The development of a mathematics teacher's professional identity during her first year teaching

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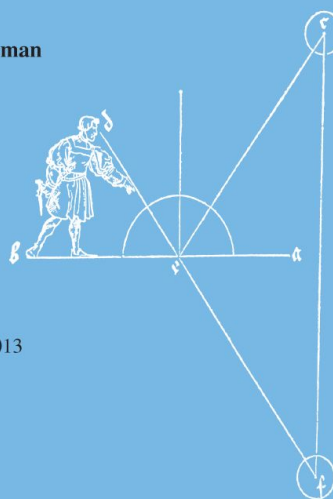# The development of a mathematics teacher's professional identity during her first year teaching

Leticia Losano[1] · Dario Fiorentini[2] · Mónica Villarreal[1]

Abstract This study is focused on a period that poses several challenges for the development of mathematics teachers' professional identities and agency: their first year of teaching in schools. During this period, beginning mathematics teachers confront tensions and contradictions among the principles, ideals, and experiences encountered during pre-service education and the demands, and restrictions of their teaching practice in schools. This article approaches this topic by developing an interpretative case study centered on one novice mathematics teacher, Sol. The aim is to describe and understand the development of Sol's professional identity and agency during her first teaching year. Considering identity development as a diachronic phenomenon, we carry out a narrative analysis of the research data. The findings show that Sol developed her professional identity and agency through a process that gathered together the teaching practices possible inside her school, the positions she could negotiate as a newcomer inside the institution, and the cultural practices and discourses embodied during pre-service education. The results bring to the forefront the profound and tense interactions between the intimate and personal terrain of mathematics teachers and the social and cultural world of the schools where they work. Sol's case also contributes to understanding the role that a robust pre-service education can play in the development of beginning teachers' professional identities and in the possibility they could become agents of transformation in their schools.

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Introduction

This article reports results from a study focused on a special period in mathematics teachers' professional lives: their first year of teaching in schools. This phase involves a transition from being a student to being a teacher, and it is usually tinged with conflicting feelings such as joy, excitement, fear, and insecurity. As pre-service mathematics teacher educators at the university, we are deeply concerned with the future of our students when they become teachers and begin teaching mathematics at secondary schools. During students' pre-service education, we have tried to generate settings in which these prospective teachers encounter experiences based on innovative teaching proposals (e.g., those involving use of technologies or promoting active modeling, among others). Meanwhile, we frequently wonder what happens to our students once they enter a school as teachers. What can they retrieve from their pre-service education experiences when they start teaching at schools? Many of them assert that they do not want to become "traditional mathematics teachers," but what happens to those desires when they actually begin teaching at schools?

Lerman (2009) describes the onset of the teaching career as a period in which mathematics teachers enter into an environment often marked by the culture of established teachers and schools, an environment where many of the ideas presented during these neophytes' pre-service education "might sink or swim in the reality of schooling" (p. 71). Beginning mathematics teachers confront continuous tensions and contradictions among the principles, ideals, and experiences encountered during pre-service education and the challenges, demands, and restrictions of their teaching practice in schools (Walshaw 2012; Rocha and Fiorentini 2009). This is a period in which one's past experiences come into play, especially those experienced during pre-service education. But it is also a period in which novice teachers project themselves into the future, imagining the kind of teaching practices they would like to develop in their classrooms and contrasting them with those they are able to develop daily.

Within the field of education, Ruohotie-Lyhty (2013) highlights that there is a large and growing body of research centered on this period, including studies about teachers' first experiences, their socialization into their work environments, and their professional development. These studies are not directly focused on novices' professional identities, but according to the author, they suggest that the first year of teaching "poses several challenges for teachers' identity development, challenges that should be addressed in systematic research" (p. 121).

Some studies report that in many cases, despite having developed innovative proposals during their pre-service courses, novice teachers resort to traditional teaching methods and practices based on the exercise paradigm (Alrø and Skovsmose 2002) or repeat teaching models employed while being students themselves in secondary schools (Zeichner and Gore 1990; Fiorentini et al. 2002). Meanwhile, we consider that becoming a teacher is neither a process in which the new teachers simply adapt themselves to pre-established cultural patterns at the school, nor a reproduction process of old or innovative teaching practices. We agree with the sociological perspective of Ensor's (2001) study in which pre-

service education and beginning teaching are considered as "distinct social activities with particular social relationships, knowledge forms, and associated pedagogic modes" (p. 297). In her work, Ensor refers to the various ways that a group of beginning teachers recontextualized their previous teacher education in the schools where they begin working as teachers. We understand that such processes of recontextualization put into evidence the possibilities of agency of the beginning teachers while negotiating with themselves, their students, the other teachers or the school principal about the possibilities of promoting changes in the teaching practices.

This article reports results coming from a large longitudinal research project focused on mathematics teachers' journeys during their passage from pre-service education to their first-year teaching in schools, a project involving six teachers. In order to develop the analysis in depth, we focus this article on the journey of one participant, Sol.[1]

Our aim in this article is to describe and understand the development of Sol's professional identity and agency during her first teaching year. Our research question is this: How does a mathematics teacher develop and negotiate ways of being and acting during her first year of teaching? We use the work of Holland et al. (1998) as a theoretical background to conceptualize identity and agency. In order to understand the development of Sol's professional identity and agency during her first-year teaching, we carry out a narrative analysis of her oral and written narratives, in a diachronic approach. Based on the chosen theoretical perspective and considering the narrative nature of our analysis, we break down our research questions into three specific questions that will be presented later on the article.

In the next section, we present the theoretical perspective; then, we describe the research design and its methodology. In the following sections, we focus on the narrative analysis describing and analyzing Sol's experiences immediately prior to and during her first year of professional practice as a mathematics teacher in a secondary school. Then, we discuss around the research question and we highlight some distinctive aspects of the case. In the last section of the article, we analyze the contributions they could bring to the field of mathematics education.

Theoretical background

Identity is a notion widely used and studied in various research fields such as sociology, anthropology, and social psychology. Over the years, it has been conceptualized in diverse ways inside these fields. This fact brings to the fore the complexity of researching identity.

Within the field of education, there is a large body of research that addresses the notion of teachers' professional identities (Cattley 2007; Timoštšuk and Ugaste 2010; Hong 2010; Pillen et al. 2013; Ruohotie-Lyhty 2013; Thomas and Beauchamp 2011; Gee 2000, etc.). Following a review of the literature, Beijaard et al. (2004) highlight that although professional identities have been understood from different perspectives, it is possible to outline some essential features about this notion. According to these authors, professional identity is an ongoing process, involving both person and context, and it is formed by sub-identities that can harmonize to varying degrees. In addition, these authors highlight that agency plays an important role in professional identity.

Within the field of mathematics education, Black et al. (2009) and Ponte (2011) point out that identity is a relatively new notion. Professional identity has been highlighted as a

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[1] All the names mentioned in this paper are pseudonyms.

relevant area within the research on and with mathematics teachers (Losano and Cyrino 2017; Skott et al. 2013). Graven and Lerman (2014) mention various issues researchers have studied that are related to professional identity, namely the following: the relationship between disciplinary knowledge and mathematics teachers' professional identity, the ways in which the specificity of the discipline influences teachers' identities, the emergence of identity in prospective or in-service teachers, identity related to teachers' retention, and the relationships between teacher change and curricular change. In addition, different conceptualizations of mathematics teachers' professional identities have been used, many of them drawing on the theoretical constructs of, among others, Vygotsky and Valsiner (Goos 2005), Lave and Wenger (Goos and Bennison 2008; Pamplona and Carvalho 2009), Foucault (Walshaw 2004; Hossain et al. 2013), Lacan (Walshaw 2010; Brown and McNamara 2011), Bernstein (Ensor 2001), and Dubar and Hall (Gama and Fiorentini 2008). Considering the many possible lenses through which to analyze and interpret our research problem, in our study we based our conceptualization of teachers' professional identity and agency on the work of Holland et al. (1998). Such theoretical perspective is rooted in sociocultural theories that highlight the mutual and dialogical relationships between persons and the social world. In this way, this theoretical perspective develops rich conceptualizations of identity and agency that we consider valuable for researching the case of novice mathematics teachers. Below we present the main theoretical concepts of Holland et al. (1998) and explain the ways we understand them in the context of our research.

Drawing on contemporary cultural studies and on the work of Vygotsky and Bakhtin, Holland et al. (1998) focus on the development of identities and agency specific to practices situated in culturally constructed worlds. In the case of our study, we are interested in analyzing the development of one novice teacher's identity and agency specific to the practice of teaching mathematics situated in the culturally constructed world of her school. Agency is understood as the following:

> the realized capacity of people to act upon their world and not only to know about […] it. That capacity is the power of people to act purposively and reflectively (…) to reiterate and remake the world in which they live, in circumstances where they may consider different courses of action possible and desirable (p. 42).

This capacity of acting upon the world, of finding and negotiating gaps for producing transformations in the world—and, therefore, for creating new ways of being—is, then, a key notion when we assume that mathematics teachers are not just a product of the social world of the school where they work. In this way, when novice teachers "are seen as enacting their identities and actively negotiating schooling, we are able to view the mathematics classroom as more than a site for enculturation or social reproduction" (Gutiérrez 2010: 51). Holland et al. (1998) begin by presuming that the social world and the person are mutually and dialogically constituted. People are not just the product of their culture; neither are they merely subject to a social position in a given situation (Holland et al. 1998). Individuals are always (re)forming themselves in a process of heuristic development: when confronted with problematic situations, people draw upon cultural resources—verbal, gestural and material—available at the moment to improvise their identities. These improvisations are created "from a cultural base and in response to the subject position offered in situ" (p. 18). From this perspective, cultural resources are a means through which people are positioned, but they are also a means that people use to construct and improvise their identities. In addition, improvisation gives margin to human agency. In this perspective, agency is always modest, mediated, and "may be frail,

especially among those with little power, but it happens mundanely, and it deserves our attention" (Holland et al. 1998: 5). The idea of improvisation using cultural resources is important because teaching has many unpredictable aspects, and such aspects become especially relevant for novices. Almost daily they are confronted with unexpected and problematic situations they do not know how to solve. In these situations, they improvise using—in innovative ways—cultural resources they and others have produced. These improvisations can lead to changes in teachers' identities and can contribute to transforming their educational institutions.

Concerning identity, Holland et al. (1998) state:

> People tell others who they are, but even more important, they tell themselves and then try to act as though they are who they say they are. These self-understandings, especially those with strong emotional resonance for the teller, are what we refer to as identities (p. 3).

On this basis, we conceptualize a teacher's professional identity as a set of self-understandings related to ways of being, living, and projecting into the teaching profession, facing the voices, demands, and social and political conditions of the teaching practice. It is important to highlight that these self-understandings are not only personally or subjectively constructed by the teacher. They are mainly socially and historically constructed with other participants of the world of teaching (colleagues, students, educators, school principals, etc.).

From this perspective, identities are always developing; they are hard-won, continuously negotiated standpoints (Holland et al. 1998). Throughout her professional life, a teacher will constantly create and recreate her professional identity during her interactions with others, namely with students, colleagues, school principals. In this way, identities are profoundly social and cultural. Because identities are developed during interactions with others and are always addressed to others, Holland et al. (1998) "conceive persons as composites of many, often contradictory, self-understandings" (p. 8).

Holland et al. (1998) understand identity as a notion that articulates the intimate and personal world with the social and cultural world. Therefore, we consider that the professional identity of a mathematics teacher is *dialogically developed* in an interface between her intimate terrain and the practices and discourses to which she is exposed in the present (Holland et al. 1998). These practices and discourses are related to the demands coming from educational policies, students, colleagues, and school principals. Many of these demands are reified in cultural artifacts such as mathematics' official curricula, mathematics' syllabi, textbooks. The intimate terrain of a teacher is composed of practices embodied throughout her history which motivate her to the social life of teaching. It is associated with the teacher's knowledge, dreams, and beliefs related to mathematics teaching and the history of learning and teaching mathematics in which she was previously involved. Thus, the intimate terrain of a teacher is related to her *future memory* (Bakhtin 2003), that is, to the horizon of possibilities about what she would like to be or do, projected from her past as well as from her present experiences. It is important to highlight that the intimate terrain is a result of "living in, through, and around the cultural forms practiced in social life" (Holland et al. 1998: 8).

According to Holland et al. (1998), identities are constructs that can be described as making reference to four activity contexts: *figured worlds*, *positionality*, *the space of authoring*, and the *production of new worlds*. In the first activity context, *figured worlds* are understood as realms of interpretation and performance that are socially and culturally constructed. A figured world offers a set of roles, ascribes importance to certain facts and

activities, and values some results more than others. During the first years of professional practice in schools, teachers enter the figured world of mathematics teaching in a given school. As newcomers, beginning teachers have to learn the meaning of certain acts inside this world. In addition, they have to learn what behaviors are considered proper and the values a member should hold. Novice teachers have to understand themselves as participants, identifying themselves (or not) with the practices of this figured world. In this sense, it may be said that each school—understood as a figured world—develops what Gresalfi and Cobb (2011) call normative identities for teaching: "a set of obligations that a teacher would have to fulfill to be recognized as a competent mathematics teacher" (p. 274) in that school. This activity context allows for capturing the interplay between figuring oneself and being figured by others. In this way, people's identities and agency are formed dialogically in these figured worlds (Holland et al. 1998).

The second activity context, *positionality*, is related to power, status, and the claim for material and social resources according to the social position of a person. When mathematics teachers perform inside their school, they are positioned by other members—as an inexperienced teacher, for example—and, simultaneously, teachers construct their social position. It is important to highlight that positional identities in figured worlds are not exempted of disruptions: "When individuals learn about figured worlds and come, in some sense, to identify themselves in those worlds, their participation may include reactions to the treatment they have received as occupants of the positions figured by the worlds" (Holland et al. 1998: 143). This activity context allows then for capturing the interplay between positioning oneself and being positioned by others.

The third activity context, the *space of authoring*, emphasizes that a person is continuously being addressed by different voices, voices charged with social intentions and meanings about her identity. In the case of mathematics teachers, these voices can come from members of the school community as well as from the teacher's own past experiences. A person is constantly involved in a dialogical process of responding to these voices and producing meanings for them. Whereas a novice surrenders to the authority voice, a more experienced person begins to re-orchestrate different voices, filling them with her own intentions. Through this orchestration process, the teacher constructs her own voice; she authors herself. This process can take a significant amount of time because the voices that have to be orchestrated are associated with socially ranked groups or individuals: school principals, experienced colleagues, students, etc. Therefore, the space of authoring is a space defined by the interrelationship of different voices in the social world (Holland et al. 1998). This activity context emphasizes that identity is multi-vocal, being tied up in the present and past discourses in which a person participates (Gutiérrez 2010).

The fourth activity context is the *production of new worlds*. This context highlights that cultural practices, especially those developed outside the regulated time and space, are occasions in which alternative worlds can be imagined and experienced, and they are also opportunities for people to represent themselves inside these new worlds. Thus, certain cultural practices, such as participating in collaborative groups or attending teachers' meetings inside the school, can be opportunities for envisioning new worlds related to mathematics teaching and for developing new professional identities. These cultural practices enable reflection on a figured world, in terms of articulating its unwritten rules and the nature of the identities it affords. These practices open the way to critical comment and change (Solomon 2012). Thus, these kinds of cultural practices allow the joint development of alternative worlds and new identities inside such worlds (Holland et al. 1998).

We consider the conceptualization of professional identity and agency proposed by Holland et al. (1998) to be highly relevant for our study, since our motivation was to understand the development of novice mathematics teachers' professional identities, taking into account the conflicts and contradictions teachers confront during their first-year acting as mathematics teachers as well as the possibilities they find, create, and negotiate for producing transformations in the schools where they begin to teach. In this way, this theoretical perspective provided us with complex and rich stances on agency and identity. The interplay among the four activity contexts previously described is a rich analytic lens for our research question. Mathematics teachers' professional identities are developed dialogically within the figured world of teaching mathematics through continued participation with colleagues, students, school principals, parents, etc. Each one of these participants positions herself and is positioned by others inside the figured world. In turn, these participants' voices become material which the novice teacher orchestrates in various ways for authoring herself as a mathematics teacher and for envisioning alternative worlds and new professional identities. In this way, this theoretical perspective provides us rich and powerful tools for analyzing how a mathematics teacher develops and negotiates ways of being and acting during her first year of teaching practice.

Research design and methodology

Project overview and educational context

The results we present in this article originate from a larger longitudinal research project focused on the lives of mathematics teachers during the passage from their pre-service education to their initial teaching practice. The research project involves six teachers who graduated at the National University of Córdoba in Argentina. By the time the research project began (middle of 2013), four participants had already graduated: Three of them were in the first year of their teaching practice in secondary schools, and the fourth was yet unemployed. The other two participants were in their last year of pre-service education. From all participants, we collected various data throughout the last year of their pre-service education and their first-year teaching in schools. In the case of the four participants who had already graduated, it was possible to access data corresponding to their last year of pre-service education (2012), thanks to another research project that Mónica Villarreal was carrying out with other colleagues,[2] a project focused on prospective teachers' practicums at secondary schools (Villarreal et al. 2015; Villarreal and Esteley 2014; Villarreal and Mina 2013; Villarreal et al. 2010).

The six research participants attended a four-year undergraduate program that prepares mathematics teachers for secondary schools. In this program, 13 of the 20 courses of the curriculum are devoted to mathematics and are mainly taught by mathematicians. A physics course and an elective course are also offered. Each one of these courses lasts fifteen weeks, 8 h a week. The curriculum also includes two courses (lasting fifteen weeks, 6 h per week) which deal with general educational issues and a 30-h seminar devoted to discussions regarding teacher education. Only two courses which specifically address issues of mathematics teaching and learning are offered in the program; both are thirty-week courses of eight class hours per week. One of these courses is offered in the third year

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[2] The research participants gave informed consent to use this set of data for the purposes of the present study.

of the program and encompasses the study of several trends in mathematics education: problem solving, critical mathematics education, uses of technology in mathematics education, ethnomathematics, and mathematical modeling as a pedagogical approach. As part of this course, the prospective teachers analyze the official mathematics curriculum for secondary schools and perform non-participatory mathematics classroom observations in different urban secondary schools. This course emphasizes reflections on and discussions about the use of technology in the mathematics classroom, highlighting the mediator role that any technology plays in the production of knowledge. In addition, the prospective teachers divide into small groups and develop modeling projects centered on problems freely selected by each group. We will refer to this course as the *Mathematics Education course*.

Finally, in the fourth and last year of the program, a course called *Teaching Methodology, Observation and Practice* (MOPE, acronym in Spanish) is offered. In this course, prospective teachers develop their teaching practicum at secondary schools. Practicum lasts for 1 month and is organized in the following way: It is carried out in groups of two or three prospective teachers who teach in the same school and in the same grade, but in different sections. Prospective teachers are free to choose the colleague(s) with whom they want to work during their practicum. One of the university teachers in charge of MOPE is assigned to the team as supervisor. Additionally, the school teacher in charge of the courses in which the prospective teachers teach also joins the team. All the activities are developed in groups. Before their practicum starts, prospective teachers make classroom observations and create their lesson plans under the advice of the university supervisor. These lesson plans are also reviewed by the school teacher who has the prospective teachers in her classroom. During practicum, when one prospective teacher is in charge of the classroom, the other colleague observes the class and can act as an assistant if necessary. The university teacher and the school teacher are also present. This brief description of the educational context in which the participants of our research were immersed during their preservice education offers elements for understanding some of their decisions when they act as teachers at school.

In this article, we develop an interpretative case study centered on one participant of our research, Sol. Several reasons justify the selection of Sol's case for this study: first, her strong interest during pre-service education related to two trends in mathematics education: the use of technology and the use of modeling as a pedagogical approach. Her deep interest in these trends helped her develop skills to use these at school. Given this background, we believe that Sol's experiences during her first year as a mathematics teacher provided worthwhile insights about the ways she utilized these practices and discourses to position herself in the figured world of her school. At the same time, we feel we can analyze how Sol orchestrated voices coming from the past that merged with those coming from the present for authoring herself as a mathematics teacher.

Secondly, Sol was hired to teach in the same school she had attended as a secondary student. Choosing Sol's case allowed us to explore her positional change from being a student to being a teacher inside the same figured world and to analyze how the practices and discourses Sol experienced as a student interacted with those she experienced as a teacher.

Finally, an initial analysis of the data revealed that this was a particularly interesting case because Sol seemed to craft multiple self-understandings as a mathematics teacher according to the various settings where she acted as teacher. In the following subsection, we describe Sol's path from her pre-service education through her first year as a mathematics teacher.

Research participant: sol's case

In 2009, at 18 years of age, Sol enrolled in a mathematics undergraduate program at the National University of Córdoba. At the end of her second year, she decided to enroll also in the mathematics education undergraduate program at the same university. Thus, in 2011 she was a student of both programs.[3] During that year, Sol attended the Mathematics Education course, in which Mónica Villarreal was the teacher. At the end of 2011, Sol decided to drop out the mathematics program and continue only with the mathematics education program.

In 2012 Sol attended the course called MOPE that we described in the previous section. In the context of this course, Sol, working together with another pre-service teacher, carried out her practicum during the months of August and September. Both prospective teachers were supervised by Mónica Villarreal, and both worked in a school where the teacher accepted and encouraged the implementation of modeling projects. Similar to the way in which they had developed a modeling project in the Mathematics Education course, Sol and her colleague required their students to develop modeling projects based on topics the students had freely chosen. Regarding technology, this was a well-resourced school. All students had a laptop they daily brought to school. The classroom was also equipped with a digital board and Wi-Fi Internet access.

From 2011 to 2013, Sol was involved in university extension projects that promoted the use of technology in mathematics classes at secondary schools. These experiences allowed her to understand the software GeoGebra[4] in depth and implement activities using it. She graduated as a mathematics teacher at the end of 2012.

Sol's first year as a secondary school mathematics teacher was 2013. In February[5] Sol was hired by the same secondary school where she had studied, a private urban school with 320 students. Like many others in our country, this school receives financial support from the state government. Sol worked as the mathematics teacher for one 2nd grade section (students aged 13 years old) and one 4th grade section (students aged 15 years old).[6] The other two sections of 2nd and 4th grades were in charge of another teacher, Camila. In addition to her 2nd and 4th grade sections, Sol was also the mathematics teacher of the two 6th grade sections (students aged 17 years old). This school had a computer laboratory resourced with 12 computers and a projector.

Data collection

Since we developed a longitudinal research project, our set of data comes from varying times and places allowing us to analyze diachronically (Fiorentini 2013) the development of Sol's professional identity. Our sources of data are written narratives and taped interviews coming from two scenarios: Sol's pre-service education (two written narratives) and Sol's first year of teaching practice after obtaining her degree (one written narrative and

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[3] The syllabus of both programs shared several subjects such as Calculus and Algebra.

[4] https://www.geogebra.org.

[5] In Argentina, school year starts in March and ends in December.

[6] The reader should keep in mind that in Argentina, secondary education is compulsory and lasts six years. It is divided in two cycles: the basic cycle and the oriented cycle. The basic cycle includes 1st to 3rd grades (students aged 12–14 years) and has a common curriculum for all the schools. The oriented cycle comprises 4th to 6th grades (students aged 15–17 years). For the oriented cycle, each institution offers at least one orientation (natural sciences, social sciences, etc.). Each orientation has a special curriculum.

two semi-structured in-depth interviews). Table 1 describes and summarizes information regarding our data, including date, descriptions of activities (instructions for writing the narratives and the main interview questions), contexts in which the activities were carried out, and the audiences Sol addressed in each case.

Table 1 Description of the data

Source	Date	Activity	Context and Audience
Data from Sol's pre-service education			
Written Narrative 1	March, 2012	Write about your pre-service education: Why did you decide to enroll in a mathematics education program? What were your expectations about this program? How would you describe your experiences during the program?	First day of class in the MOPE course Classmates and teachers (Mónica Villarreal was the teacher of the course)
Written Narrative 2	December, 2012	Write a narrative telling about your first experience of teaching at the school	A day after finishing the practicum at school. Teachers of the MOPE course.

Data	Date	Activity	Context and audience
Data from Sol's first year of teaching practice			
Written Narrative 3	November, 2013	Write a narrative telling about your first day as a mathematics teacher in the school	The research project Leticia Losano and Mónica Villarreal
Taped Interview 1	October, 2013	Interview about the following: School setting: How would you describe the school where you work? How would you describe your relationships with your colleagues? Did you receive any advice regarding teaching? Professional practice: How would you describe your day as a teacher? How are your relationships with your students? What are the difficulties you confront regarding teaching? Professional identity: How do you feel about your profession? Did you change the way you saw yourself as a teacher? How?	The research project Leticia Losano and Mónica Villarreal
Taped Interview 2	December, 2013	Interview about the following: The first year as a mathematics teacher: How would you describe and evaluate your first year as a teacher? Can you recall important moments or events? Classroom management: What are your roles in the classroom? Planning: What kinds of tasks do you propose to your students? How do you plan your lessons?	The research project Leticia Losano

Analytical procedures

We developed the data analysis in the form of a narrative analysis (Skinner et al. 2001; Riessman 2002, 2005) since in the interviews and written narratives, Sol selected, organized, and connected a group of episodes that she considered meaningful for a particular audience (Riessman 2005). In this way, our data have a narrative nature.

The analysis was developed in two stages. In the first analytical stage, we transcribed the interviews' audiotapes and read the transcripts of Sol's interviews as well as her written narratives. This initial exploration of the data allowed us to identify two figured worlds that emerged as being relevant to answering our research question: the figured world of pre-service education and the figured world of teaching in the school. Each had its own set of participants and specific physical and social spaces. These figured worlds were interpretable realms in which students, teachers, schools principals, mathematics educators, etc., fashioned their senses of self (Boaler and Greeno 2002). In Sol's case, the figured world of teaching also had its own configuration because it was possible to identify three settings inside this figured world: 2nd grade, 4th grade , and 6th grade. As a result of this first stage, we decided to structure the analysis in five sections: pre-service education, the (re)entering to the figured world of teaching in the school, 2nd grade, 4th grade , and 6th grade.

The second analytical stage involved the narrative analysis of these five sections. First we broke down our general research question into three specific questions formulated in terms of the chosen theoretical perspective and in terms of the narrative nature of our data. Those specific questions were as follows: How did Sol

- position herself and position other participants of the figured world of teaching?
- orchestrate voices from her social and personal world—voices from the past, the present and from her future memory—to create self-understandings as a mathematics teacher and to envision herself in new social worlds?
- act upon the social world of teaching and negotiate—with others—new possible actions inside this world?

Secondly, we selected a set of episodes from Sol's written narratives and interviews. We view an *episode* as involving a setting where an *event* (Bakhtin 1984) occurs and where a set of participants interact, produce, and negotiate meanings related to this event. The events occurred in the figured worlds in which Sol participated and revolved around the positionality of Sol and other participants, Sol's orchestration of voices, or the development of new figured worlds. Finally, we developed a *performative narrative analysis* (Riessman 2005) of each episode in terms of our three specific research questions. Performative narrative analysis considers *what is said* in a narrative, but its main interest is on *how it is said*. According to Riessman (2002), this kind of narrative analysis considers the positionings of the participants in a story (including the narrator), the setting of the story, the enactment of dialogue between the story's participants (reported speech), paralinguistic features like pauses, laughs, and interruptions, and the audience the teller is addressing. Regarding Sol's audience, it is worth noting that the episodes, thoughts, and opinions she expressed were those she decided to reveal to us, a group of researchers, one of whom had been her teacher during her pre-service education. In this sense, it is important to highlight that the interviews and the written narratives were not just opportunities for Sol to deliver information to us. Instead, they were joint constructions in which we as mathematics education researchers interested in teacher education played an important role (Solomon 2012).

According to Clandinin and Connelly (2000), a "good narrative inquiry" (p. 185) should satisfy criteria of *authenticity*, *adequacy*, *plausibility*, as well as *explanatory* and *invitational quality*. These criteria imply the development of mutual trust between researchers and research participants, a relationship in which they work collaboratively to understand the phenomenon being investigated. In order to meet these criteria, especially the authenticity of the analysis, we shared a preliminary version of the analysis with Sol to determine whether she recognized herself in the narratives. In this way, she had the opportunity to propose changes and amendments. After that, she authorized its publication.

The following section presents the narrative analysis. Throughout the analysis, we quote Sol's own words. Such words appear "in italics between quotations marks" or in a separate paragraph when the quotation is longer. It is important to highlight that the construction of narrative excerpts from interviews or written texts is by itself a complex interpretative task, strongly influenced by the researcher's theoretical perspective and questions (Riessman 2002).

Narrative analysis

Figuring herself as a mathematics teacher during pre-service education

The transition from being a mathematics student to being a prospective mathematics teacher involved a change in the way Sol positioned herself. In Narrative 1, she wrote about this transformation using the following words:

> Last year (2011) I decided to drop (for the moment or maybe forever) the mathematics program and continue only with the mathematics education program. It was only at the middle of the year that I realized the meaning of a mathematics education program, about the importance of the teacher, of the student, of knowledge construction. Then, many topics that we were studying in the Mathematics Education course became meaningful for me. The importance of the teacher in society, of active students, of participation, among others, were issues that encouraged me to explore, share, debate with others, and to get more involved regarding my "future as a teacher". Recently I realized that part of this "role" as a teacher was related to my time in high school and I hadn't realized that until now […] In high school before tests I always did a review on the blackboard for my classmates […] Regarding mathematics, two days before the tests, it was customary that a group of classmates came to my home, I explained to them and we solved the exercises, etc. Although these were particular experiences where all of us were students, they were very important and positive for me and I think that they partly encouraged me to enroll in a mathematics education program.

In this episode, Sol wove voices coming from the fields of education and mathematics education for authoring herself as a prospective mathematics teacher. Thus, Sol chose words coming from the Mathematics Education course such as "knowledge construction" or "active students." For Sol, those discourses were useful and meaningful for expressing the importance of teachers and students in society, allowing her to imagine her future "role as a teacher." We consider that in this process she was beginning to develop her future memory as a mathematics teacher. Then Sol moved back to the past, remembering experiences encountered in secondary school. In those experiences—although she was

positioned as a student—Sol partially assumed the role of a teacher, helping her classmates before tests. She brought these experiences to her narrative and used them for positioning and envisioning herself as a prospective mathematics teacher.

In 2012, Sol carried out her practicum in a secondary school working together with another pre-service teacher, Marina. The school's teacher and the university supervisor encouraged Sol and Marina to implement modeling projects and make intensive use of the technology available in the school. In Narrative 2, Sol narrated her expectations about carrying out her practicum at this school: "I loved the idea of "doing modeling" during practicum; we had "read," "listened" and "lived" so much about it during the Mathematics Education course, and finally now we had the opportunity of experimenting with it from another position." This "another position" was precisely the position of a prospective teacher in charge of a classroom during her practicum, the closest position to being a teacher she would experience during pre-service education. Sol put quotation marks around some keywords, which seemed to reveal the relevant influence she assigned to the mathematical modeling experiences that she lived during the Mathematics Education course. She ended Narrative 2 with the following words:

> It was finally OUR practicum [referring to Marina's and hers] because it wasn't only that I had the opportunity of "doing modeling" [during practicum]; we experienced, wrote, and thought [about] modeling as a different and fruitful way of teaching mathematics. Personally, the experience was great and now, thinking about my future as a teacher, I feel that many challenges will arise, but I know that many of the things that I studied and experienced during practicum will help me to face such challenges.

Sol decided to use capital letters to highlight the word "our." After practicum, "doing modeling" was not only a discourse reified in a book or a project carried out during the Mathematics Education course. Modeling was now her and her colleague's practicum. Sol seemed to take up discourses related to modeling as a pedagogical strategy and filled them with her own intentions and accents for authoring herself as a prospective mathematics teacher. This process allowed Sol to relate her experience during practicum to the several challenges she envisioned when she projected herself into the future as a mathematics teacher. Thus, practices and discourses about modeling as a pedagogical strategy played an important role in Sol's future memory and became important resources for developing her professional identity.

Entering the figured world of school teaching: Returning to her school as a teacher

During Interview 1, Sol began to speak about the school where she started working as a teacher with the following words: "It's rather strange because I was a secondary student in that school, so I know all the teachers because they were my teachers." In this way, Sol appealed to her past position as a student in the school and she positioned the others according to their old role: they had been her teachers. Sol used the words "rather strange" maybe to highlight that becoming a teacher in this school implied an important positional change; it implied Sol figuring herself and being figured by others as a teacher, not as a student. The following episode, in which Sol said she felt uncomfortable in the teachers' lounge, illustrates the complexity of this process:

It's rather strange [pause] The people are old [she refers to the teachers] I mean, there is an age gap and there are teachers with whom I had problems when I was a student so [pause] there are relationships [with them] that aren't good [she laughs] Luckily, there are two spaces quite different in the school; they are the library and the teachers' lounge. We use the library as a meeting space; I and a couple of teachers used to go to the library […] It offers a more pleasant and relaxed atmosphere. When I was a student I always went to the library. Now I spend some time in the teachers' lounge in order to sign some papers and then I go to the library. I feel much more comfortable in the library than in the teachers' lounge. The teachers' lounge is quite stifling; everybody complains […] it's frustrating. At the beginning [of the year] they [other teachers] said to me: "No! With that class [referring to one of the classes Sol was in charge of] you won't be able to do anything!" [Simulating a response to those teachers, she said] "No! We are just starting! Don't say that to me!" So, I prefer not to listen to these things and rather see what I can do.

In this episode, Sol began positioning her colleagues and herself according to age. It seemed that an age gap could explain her discomfort in the teachers' lounge. But immediately she brought to the forefront her past position as a student to explain that she had had problems with some of the oldest teachers when she was a student. Her laugh when she referred to her relationships with those teachers seemed for us to be evidence of her difficulty in overcoming such tensions. In the episode, Sol also turned to her past position as a student to introduce another place and its participants: the library. She contrasted this place with the teachers' lounge mainly to highlight that inside the figured world of teaching in this school, the teachers' lounge was a space occupied by old teachers whose discussions expressed frustration and weariness. At this point in the episode, Sol used reported speech to introduce the voices of other teachers that, at the beginning of the year, predicted she would not be able to work well with her students. Although during the interview we were her audience, at this point Sol raised her voice and answered to those colleagues. Her voice opposed the voice of other teachers, which is evidence of the conflicts and struggles generated when she listened to these kinds of comments from her colleagues. Within her realm of possibilities, she developed her agency: Sol avoided these colleagues and their comments by spending only a minimum amount of time in the teachers' lounge.

After referring to her tense relationships with some of her colleagues, she introduced Ana, the vice principal:

The vice principal is a mathematics teacher; she was my mathematics teacher during almost my entire secondary education. So, she knows me and I know her. We meet and talk [about] how I am doing with the lessons. Sometimes she tells me about the strategies she implemented in some situations. We talk a lot about how to react in different situations. She helps me mainly with my 2nd grade students […] We work well together […] At least I could talk with someone about the concrete things that were happening; she had lived them, so, she knew what to tell me.

Sol began positioning the vice principal as a mathematics teacher and herself as her former student. Due to the history they shared in the past, Ana appeared in Sol's episode as an experienced advisor with whom Sol could discuss some problems that emerged during her first year as a mathematics teacher. During their conversations, Ana shared some "strategies she implemented" to manage situations that baffled Sol. This knowledge-in-practice (Cochran-Smith and Lytle 1999) seemed to provide the solutions to manage conflicting classroom situations. Such solutions were the ones accepted and expected in the

institution. We consider that when Sol introduced Ana in her speech, she was also introducing aspects of a teacher's role, a role historically and socially constructed inside the figured world of teaching in a particular school.

During Interview 1, when we proposed Sol speak about the strengths and weaknesses of her pre-service education, Sol decided to begin with the weaknesses, narrating an episode about her first weeks as a teacher in the school, one that questioned her pre-service education:

> At the beginning, when I began teaching, I told myself: those four years [of the undergraduate program] weren't useful at all! […] Those weeks were awful because I wondered: What was the undergraduate program for? I said to myself: Ok, I'm going to plan my lessons. Ok, let's see. The textbooks. I said: No! What do I do with a textbook? I didn't know how to analyze textbooks. I said: Ok, let's see. How do I explain this topic? Mathematically I knew how to explain it but [pause] I tried to use material we had studied during the Mathematics Education course and MOPE, and I was able to do something, but I felt that I had no strategies; the kids were fighting [inside the classroom] and I wondered: What do I do now? […] I wondered: Is this what it's like to be a teacher? I wanted to die.

Intertwining dialogues she had had with herself, Sol presented the beginning of teaching as an experience strewn with challenges and conflicts, one after the other. The questions she posed and left without an answer helped Sol to highlight her struggle for taking control of such conflicting and challenging situations. Regarding lesson planning, she first referred to cultural artifacts developed inside the figured world of teaching: the textbooks. But these artifacts did not seem useful to solve her problems because it was difficult for her to interpret and make decisions about the tasks they proposed. Then, she turned back to her pre-service education, retrieving other cultural artifacts—"the material we had studied"— that allowed her to make some progress regarding planning. In the episode right after that, Sol introduced new urgent problems arising from teaching practice: disciplinary problems in her classroom. With the last sentences of the episode, Sol clearly expressed that the way she had figured herself as a teacher in the past collided with her first experiences teaching; there was disagreement between her future memory constructed during pre-service education and the harsh reality she encountered in the school.

The challenge of being a teacher in 2nd grade

During Interview 1, Sol began referring to her experience as 2nd grade teacher by describing her students and the disciplinary problems she faced:

> It's more complicated because they are younger[7] and the difficulties I face are disciplinary, I mean, that they pay attention, that they keep quiet, that they don't fight. Until you get 70% of the students paying attention, the situation is hopeless. My 2nd grade class, it's the most contentious class in the entire school, so it's very difficult. It's so tiring because they overwhelm me. To teach in this class is so complicated; they only respond to study guides, grades, and referrals.[8] I had never before imposed referrals and I had to impose referrals on some of them. So, it's a job that I don't like. I don't know if it's this particular group of students or if it's the age

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[7] In Argentina, 2nd grade students are 13 years old.

[8] Referrals are disciplinary sanctions that teachers impose on students because of their misbehavior.

[…] I feel that neither I nor they are going anywhere […] I mean, it's a very contentious group of students; we have had many meetings with the other teachers trying to figure out what to do [with them].

In this episode, Sol began describing some of the roles she had to assume as a 2nd grade teacher: control the discipline, ask for attention, and ask for silence. This description enabled her to underline her fatigue and discouragement while working with the 2nd grade students. In an attempt to articulate reasons that explain the problems she faced, she positioned her 2nd grade students as younger students that, inside the figured world of teaching in her school, had been labeled as the "most contentious class". Sol also positioned herself as being "overwhelmed", conveying in her discourse the impression that working in this setting was an experience in which getting control of the classroom was difficult. Also Sol introduced other colleagues in the episode, pointing out that she was not the only teacher in the school who had problems with this class. This allowed Sol to share her difficulties with other colleagues. In order to work in this contentious setting, Sol resorted to practices and discourses accepted in the figured world of teaching in her school: disciplinary sanctions, tests, exercises. Although these practices seemed to help her to manage the classroom, they came up in Sol's speech as strategies that she did not like and made her felt very frustrated.

Imposing referrals on her students seemed to be a difficult experience for Sol. Later on, during Interview 1, she returned to this issue when we asked her about the process of becoming a teacher:

You learn along the way [to be a teacher] I learn a lot from the conversations with the [other] mathematics teachers. That helps me to know how to face some situations. You gradually create some strategies regarding [pause] disciplinary problems. I wasn't ready for that; that was something that I never thought about, that I never studied. At the beginning [of the year] two kids were fighting using a chair and I said: what should I do? When I imposed referrals for the first time, I wondered: What am I doing? Why am I imposing referrals? Because I said: seeing them [disciplinary sanctions] as a student, which I was not such a long time ago, and seeing them as a teacher, it's [pause] it's difficult to change the point of view.

In Sol's speech, disciplinary sanctions were strategies that she came to know through conversations with her colleagues. Inside the figured world of teaching in her school, imposing referrals was an expected practice for a student who behaves badly. It seemed that Sol was trying to use the discourses about imposing referrals for authoring herself as a mathematics teacher. But filling such discourses with her own intentions was not simple, maybe because working in a verbally and physically violent atmosphere was not part of her future memory constructed during pre-service education. Through a dialogue that Sol had with herself, she communicated the struggles she faced when she decided to impose referrals. At this point, Sol's past positional identity as a student emerged again and highlighted that the transition from being a student to being a teacher was complex. At present, Sol is a teacher, but the episode she narrated is still populated by discourses and experiences from her past position as a secondary student. Regarding disciplinary sanctions, Sol seemed immersed in an intense and unresolved struggle, trying to orchestrate the contradictory voices and discourses coming from her colleagues, her past experience as a secondary student, and her future memory.

During Interview 2, Sol mentioned another strategy she created to manage her 2nd grade class: "I perceived that they calmed down a bit when they worked in different places,

half [of the students] inside the classroom, the other half in the hallway". Although this strategy made her work "more exhausting and slower" because she had to move continuously in order to attend each groups' demands, it also improved the working atmosphere. In this way, Sol improvised a solution for a conflicting situation by drawing on cultural resources she had at hand. In this case, the fact that the students worked outside the classroom was something naturally accepted inside the figured world of teaching in her school.

During Interview 1, when we asked Sol about her lesson planning, she referred to this as a conflicting aspect of her work in 2nd grade. On this occasion, Sol told us about the use of a workbook created by Camila:

> When I started teaching in the school, the other teacher [Camila] had already prepared material for 2nd grade; I couldn't introduce many changes to this workbook. So, I'm following the workbook she created. I'm not very much in favor of this kind of workbook. I don't like to follow it too much. In fact, I move away from the workbook and I make other kinds of exercises with my students. But, supposedly, we are developing [the syllabus] hand in hand [with Camila], so, I have to go back periodically to the activities of the workbook [she laughs] For those lessons I don't have to think about many things. Rather, I have to think how to contribute, but with a given textbook, it's difficult to be the one who plans the lessons.

In this episode, the workbook was a cultural artifact produced by more experienced mathematics teachers. It was an artifact in whose production Sol did not participate. This fact allowed Sol to highlight that she could not act upon the workbook. When Sol introduced a reference to the workbook in her speech, she emphasized her position as a newcomer in the school; she decided to "follow" the workbook, making an effort to adapt herself to the artifacts and practices already established at the school. Sol continued positioning herself regarding this situation and expressing her struggles when she tried to organize her practice as a teacher around this artifact. The compulsory use of the workbook prevented Sol from planning, an important role for any teacher. We consider that her final words, "it's difficult to be the one who plans the lesson," expresses the fact that she did not feel in charge of lesson planning, creating, changing, or experimenting with new classroom activities for her students. Using Bakhtin's (2011) ideas, we consider that the workbook functioned as an *authoritative discourse*, i.e., a discourse associated with the authority (in this case, an experienced mathematics teacher) that "demands that we acknowledge it, that we make it our own; it binds us […] Its authority was already acknowledged in the past" (p. 81). Thus, it is particularly difficult to introduce modifications in such authoritative discourses, to fill them with one's own accents and intentions. In this way, the lesson planning embodied in the workbook resonated as a foreign voice for Sol, since her own teaching intentions and proposals were not present there. Nevertheless, in the episode narrated by Sol, she included opportunities where she was the main protagonist, leaving her mark in the lesson planning. From time to time, she decided to move away from the workbook and propose activities she created by herself. We understand this as a way of developing her own agency.

The workbook was not only a cultural artifact that mediated Sol's lesson planning. It also mediated the work with her students inside the classroom:

> When I began to explain to them [her students], they asked me: "Is this in the workbook or isn't it in the workbook?" If it [the topic] was in the workbook, the students didn't listen or they directly opened the workbook and read it. If I said: "It's

not the same thing as the one in the workbook", they listened to me a bit more. If I said: "It's not in the workbook at all", they listened. It was quite complicated.

Sol brought to her speech the voices of her students in order to highlight that they used this cultural artifact for positioning themselves and Sol. In this way, the students used the workbook as a tool to restrict the activities that were possible inside the classroom. Then, the workbook was an important mediator for the development of Sol's identity, agency, and teaching.

At the end of the year, during the Interview 2, Sol mentioned the workbook again, recounting a meeting with Camila:

I told her [Camila] that I didn't like the workbook, that I wasn't going to use it next year! [she laughs] I told her: "I had no trouble in following the same syllabus, with the same contents, but I wasn't comfortable working with the workbook". I felt tied to the workbook. I didn't like its structure […] Planning the lessons based on that workbook was really uncomfortable.

When Sol remembered and relived this meeting with Camila, she expressed the struggles and conflicts she faced as a 2nd grade teacher. She raised her voice and emphatically explained to Camila her desire to abandon using the workbook next year. Her laugh at the end of the sentence seems to suggest the difficulty entailed in her taking this stance in front of her colleague. Although during Interview 2 Leticia Losano was Sol's audience, at that moment it seemed Sol was speaking to Camila, finally expressing ideas and feelings that she had concealed during a year. This was a turning point in Sol's speech. She did not want to be tied to the artifacts already established in the school. In this episode, she confronted Camila in order to negotiate the resources they would share and the ones they would not share anymore. After a year of trying to adhere to this *authoritative discourse,* Sol raised her voice against it.

After narrating this episode, Sol told us about the new agreements she established with Camila: "we said that we could share some study guides that we could consider and create together, and if [this were] not [possible], each one would continue to follow her own criteria". With these words Sol positioned herself and Camila as equal protagonists to plan their lessons for the next year. She projected herself into the future, a future in which both teachers would work collaboratively, transforming practices, artifacts and discourses for 2nd grade or they would work independently. With this statement, we consider that Sol envisioned an alternative world related to teaching mathematics in 2nd grade, one that opened up the possibility of developing alternative identities different from the roles traditionally assumed by the teachers in her school.

Negotiating a way of being a teacher in 4th grade

During Interview 2, Sol began speaking about her experience as a 4th grade teacher by referring to her students' behavior and attitudes toward mathematics:

The problem was that they [the students] didn't care about anything. They asked me to give them the final result, the formula. They didn't care about the process or about what we could solve using these formulas. No. They wanted a way to get the solution and that's all! That was difficult because I ended up getting angry and teaching in [pause] a rather algorithmic fashion. There was no debate; we couldn't work on

many problems because they complained saying that they didn't understand […] I couldn't find ways to reach them in order for them to get involved and pay attention.

In this episode, Sol outlined the 4th grade students' demands and the role they expected the teacher to assume inside the classroom. The students clearly established the positions they and Sol had to occupy inside this setting, laying down clear limits about what kind of activities they would be willing to do during class. The students were reluctant to solve problems or debate strategies, but these were activities that Sol considered valuable. In the light of this situation that Sol could not manage, she positioned herself in this setting getting angry and developing her lessons "in a rather algorithmic fashion". The pause before this sentence seems to reveal her discomfort associated with assuming this position and, in some sense, succumbing to her students' demands.

Although her relationship with the 4th grade students was always strained, during Interview 2 Sol showed satisfaction remembering a lesson about graphical solutions of linear equation systems with two variables using the software GeoGebra. Since she did not feel confident about working with these students in the computer laboratory, she implemented an alternative strategy: working with GeoGebra inside the classroom using a projector and connecting it to her personal computer:

We worked graphically using GeoGebra. I carried the projector [into the classroom] and I showed them different linear equation systems, and the students classified them [according to the existence and uniqueness of solutions of the systems]. It was very good because everyone wanted to participate and answer; this didn't happen frequently. It was easy to see, we could work quickly with different cases. Many frequent mistakes about [the meaning of] solving a linear equation system emerged. Previously some of them had said: "[the solution] is the intersection with the x-axis", others said: "it's the intersection with the y-axis". When the students saw the lines, they realized by themselves and said: "No! It's the intersection point [between the two lines]!" and they explained this to each other. That was the best lesson with them because they told each other the answers. That was very good.

GeoGebra was an artifact that Sol knew in depth and that she had considered to be a valuable tool for teaching mathematics since her pre-service education period. In this episode, GeoGebra allowed the students to easily visualize the solution of different linear equation systems with two variables. In her speech, Sol brought her students' voices to the forefront and orchestrated them in order to communicate how her students could better understand the meaning of the solution of a linear equation system. With this episode, Sol recalled a lesson in which the usual dynamic of the classroom changed: the students participated and explained their understandings to each other. They appear as main protagonists in Sol's episode, deeply engaged in discussing mathematical ideas. We considered this lesson as evidence of Sol and her 4th grade students creating a new figured world, since they produced an alternative way of teaching and learning mathematics using technology.

Similar to the situation in 2nd grade, there was a workbook for 4th grade , which had also been prepared by Camila, but this workbook was a cultural artifact with different characteristics. Sol took a different stance regarding this workbook:

It's a compilation of different textbooks, of different topics […] It's a set of photocopies of several textbooks, of different topics […] I didn't even tell Camila that I moved away from the workbook [she laughs] No chance! At the beginning [of the

year] I followed the workbook to review some topics. That's OK, we'll follow it. But when I started teaching trigonometry I saw it [the workbook] was too complicated and it was far beyond what I could explain to the kids and what they would listen to. At this moment I created a different study guide […] I followed it [the workbook] at the beginning [of the year] and then I didn't use it anymore.

In this episode, Sol began describing the structure of the workbook, emphasizing its vague characteristics. This fact seems to reinforce her decision to abandon using the workbook. Such a decision involved breaking the agreement she had established with Camila at the beginning of the year. In the episode, Sol came back to the beginning of the year when she started teaching using this workbook. With the sentence "That's OK, we'll follow it" Sol seemed to succumb to this artifact. But immediately she brought her agency to the forefront; she decided to stop using the workbook when teaching trigonometry. To justify her decision, Sol gave reasons coming from the figured world of teaching: The material was not adequate either for her or for her students. Sol created her own classroom activities and when she talked about them, she said, "They were completely constructed by me, with my words. I didn't take exercises from [pause] anywhere! I created the exercises and I solved them in order to see whether they had a solution". With these words, Sol positioned herself as the author of her lesson planning: Sol was the one who created and decided what exercises she would propose to her students in this setting; her own voice was reflected in the classroom activities.

The reflection about the nature of the activities she developed in 4th grade led us, during Interview 2, to speak about the kind of mathematics she taught in 4th and 2nd grades:

The meaning of the mathematics that I want to develop in my classes is something I'm constructing currently. It's not something about which I can say: Yes, this is the meaning! I'm always questioning myself about that. It's all mixed up for me! […] The mathematics that will be useful for the students, the mathematics I learned here [at the university], the mathematics that […] some researchers proposed, the mathematics of the official curriculum. I mean, there are so many ways to see it, and I don't know… All of them are mixed up in my head! I didn't like the meaning that mathematics acquired in those courses […] Obviously, I contributed to that situation. My idea is to change that, obviously. It was a mathematics quite isolated from the everyday environment, pure mathematics. I don't think that this is all what it should be […] It has been purely algorithmic and numerical mathematics. I don't like it […] I don't see how it can be useful for the students, just to know how to make calculations.

Sol populated this episode with multiple and contrasting voices that spoke about the type of mathematics a teacher should teach. Sol was challenged by these voices, and she had to respond to them in some way. All of them seem to participate when Sol planned and implemented her teaching. Sol appeared immersed in an unfinished process of orchestrating these voices in order to craft her own vision about the mathematics she should teach. In the midst of this struggle, Sol focused her vision on the meaning of the mathematics she taught in 2nd and 4th grades. Sol did not feel comfortable because, in her view, the teaching of mathematics should not be reduced to algorithms or calculations. In this episode, she expressed her desire of figuring mathematics differently and envisioning a new world in which mathematics was not reduced to numbers and abstract concepts.

Finding a way of being a teacher in 6th grade

During Interview 1, Sol also spoke about her experience as the mathematics teacher of 6th grade. She started telling us about her students and the relationships she established with them:

> When I entered the school [as a teacher] they [her 6th grade students] already knew me, so, this relationship was a bit strange, because we were very close in age and they knew my background at the school. So, it's a quite close relationship […] In 6th grade I was able to do things because I made a deal with them from the beginning. I said: "You are in 6th grade; you have to study mathematics even though you don't like it; you have to graduate, so, here we are, I'm going to be your teacher". The contract was like that. The students respond well to this contract. This school gives freedom to the students and that's good in some sense. Since I experienced this freedom [while being a student in the school] I couldn't say that I would forbid it. If they want to go to the bathroom, they can do it, that sort of thing. I can implement many things. They pay attention in class. I don't have disciplinary problems with them, so, I can teach. With some of them, we went to the computer lab, we worked with GeoGebra […] We studied statistics using a text from another subject. It's possible to do this job because the students are willing to do it.

In this episode, Sol brought up, once again, her past position as a student in the school. Also she resorted to another issue related to the positional identity of her 6th grade students: their age.[9] The age gap between her 6th grade students and herself was less than in the case of the 2nd grade students. The fact that Sol's 6th grade students knew her background at the school as a student and the resulting small age gap between them, made Sol describe her relationship with the 6th grade students as "strange", in the sense of being "quite close". In this way, Sol positioned her 6th grade students very close to her own position. In the episode, Sol continued talking about the didactic contract she established with them. Although during Interview 1 Leticia Losano and Mónica Villarreal were Sol's audience, at this moment Sol addressed her students, bringing words to the interview that she previously had told them. In doing so, Sol resorted to discourses of the figured world of teaching—mathematics is a compulsory subject needed for graduation—and clearly positioning herself and her students with the sentence, "I'm going to be your teacher." In this episode, Sol seemed to be the main protagonist for establishing this didactic contract, different from her experience with the 4th grade students who, in a sense, were the ones who established the position that Sol had to assume. Her past identity as a student in the school emerged again in this episode Sol narrated. She resorted to her knowledge of the figured world of teaching in the school to justify the fact she gave her students the freedom she had enjoyed in the past as a secondary student. Sol ended the episode listing different activities she had implemented in this setting and describing her students' behavior in classroom. It seems that having a good classroom atmosphere allowed Sol to take some risks, proposing her 6th grade students develop interdisciplinary projects or carry out activities in the computer laboratory. Throughout this episode, Sol underlined for us that 6th grade seemed to be a setting in which she could act as a teacher. In this setting, she was an important protagonist who took charge of decisions concerning different aspects of her classes for 6th grade.

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[9] In Argentina, 6th grade students are 17 years old.

When Sol was talking about the classes in the computer laboratory, we asked her about her possibility of using the technologies available at the school with her students. In answer to our question, she narrated the following episode:

> They [the school administrators] implemented a new system because the students were breaking many computers, so, you had to fill out a form with the names of the students using each computer. I was very upset about that. No. I wouldn't assume the role of a policeman. When I went [to the lab] […] I wrote [on the form] that all of us were responsible. I spoke with the students and I told them that I didn't agree [with the idea of having to fill out the form]. I asked their opinion. They told me that they thought that everybody was responsible and that nobody would break the computers. These are things that I don't like. I don't like to be a policeman in the lab.

Sol began this episode by implicitly stating the authors of this new control system: the school administrators. This enabled Sol to reinforce the idea of the laboratory form as an imposed cultural artifact developed inside the figured world of teaching in her school. In this episode, the laboratory form assigned a control role to the teachers who wanted to use the school's technological resources. Sol did not want to assume that role and, in her speech, she raised her voice against this imposed role. Facing this conflict, Sol improvised a reaction to resist this cultural artifact: She decided to fill out the form in an unexpected way. In this episode, Sol was the agent of action: She acted upon the laboratory form, expressing her discomfort with the implemented system. In the episode, Sol also says that she involved her students: She shared with them her disagreement with the form and engaged them in taking care of the school's technological resources. The students' support seemed to reinforce Sol's confidence in her claim of not assuming the role of a policeman in the laboratory.

The possibility of being an active agent was also reflected when Sol talked about how she planned her 6th grade classes: "I planned those [classes] by myself, without following any teaching material. I teach my classes and I bring my own classroom activities. I like those classes more. I enjoy much more when I plan my own classes". Through the repeated use of the pronoun "I," Sol expressed her feeling of being entirely in charge of the curriculum management and not having to adapt her activities to pre-established materials. This fact transformed lesson planning for 6th grade into a more pleasant task than for 2nd grade.

During Interview 2, when we asked Sol to analyze her first year as a mathematics teacher in 6th grade, she highlighted:

> In 6th grade I felt very comfortable. I felt that I had reached the minimum expectations I had about the first year teaching. That was great […] mainly because for the next year, I can think about implementing other kinds of strategies that go beyond the simple contents I have to teach. This was what interested me the most about teaching.

In her speech, Sol connected her sense of comfort with the development of her agency as a 6th grade teacher and with the possibility of producing self-understandings in which she met her expectations for the first-year acting as a teacher. She enthusiastically projected herself into the future, bringing to her discourse part of her future memory. Thus, in her speech, Sol began to envision a new world related to teaching and learning mathematics, a world in which she could bring to the forefront her own interests when teaching mathematics. In this direction, she continued telling us about a proposal she made to other 6th grade teachers for the next year: the development of interdisciplinary projects involving modeling as a pedagogical strategy. Sol referred to her colleagues' answers with

the following words: "They told me that they were well disposed to carry out these projects. They told me: yes, next year I'll be already established at the school, and they'll allow me". In Sol's speech, she is positioned by other colleagues as a full member of the institution. This position enabled her to propose changes regarding the mathematics teaching practices established at the school. According to our analysis, Sol's teaching practice in this setting retrieved part of her future memory. In order to develop her professional identity and agency, Sol resorted to cultural discourses and practices—those related to modeling, technology, and the application of mathematics to other disciplines— stemming from her pre-service education. It is important to highlight that these discourses and practices did not remain unchanged; they acquired new meanings influenced by Sol's teaching experience over the year and by the characteristics of the school in which this experience occurred. Thus Sol orchestrated voices coming from her past and from the figured world of teaching in her school in order to author herself as a teacher and develop her agency.

Her future memory and her experience during pre-service education also emerged during Interview 1 when she recalled a conversation with her 6th grade students about imposing disciplinary sanctions:

S: The guys said to me: Do you really feel you are a teacher?
Leticia Losano: And what did you answer?
S: Erm, the truth is that I don't feel I am a teacher yet [pause] I don't know.
LL: But you are a teacher, aren't you?
S: I think so [pause] How can I express it? [pause] I feel that there are certain educational goals that I try to reach but I'm quite far of them. In that sense, I don't feel I am a real teacher [she laughs] I think that I'm still not comfortable with the way I teach, with how I am now as a teacher. When I achieve them [her goals], then I'll say: I'm a teacher. My educational goals are based on my experiences in the Mathematics Education course and during my practicum. Thinking about that, I analyze my ordinary day as a teacher. I say: I would love to do modeling in classroom, use technology, I love many things we discussed during practicum, but I know that right now I'm not achieving them [her goals]. Today when I analyze my teaching role, I analyze it according to my ideal. I formed my ideal during my practicum, during the Mathematics Education course […], during my participation in projects, in the days before I became a teacher.

With silences, laughs, and difficulties in finding the words to express her ideas, Sol articulated self-understandings as a mathematics teacher in order to answer our questions and her students' questions. Sol's words stressed the fact that professional identities are always incomplete. As Beijaard et al. (2004) pointed out, professional identities are not "only an answer to the question 'Who am I at this moment?' (…) but also an answer to the question, 'Who do I want to become?'" (p. 122). In her speech, Sol captured this future-oriented dimension of her identity with the words, "I don't feel I am a real teacher yet". In order to become a "real teacher", she felt she had to achieve her educational goals. It is at this point of her speech when her future memory emerged. She reverted to the past, bringing to her speech the teaching practices and discourses she experienced during her pre-service education that were related to modeling as a pedagogical strategy and to the use of technology in mathematics classrooms. Sol encapsulated those practices and discourses in what she called her "educational goals". Sol seemed immersed in a struggle to orchestrate these past voices and the voices that questioned her at present in a way that would enable her to bring her future memory closer to the professional identity she had

developed in her teaching. In Sol's speech, her future memory acted as a beacon that indicated the direction Sol wanted to go. Thus, the voices coming from her pre-service education were important tools for envisioning a new world related to mathematics teaching and for representing herself as a teacher inside this alternative world. In addition, these voices became tools for authoring herself as a teacher and for reviewing her daily teaching practice. Finally, those voices helped her to express her feeling of incompleteness.

Discussion

The narrative analysis reveals the complexity of the development of Sol's professional identity and agency during her first-year teaching. Considering our general research question, the narrative analysis reveals that Sol developed and negotiated ways of being and acting in a process in which:

- *She sometimes adapted to the practices and discourses established in the figured world of teaching in her school and to the identities they afforded.* During her first year as a mathematics teacher, Sol became a participant in the figured world of teaching in the school, a world historically developed through the daily participation of students, teachers, and principals. This was a socially organized world with norms and values that divided and assigned different positions to its participants. Throughout the year, Sol came to know this world and experienced the forms of participation and practices that it allowed. This figured world allowed her to organize and understand some aspects of her professional identity. In this sense, what Gresalfi and Cobb (2011) called *normative identities for teaching* seemed to play a relevant role in the development of Sol's professional identity.

- *She searched for and found gaps in which to negotiate possible new actions inside the figured world and, therefore, new ways of being.* The analysis shows how cultural resources established in the figured world of teaching can be used for positioning novice teachers as well as for improvising new ways of being and acting. In this way, Sol's improvisations sometimes involved using the same cultural artifacts which placed her in a vulnerable position in a novel way. Although small, these improvisations should not be ignored. Based on Sol's knowledge about the figured world in which she participated, these improvisations allowed her to create new solutions for problematic situations. Through these improvisations, Sol acted upon the figured world of teaching in her school, reifying novel practices, carrying out small transformations in her school, and developing her agency. According to Holland et al. (1998), such improvisations "are potential beginnings of (…) an altered identity" (p. 18).

- *She retrieved part of her future memory using practices and discourses from her pre-service education to reflect upon her daily teaching practice and project herself into new envisioned worlds.* The figured world of teaching in Sol's school was populated with multiple voices that presented challenges, ambiguities, and conflictive situations. Sol sought to actively make sense of it. In some of the episodes we reported, Sol surrendered to authoritative discourses, but in many others she began to re-orchestrate different voices, sometimes filling them with her own intentions and other times opposing to them. In this way, Sol used strategies to negotiate and develop an identity closer to her future memory. Throughout the episodes, Sol was immersed in an intense struggle to establish an *authorial stance*, that is, "a voice that over time speaks categorically and/or orchestrates the different voices in roughly comparable ways"

(Holland et al. 1998: 182). In this process, the discourses and practices stemming from Sol's pre-service education played a fundamental role.

In this way, Sol developed ways of being and acting in the figured world of teaching that on some occasions were aligned with the ways of being and acting expected in this figured world, but on many other occasions were not. Using Sfard and Prusak's (2005) notions of *actual* and *designated identities*, we can say that Sol's actual identity was not aligned with the designated identity expected by her school. We consider this a positive feature in the development of Sol's identity as a mathematics teacher, since it illustrates the scope of her reflexivity in developing new identities that contribute to refiguring the world of teaching mathematics in her school.

We consider the narrative analysis of Sol's experience during her last year of pre-service education and her first-year teaching to be significant on two levels: the *bi-directional nature* of Sol's speech and the *multi-vocal and social nature* of her identity. Regarding the first level, Sol's discourse constructs a constellation of self and others, dialogically joining conflicting practices of the figured world of teaching in her school with alternative visions of the social relationships inside this figured world. In this sense, Sol brought several actors to the episodes she narrated to us—her students, colleagues, and principals, etc.—and wove their voices together in order to speak about and reflect upon conflictive practices such as the use of workbooks, the laboratory form, disciplinary sanctions. In addition, Sol envisioned collaborative relationships between herself and her students or colleagues. In this way, we see bi-directionality in Sol's speech (Skinner et al. 2001). That is, Sol does not seek just to refashion aspects of her own professional identity with which she felt uncomfortable, but also to reconfigure the figured world of teaching in her school.

Regarding the second level, the narrative analysis stressed that from her participation in the figured world of teaching—with its norms and rules—and from the position she could enact as a newcomer, Sol daily negotiated varied, and in some cases contradictory, self-understandings about being a mathematics teacher. Such self-understandings were developed inside various settings and were contested by several participants. In addition, Sol tried to deal with the tensions between the identity she negotiated in practice and her future memory developed during pre-service education. In this way, several present and past voices participated in Sol's identity development. In our analysis, we showed examples regarding the ways Sol coped with some contradictions among the different self-understandings she developed as a mathematics teacher. On occasion she was able to resolve these contradictions while other times they remained a conflict.

Final conclusions

Our case illustrates that the first year of teaching involves important challenges for the development of novice teachers' agencies. Being a novice teacher and conceiving oneself as an agent whose acts count in, and account for, the figured world of teaching in the schools where they begin to work is not an immediate or simple process (Holland et al. 1998).

However, this case is an example of how novice teachers do not passively internalize the practices and discourses established in schools. In this way, novice teachers are not just a product of the social world of the school where they work. Moreover, our findings bring evidence to the fact that figured worlds of teaching in schools are neither finished nor

static. They are continuously being created and recreated by their participants. In this way, although sometimes novice teachers surrender to the identities afforded by the figured world of teaching in their schools, they can also develop their agency finding and creating gaps to introduce transformations. In order to introduce such transformations, they use the cultural resources established by schools or the practices and discourses embodied in the past.

Our study also shows that though the practices and discourses experienced during pre-service education are not directly transferred to teaching practices in schools, they seem to reverberate in the ways of being and acting of the novice teachers. In this sense, our work contributes to future studies about novice mathematics teachers by shedding new light on the relations between pre-service education and the development of novice teachers' professional identities. During pre-service education, early experiences, including collaborative work with other colleagues or analysis of exploratory and investigative teaching practices, help prospective teachers to develop their future memory. Such embodied practices and discourses can become important tools for novice teachers authoring and projecting themselves into the future. During the first years of teaching, these former experiences support novice teachers, allowing them to develop and negotiate ways of being and acting in schools.

We consider that our findings have implications for the development of strategies for supporting prospective teachers during pre-service education and novice teachers during immersion in schools.

Regarding pre-service education, an important emerging question is the following: What makes innovative teaching practices—presented and discussed during pre-service education—become part of prospective teachers' future memory? Our work suggests that this process can be related to the possibility of not only learning about innovative practices but also implementing innovative practices during practicum. Therefore, it is important to promote the creation of settings in which prospective teachers can implement innovative practices that they have been studying during their mathematics education undergraduate program. Such settings should help to narrow the gap between theory in the university lessons and practice in secondary school classrooms. However, the resources and possibilities of the schools strongly condition the practicum that can be carried out. In this sense, it is important that the universities and secondary schools work collaboratively in order to come to agreements on the possibility of implementing innovative teaching practices in schools and the ways in which school teachers and university teachers work together to support prospective teachers. This is an issue which is still difficult to manage in our country.

Our findings also indicate that the beginning of a teacher's career is complex and contradictory but is also a fundamental and rich period for the development of teachers' professional identities. In this way, our work suggests the need for induction programs in which novice teachers are the main protagonists that reflect upon and inquire about the tensions and struggles they experience during their first-year teaching. A promising strategy that heads in this direction is the participation of novice teachers in collaborative groups constituted by school teachers (novice or experienced) and university teachers. In these groups, the school teachers are the ones who decide the issues that will be addressed during the meetings and are the creators of their own classroom proposals. This is a strategy that we are currently exploring in our universities (Losano et al. in press; Gonçalves et al. 2014; Gama and Fiorentini 2008). We consider that such settings could help novice teachers in the following ways: to resignify the discourses and practices coming from their pre-service education in light of their teaching practice in schools; to orchestrate

the multiple and contradictory voices that addressed them, constructing, through this dialogical process, their own voices; and to envision new worlds inside the schools where they work, using such envisioned worlds for negotiating and carrying out innovative teaching practices in their classrooms.

We consider that the articulation of the theoretical notions of *figured world of teaching*, *positionality inside the school*, *teachers' space of authoring*, and *production of new worlds related to teaching mathematics* allowed us to capture two fundamental aspects of teachers' professional identities: They are always developing in a process that gathers together past, present, and future practices and discourses, and they are continuously being negotiated with different participants of the figured world of teaching. Regarding our methodological approach, the narrative analysis proved to be useful to capture the historical productions, transformations, and changes of a novice teacher that participated in the figured world of teaching mathematics. The possibility of collecting data from different moments in the teacher's trajectory allowed us to carry out a diachronic analysis. Such an analysis reveals how, over time, novice teachers resort to different past and present discourses and voices for authoring themselves and for negotiating with their colleagues ways of being and acting during their first years of teaching. In this way, we believe that our study shows that narrative analysis is an auspicious methodological tool for revealing the dialogic development of novice teachers' identities and agency.

In summary, our findings contribute to understanding that beginning teachers are involved in a complex process of identity development where three aspects converge: first, the forms of participation and the practices that are possible inside the figured world of the schools where the teacher works; second, the positions that a newcomer can claim, negotiate, and assume inside educational institutions; and third, the cultural practices and discourses embodied in the past. Our work brings to the forefront the profound and tense interactions between the intimate and personal terrain of mathematics teachers and the social and cultural world of the school where they work. In this complex landscape, novice teachers daily develop their identities in an intense interaction between their personal possibilities and the social and cultural conditions offered by their schools.

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