senses</u> like nose or skin

Javier: Who else wants to comment on how they felt the experience

Jacinta: Here, with my partner

Javier: [Shhhhhh

Jacinta: [I felt really good because <u>I got carried away</u>

Javier: [Ok

Jacinta: [She was leading me (.) I felt good; I trusted her because she wasn't going to take me anywhere risky (.hhh) <u>let say, falling</u> (.) nope, so it was good

Javier: From that, I´m wondering ((writing in the whiteboard))

Eliseo: ((reading from whiteboard)) [<u>Who guided who?</u>

Javier: [In this activity of reverse *Lazarillo* who guided who? I´m <u>not so certain</u> of the answer (.) who guides who?

Rircardo: I think there was a <u>mix of both</u>

Javier: [Mmm

Ricardo: Yeah, since you could not speak or express yourself I think she was <u>also groping her way</u> (.) <u>the</u> <u>only thing</u> I did was squeeze her shoulders as yes or no when <u>she asked me</u> if there was danger or a ladder (.) then, in the end, both of us were guiding because she was guiding herself, and I was answering her questions, so both of us were <u>o:bviously</u> guiding each other

Javier: Great (.) How did others feel it?

María: In my case <u>when I was guiding</u>, I felt that she guided me more than the other way around (.) because it was <u>hard to no:t speak</u>, in fact, I ended up <u>grabbing</u> her to the building ((laughs)) (.) yeah, it was hard <u>not</u> <u>being able to explain</u>

Paloma: Is <u>also difficult not to hear</u> an answer when you ask something

Javier: Yes

Paloma: That silence when you ask something (.) maybe with gestures you are guided but <u>the *silence*</u>, <u>not</u> <u>he:ar an answer</u> is hard <u>((laughs))</u>

Javier: I must admit that I was watching you (.) at the beginning you started slo:w then you were <u>walking</u> <u>with ca:sualness</u> ((laughs)) (1) so <u>who guided who?</u> **35.01** {Cesar and I came back and the conversation went to another direction for a minute}

36.02 Javier: This is a <u>legitimate question</u> (.) I do not know if the guide is the one <u>who does not *see*</u> or who <u>does not *speak*</u>

Jorge: I think it also has to do with <u>trust</u> and <u>empathy</u>

Javier: Ok, go-ahead

Jorge: Between the two there is only <u>one guide</u> (.) because as you go along you also know how the other person sees your surroundings which is *transferred* to you through just <u>two words</u> {yes or no} (.) I don't think there's a just one guide here, and I think it is a <u>game played together</u>, teamwork

36:38

Appendix 9: Interlude 2

Do you remember when in my analysis I said I used dialogue in different layers? One layer was related to dialogue as a tool to read the data; another layer was a dialogue that contributed to my subjective change, partly influenced by the collaborative analysis group, which recursively contributed to the way I analysed the data, meaning that this second layer was crucial to the first layer. I'm remembering this because in one of these conversations with Coca and Felipe (in the collaborative analysis group) we discussed how an activity during which the schoolteachers created research questions was surprising to me. And not just to me; I think those kinds of activities were a revelation to NIPDE itself because we did not plan that many activities around this aim. I started to think about the role of questions. Perhaps it was because formulating questions is singled out as an essential task through which scientific inquiry is developed, related to school science and as a relevant process of thought in science in general; at least, that was the discourse that was operating during my undergraduate education. I keep wondering: why questions?

Reflecting on this, I came to think on the importance of questions in my research. For one thing, my research questions guided this study. But also, questions were generated by the schoolteachers in terms of the potential to use questions in their lessons as well as the emergent potential that we (the design team) saw in the sessions while implementing the course. When thinking through the pedagogical potential of questions, Paulo Freire came to mind. Freire was a Brazilian pedagogue and philosopher who has greatly influenced the field of education in Latin America and in other parts of the world too. I have been reading Freire for many years; however, in relation to my thinking around this thesis, Freire was relevant because of two conceptualisations that he produced: one is presented in the form of a book called A pedagogy of the question: Criticism of an education based on answers to non-existent questions; *and the second is the notion of 'generative themes'. With the book, the relation to the role of questions in my thesis was kind of straightforward because in the course, I would say we were developing a pedagogy of the question without being aware of the fact. Freire, in a written dialogue with the Chilean Antonio Faundez (2013), suggested exploring the complexity of making 'good' questions, which is not as simple as thinking that it is those who do not know who ask. Rather, making questions is related to making mistakes, to try, and to generate dialogue between teachers and students.*

Usually, the world of education is full of answers. The curriculum is organised as answers to questions that, perhaps, the students did not pose or at least not in a specific order or neither nationally conceived. For instance, in the case of Chile – a long and different country – it bears asking if all students from north to south are asking the same questions? Freire and Faundez suggested that questions open dialogue; questions are an invitation to talk which starts with curiosity. The way I see it, questions opened the opportunity to know who we are in the

situation of teaching and learning, questions opened the recognition of our positions, the acknowledgement of the setting, the world that the subject brings forth (following Maturana and Varela in Interlude 1), so questions opened the dialogue with ourselves, recognising ourselves.

Freire pointed out that there is fear associated with questions because they could be seen as a challenge to some authority. Too often, repression of questions is related to a prior negation, namely, the exclusion of the self, its relation to the world, and within the world. I would say that in the course we were afraid of ascribing this much importance to creating questions; many times, I was worried what would happen if we did not know the answer to questions the schoolteachers were creating, and perhaps, I'm still frightened by the world that is opened-up with questions. However, considering that openness makes me turn to experience a contested feeling of being afraid yet excited – troubled – by the generative potential of questions. Perhaps that was also what the schoolteachers expressed as chaos in relation to creating questions. Here the pedagogy of the question meets generative themes because the dialogue around the activities of creating research questions was a contested experience, for the schoolteachers during the course, as well as for me thinking about them with my fear and excitement. Freire said that these kinds of themes are generative because they contain in themselves the possibility of unfolding into many themes that, in turn, provoke new tasks that must be fulfilled; in that generation there could be contested positions and conceptualisations that are productive for exploring the limits of the subject as well as their positionality. I connected these thoughts with the work of Judith Butler, a US philosopher with whom I was not previously familiar and who, while highly cited in some educational fields, is not very often referred to in the science education field. It could be argued that Freire and Butler do not 'go' together because of the contested understanding of consciousness between the two; however, I want to point out where I think they can meet.

After another meeting with the collaborative analysis group, Felipe sent me an invitation to read a chapter in a book. The book was Giving an account of oneself *(Butler, 2005) and it was recommended that I read the chapter entitled 'Against ethical violence'. In here, I found a very productive echoing of my reflections from this thesis in relation to the meaning of a pedagogical narrative that seems very coherent yet begins to become unbound by changing its pedagogical positionality in relation to others. I started to think with Butler about the limits of the subject in this expected coherence or a discourse of coherence around what does it mean to be a teacher or a student around the question of 'who are you?'. This narrative collapse, in the course what the schoolteachers named chaos, which is, perhaps, a way to embrace the incomplete articulability or the limit of the positionality of the self, remaining persistently inarticulable. This pedagogical narrative was/is interrupted because of the activities around the creation of research questions by the schoolteachers, which implied an acknowledgment of their own limits and, perhaps, the acknowledgment of failure of definition.*

Butler talks about the limit to acknowledgment of the self which is related to acknowledging that 'opacity' of the definition, meaning, to acknowledge the limits of acknowledgment itself. I think that happened when the schoolteachers started to narrate themselves, shifting themselves in that process of narration, experiencing their own limits of knowing. Hence, chaos is a way of mocking what is seen as narrative control, depicting, even though in a limited way, what we know about ourselves. Therefore, unpacking the supposedly coherent pedagogic narrative. When did this destabilisation happen? I would say that it happened when we were working at creating research questions, but when, if at all, is it materialised? Inspired by Butler, the answer is when one gives an account of oneself to others. In the case of my work, that happened when the whole group of participants was talking about what it meant to create research questions. In so doing, the schoolteachers were giving an account of their selves as teachers when reflecting on those activities with one another. Butler said that engaging in a reflexive activity, thinking and rearticulating the 'I', is also an act of speaking to 'you', making a relation to the other in language. Then, the dialogue between the participants of the course was/is shifting something in 'I' and in 'you', perhaps in a way that neither could understand as it happened.

When writing about this here, I want to go back to say that what the teachers named chaos is the result of this very idea of reflecting together on their positionalities that has a part of acknowledgement but also a part of not-knowing. Thus, chaos is that unmentionable experience that moves between the knowing and not-knowing. I would say that the not-knowing part was willingly received by most of the teachers; perhaps, there was a moment of needed failure in the self-narration which was embraced by the teachers. In Butler's words this is a moment of failure that the very project of self-narration requires. This not-knowing part of the positionality did not scare the teachers, yet it surprised them, because everything happened through talking to one another. That dialogue was, although with opacities/limits, enough to re-articulate the pedagogic narration.

Maybe you could think that I´m pushing to my benefit what Butler and Freire produced in their conceptualisations, and perhaps I´m thinking that in this exercise of talking to 'you' I realised that I´m pushing the mobilisations of these authors, trying to put them together in this piece. Despite my fear-yet-excitement of this provocation, I firmly think that the exercise is productive because it has allowed me to reflect with these authors in a playful way. I finish this with more opacities, thinking on questions rather than certainties and maybe with a sense of incoherence, but that does not worry me; perhaps I have willingly started to embrace the opacity of this chaos.

Appendix 10: Big ideas in the Chilean science curriculum

The thematic axes of the Natural Sciences are crossed with big ideas of science. Each one of them is transversal to the thematic axes and is built with a set of Learning Objectives of the three thematic axes (Mineduc, 2015).

Grandes ideas as presented in the Chilean currriculum/big ideas by Harlen, 2010.		Objetivos de aprendizaje de las ciencias naturales/learning objectives of natural sciences											
		Biología/Biology				Física/Physics				Química/Chemistry			
		7°	8°	1°/9°	2°/10°	7°	8°	1°/9°	2°/10°	7°	8°	1°/9°	2°/10°
Ciencias naturales/natural sciences	GI.1 Los organismos tienen estructuras y realizan procesos para satisfacer sus necesidades y responder al medioambiente/(not in Harlen) *The organisms have structures and conduct processes to satisfy both their needs and to respond to the environment.*	1 2 3 4 5 6	1 2 3 4 4 7	1 2 3 7	1 2 3 4 5	8	11	10 11 12	11	13	13 14 15	17 18 19	15 17 18
	GI.2 Los organismos necesitan energía y materiales de los cuales con frecuencia dependen y por los que interactúan con otros organismos en un ecosistema/*Organisms require a supply of energy and materials for which they are often dependent on or in competition with other organisms.*	3	4 5 6 7	4 5 6 7	8	12	9 11		11	15	15	17 18 19	15 17 18
	GI.3 La información genética se transmite de una generación de organismos a la siguiente/ *Genetic information is passed down from one generation of organisms to another.*	2		2 3	3 4 6 7 8						13 15	19	17 18
	GI.4 La evolución es la causa de la diversidad de los organismos vivientes y extintos/ *The diversity of organisms, living and extinct, is the result of evolution.*	1 2 5	2	1 2 3 4	6 7 8	9 12					15		17 18
	GI.5 Todo material del Universo está compuesto de partículas muy pequeñas/ *All material in the Universe is made of very small particles.*	6	2 3 4 5 6	2 6	1 2 6 8		8 10 11	11 15		13 14 15	12 13 14 15	17 18 19 20	15 16 17 18
	GI.6 La cantidad de energía en el Universo permanece constante/ *The total amount of energy in the Universe is always the same but energy can be transformed when things change or are made to happen.*			6 7			9 10 11	9 10 11 12 13	11 12 13	13 15		17 18 20	
	GI.7 El movimiento de un objeto depende de las interacciones en que participa/ *Changing the movement of an object requires a net force to be acting on it.*		3 4 5			7 8	8 10 11	11 14 15 16	9 10 11 12 13 14	15		19	15 18
	GI.8 Tanto la composición de la Tierra como su atmósfera cambian a través del tiempo y tienen las condiciones necesarias para la vida/ *The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate.*		3	1 4 5 6 7 8	8	9 10 11 12	11	13 14		13 14 15	15	17 19 20	15 16 17

Appendix 11: Interlude 3

As pointed out in different parts of this thesis, when I started this research in 2016, the big ideas of science approach was incorporated into the Chilean science curriculum. For the schoolteachers that I asked (and if I may say, for myself too) this new understanding of what is important to teach in science education was/is extremely helpful. The principle behind this framework is the integration of school science content into clear, coherent ideas which, according to some of the schoolteachers, is a natural way to teach science because it is linked to the daily life of the students. Many of the teachers consulted had their own understanding of big ideas and, although they weren't aware of it, hadn't in fact followed the precise guidance in implementing the curriculum. This made me think about: Why were schoolteachers not asked before incorporating the existing framework into the curriculum? How did they conceptualise the approach? If they had some experience teaching in this integrated way before, why was this experience not considered?

Then my attention turned to the role of policy discourse in curriculum development and how a curriculum is a form of control. An interesting point related to this incorporation is that, alongside the big ideas, the Chilean science curriculum is very thorough in terms of expected aims, activities, and other content in science that was previously in the curriculum. The curriculum developers did not erase anything, rather they just incorporated the big ideas. In this sense, even though the purpose of the big ideas' framework is to integrate scientific knowledge, it was just treated as additional content, meaning that the purpose of the original idea is more than a little lost. I saw this as another way to control schoolteachers. In my view, the way the curriculum was presented generated contestation, because under a neoliberal understanding, the curriculum is posed as a suggestion related to freedom of teaching, yet is very detailed. In other words, in Chile we have at the same time a very thorough curriculum and standardised tests (related to the State's control) but at the same time an educational system that is organised around market-oriented principles with a supposed flexibility, in a country with huge inequalities. Thus, the rhetoric behind the policy seems contradictory with the content of the curriculum and the level of regulation in the Chilean educational system.

How is this changing who the teachers are and what they do? I think schoolteachers are treated as technicians which is more evident with their non-participation in curricular decisions and the comprehensive curriculum that leaves very little to their own ideas. As I started to analyse Dora's and Ricardo's conceptualisations of the big ideas and how their subjectivities are produced in the context of the school, the CPD and policy decisions, I came across a special issue of the journal Discourse: Studies in the Cultural Politics of Education *(Braun et al., 2011; Maguire et al., 2011; Ball et al., 2011a; 2011b) around policy enactment. Also, I found very compelling arguments in Ball's (2003) article 'The teacher's soul and the terrors of performativity'. These papers are interesting in the way schools and teachers enact policy in different ways, such as making adaptations or faking aspects of the policy that conflict with their own values and are less focussed on the lack of involvement of teachers in policy formation.*

However, in here, the work of Ball, and the other authors' understandings of policy enactment, resonated with my own questioning. Why is the curriculum imposed? Why do we have a single National Curriculum when the Chilean territory is so diverse? Why are the teachers not considered as professionals who reflect on their practice? I keep wondering about these kinds of questions which have been taking different shape in this research. I have been working with science teachers since 2008 and I can see the exclusion that they are experiencing as a result of changes to the curriculum as well as the exclusion that the teachers are doing to the curriculum – like a double debarment. Then, what is this control doing and how is it operating? How does policy speak to teachers and vice versa? I would say that there is not much of a dialogue.

In the case of the big ideas, as with many other curricular reforms, the relationship between policy and practice in the school might be mediated by the CPD programmes being delivered, mostly by universities in Chile, meaning that again the schoolteachers risk being treated as technicians. What I started to realise during this research is that perhaps the teacher educators, far more 'heard' and privileged by the policymakers, were also treated as technicians in the context of CPD programmes when those are conducted to ensure the proper implementation of curricular reforms. I think that is related to what Ball refers to as policy technologies (market, managerialism, and performativity) applied similarly to schools and universities. Then I started to wonder, following Ball, how this is changing our souls? In here I'm not answering that question, I cannot, but I would say that I'm starting a journey as I go, to explore how the subjectivity of the schoolteachers and teacher educators such as myself are produced under these technologies. The technologies that I think are resonating more to my current questioning are the relations of hierarchy (in my case in the relationship between schoolteachers and teacher educators, as well as between teacher educators) and mechanisms of reformation or therapy (when 'development' in CPD programmes is related to meet a supposed lack of knowledge).

In line with theories of policy enactment, I started to also disrupt this discourse of the teachers as victims (technicians, colonised) even though I recognise the control operating on them/us. Perhaps I was reluctant to believe that teachers behave like technicians because I have the experience of teachers who reflect on their practice, changing and criticising the curriculum amongst other things. I thought that the teachers were not just receiving what was imposed upon them. With this experience I saw that the teachers also have a critical response to the curriculum, perhaps another understanding of the struggle, changing the logic of teacher-as-problem to a reflective self in contact with others, towards the older ethics of professional judgement and cooperation. However, the control and impositions are still there, happening as a kind of a reminder that 'you can think differently but we are still here in your context affecting your very being/soul'. Schoolteachers develop their practice in a site of contestation, namely they are prepared, they are creative, but they are also under 'agobio' (Spanish for overworked or burdened). They are coping with what the curriculum says and with what they believe they should do but they are also inside policy discourses positioned as technicians, not consulted. Besides, how is this control affecting the

CPD programmes and the teacher educators delivering them? I think the teacher educators' subjectivity under this control may have shifted our aims and the purposes of CPD programmes, for example, using the word development yet we want to talk about learning, and more, our own learning. This could be an illustration of how the university team were controlled and resisted/rearticulated by the policy discourse during NIPDE as well.

I feel this process of the PhD changed how I see myself as a teacher educator. Following Butler (Interlude 2), because this reflexive activity rearticulating the 'I' is also an act of speaking to 'you', making a relation to the other in language. I guess for the schoolteachers feeling 'chaos' changed them a little bit too. Ultimately, I think we enjoy thinking around big ideas, what they thought and what I thought about them. I'm sure I have been having a good time (arguably also painful) reflecting on these issues: How do teachers and teacher educators learn? What would happen to our students if we think on how we think? What happens when we experience failure? Because it is not all about excellence and 'good' performance; in fact, on the course we did not work all the things we planned because we changed the plan as we went around activities on research questions. One could say that we failed in implementing both our curriculum and the science curriculum as it is. However, I think we were building a sense of meaningfulness of what we do and want to do as teacher educators in the context of the university. Perhaps, I hope, the schoolteachers did the same, for example, thinking: Why should we teach with big ideas? Is it useful in my context with my students? Dora and Ricardo showed me some of that usefulness.

In this experience, I'm talking about myself and perhaps also about the schoolteachers in chaos; we are embracing the struggle being comfortable not-knowing, cooperating instead of competing. Having said that, and as I said that I 'like' this struggle, makes me think that I can become content which is also something that I would like to explore. You could think that I'm going very far away from the science education field, many times that is my concern as well; however, how can we think about teaching big ideas at our schools when these policy technologies are operating? I argue that this questioning is also part of the science education field. I would say, hoping to sound humble, that we should think on these policy technologies as well as how to teach science; it's all part of the same purpose. Maybe these initial questions open hidden (for me too) discussions which are necessary but still insufficient to depict the complexity of teaching science, school science, professional development processes and subjectivities of both schoolteachers and teacher educators. I finish this thinking that the technologies and discourses are not operating in the same way at schools as at universities nor are they experienced similarly by the schoolteachers and teacher educators (neither amongst teacher educators); we act differently and because of that it is worth continuing to pay attention and explore our subjectivation processes under these discourses. I would like to keep tracing this issues that could be 'relentlessly rejected' (Derridian term) in the science education field because for me it has been useful to reimagine my own role and what I'm doing (and could do) as a teacher educator.