Contribution of Collaborative Work to Teacher Reflection and the Transformation of Pedagogical Practices of School and University Science Teachers

Contribución del trabajo colaborativo en la reflexión docente y en la transformación de las prácticas pedagógicas de profesores de ciencia escolares y universitarios

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Abstract

Poor results of science learning, both at school and university, have led us to acknowledge the need to transform our teaching. Currently, reflection and collaborative work with colleagues are conceived as being key factors in the process of the transformation of practices. Based on the experiences of a group of school and university science teachers working on action-research, we describe the contribution that collaborative work has on reflection for the transformation of practices. The main aspects are the recognition of strengths and weaknesses, listening to and learning from the experience of others, and the discussion of specific classroom practices. On the other hand, these reflections contribute to the transformation at different levels: the teacher, classroom teaching practices, and the school community. The fact that it is a diverse group that includes both school and university teachers generate enriching reflections that help to transform practices in both areas. These reflections not only benefit the school system, but also science teachers education, and provide insights on a new University-School relationship.

Keywords: teacher professional development, reflection, collaborative work, science education, action-research

Resumen

Los deficientes resultados de aprendizaje en el área de las ciencias, tanto en el ámbito escolar como universitario, nos han llevado a la necesidad de transformar nuestra enseñanza. En la actualidad, la reflexión y el trabajo colaborativo con colegas se conciben como claves en el proceso de transformación de las prácticas. A partir de la experiencia de un grupo de docentes escolares y universitarios de ciencia que realiza una investigación-acción, describimos la contribución que tiene el trabajo colaborativo sobre la reflexión para la transformación de las prácticas. Destacan aspectos como el reconocimiento de debilidades y fortalezas, el escuchar y aprender de la experiencia de otros y la discusión de prácticas concretas de aula. Por otra parte, estas reflexiones contribuyen a la transformación en diferentes niveles: del profesor, de las prácticas del docente en el aula y de la comunidad escolar. El hecho de que sea un grupo diverso, que incluye a profesores tanto del sistema escolar como universitario, genera reflexiones enriquecedoras, que ayudan a transformar las prácticas en estos dos ámbitos, beneficiando no solo al sistema escolar, sino también a la formación de profesores de ciencia, y dando luces acerca de una nueva relación universidad-escuela.

Palabras clave: desarrollo profesional docente, reflexión, trabajo colaborativo, educación en ciencias, investigación-acción

For some decades, at an international level, it has been acknowledged a «science education crisis» (Pozo & Gómez, 1998). This crisis is not just that students do not understand a set of basic scientific concepts, but also that they have serious problems in terms of their skill development and comprehension of Science as a human activity. In Chile, test results such as PISA and TIMSS, together with analysis performed by the Chilean Academy of Sciences (2005), and the high failure rates in scientific subjects at university, show that there is a serious cause for concern at all levels of education. Being recognized the fundamental role of teachers on student learning (Barber & Mourshed, 2008; Cofré, et al., 2010), one of the major causes of this crisis is the predominance of frontal and decontextualized science teaching that does not take into account the students' interests or prior knowledge. In addition to impeding the development of attitudes, knowledge and scientific skills, this has led to a lack of motivation to learn science in students, which —among other consequences— has an adverse effect on the decision to study science at university, and therefore also on the scientific and technological development of countries. This situation shows that there is an urgent need to reform science education, and, in particular, to transform teaching practices both primary/secondary and university education. But what are the conditions needed for a teacher to transform his or her practices?

Historically, and not only in Chile, the design and implementation of new educational reforms has been the responsibility of academics and public policy makers, with little teacher involvement in the process (Lang, 2007). While there have been many professional development initiatives designed to transform teaching practices, these have been mainly conducted from the top down («de arriba abajo», Muñoz & Vanni, 2008), with a central technical ministry that does the design, a regional/provincial ministry that implements the program, and a school or high school that receives the intervention without having any further influence on the process. Meanwhile, professional development opportunities are also implemented in a top-down manner, where the «expert» from the university instructs teachers on how to act, without regard to their experience and context, assigning them the role of *technicians* who will execute a task. In contrast, and in our opinion, teachers who take part in an opportunity for professional development should be considered in their *professional* role (not technical). In other words, it should be recognized that teachers are creative and able to make decisions, based on their ability to identify needs and respond with the knowledge they have acquired through both training processes and their own teaching experience.

With respect to the professional development of science teachers in particular, in 1996, Bell and Gilbert proposed a model based on a study investigating how a group of science teachers transform their teaching practices from a transmission approach to a constructivist approach (Simon & Campbell, 2012). The model shows three areas of development: personal (the teacher's feelings, motivation, availability and commitment), professional (knowledge and conceptions, as well as visualization of the practice effects on students) and social (valuing collaborative work and the work context) (Bell, 1998; Mellado, 2001). These

areas are related to each other and develop continuously and in parallel, spurred by processes of *reflection* and *collaborative work*.

There are several studies, not just in the realm of the professional development of science teachers in particular, where *teacher reflection* appears as an instrument that promotes change (Ávalos, 2011). A study done by Schnellert et al. (as cited in Ávalos, 2011), indicates that changes in teaching practices, rather than being related to years of experience, are triggered by the teachers' degree of involvement in a reflective and collaborative inquiry. Thus, teacher reflection seems to be the key factor in transforming teaching practices: a teacher who does not question and reflect upon his or her practice will not feel the need to act differently in the classroom. On the other hand, a learning community context strengthens the act of reflecting on teaching practice.

Feedback and access to new ideas and information are made possible through interaction and dialogue with others in the context of *collaborative work*, which in turn helps to create a learning culture and a community where learning is valued and stimulated (Chou, 2011). The learning of students of participant teachers is also benefitted by the work done in these communities (Vescio, Ross, & Adam, 2008). Lastly, Collaborative Action Research (CAR) is an interesting option for enhancing reflection through collaboration. CAR is understood as research done by teachers in order to understand and improve their professional practice. It is considered an effective form of teaching professional development, especially when it is performed collaboratively (Chou, 2010; Lebak & Tinsley, 2010; Ponte, 2010). The current study is part of a professional development proposal that entails collaborative action research conducted jointly by primary/secondary science teachers and university science professors. Its objectives are: (a) to understand how collaborative work contributes to the pedagogical reflection processes, aimed at transforming the teaching of the participating science teachers and (b) to analyze the scope of possible teacher transformations that facilitate the transformation of their classroom practices.

Methodology

Context and participants

This study was part of a research project that entailed the implementation of a CAR between April 2013 and April 2014[1] by a group of approximately 23 science teachers and science education professors (about 15 participants who attended regularly), distributed as follows: 14 secondary school science teachers (3 chemistry, 6 physics, 3 biology, 1 auto mechanics and 1 mathematics); 2 primary school science teachers; 4 university science and/or science education professors,[2] 4 science teachers in training[3] and 1 biologist as part of the research team. This group of teachers, of which the principal investigator and four co-investigators formed an active part, met every 15 days for 10 months (16 sessions in total, three hours each) at the university. Our initial collaborative research question was: *How do we respond to the needs of students and the local community through science education?* The sessions first focused on finding a common problem (student need) that was afflicting our teaching practices (at the three levels of education) and was related to science teaching (or in the case of teacher education, science education teaching), which together we could overcome by designing and taking actions for this purpose. After several work sessions, the group chose to address the problem of how to incorporate creativity into the classroom to enhance the use and development of scientific thinking skills. We also discussed how to link science education to the context of the student body through the use of socio-scientific issues and, when possible, how to link it to the needs of the school's community or local community. It is important to note that the focus was on a reflection on the classroom experience of *all* the teachers participating in the group, who work in different contexts (primary and secondary teachers, teacher educators and teachers in training).

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[1] For purposes of this article, the evidence was collected until April 2014. However, it should be noted that, to date, the group continues meeting every week.
[2] Of these four professors, one is a psychologist and two also work in primary or secondary schools, one as a physics teacher and the other as a primary school teacher.
[3] Final-year students of Biology and Natural Sciences Education and Physics Education.

Moreover, it should be noted that about half of the teachers participating in the group (including the researchers) belong to a teacher reflection group that has been meeting regularly since mid-2010 and has focused on investigating science teaching practices in the context of secondary education. In 2013, new teachers joined and the investigation was expanded to include primary and university education.

Source and Data analysis

This study is a single case study (the case being understood as the entire group, including the researchers). The research team in charge of the analysis presented in this article consisted of a subgroup of the participating teachers, and included: the principal investigator (university professor, teacher educator), four co-investigators (two secondary school physics teachers, one elementary school teacher and one biologist, of whom two are also university professors) and three thesis students (one biology teacher in training, and two graduate students: one a secondary school chemistry teacher and the other a psychologist and university professor). The data was collected from different sources: (a) written questionnaires and queries conducted *ad hoc* to ask participants about specific aspects of the project, in particular about the value of the collaborative work and the use of socio-scientific issues the classroom, and which were the main source for the analyses; (b) the co-investigators' notes and logs and (c) the filming of all the sessions, which served as a reference for general analysis. These sessions were viewed and comments or quotes from the participants related to the research objectives were recorded. Material from different sources was distributed among the research team, who analyzed the data using content analysis (Krippendorff, 1990). The questionnaires and queries were transcribed and analyzed using Atlas Ti software. The results of this analysis were triangulated with the contents of the notes and logs and supplemented with quotes from the session footage. Finally, the results of the analysis were presented to the entire group to verify their consistency.

Results

I greatly value these opportunities for reflection; they make me feel that what I'm doing is worth it, when I see that my students are interested and learning (P10, T-O 1[4]).

Aspects of collaborative work that impact teacher reflection

According to the group of teachers, collaborative work offers a professional space for reflection, contributing in three ways: (a) promoting self-observation of practices and the context itself; (b) expanding knowledge about the use of different teaching strategies and (c) motivating change in the teachers' own practices through peer validation. The following are the categories that arose while attempting to understand the collaborative opportunities that provoke reflection and examination of practices and their transformation:

Historical and cultural transmission. «It is a pleasant environment; ideas intersect in this reflective context. I feel I really like teaching, like I've fallen in love with my profession again» (P10, T-O 2[5]). As noted above, during 2013 new teachers joined a group that had been working together to examine their classroom practices since 2010. In a short amount of time, this new group of teachers acquired a discursive construction similar to that of the rest, even when they had characteristics that were not easily assimilated, such as sense of humor, socio-political stance, and their view of the student, the role of education and the value of experience, among others: «I will always defend the premise —and I'm not going to stray from it— that our work will be based on we have to know our students: skills, abilities, interests… it all starts there» (P16, S15[6]). For Vygotsky (as cited in Undurraga, 2007), this is related to how the group functions as an artifact of cultural transmission with specific mechanisms and devices and particularities that feed the learning of certain dynamics over others.

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[4]   P10, teacher participant code. T-O: ticket-out: reflections on a particular question that teachers write at the end of a session. So P10, T-O 1 corresponds to what the teacher P10 responded in ticket-out N° 1.
[5]   Teacher 10, ticket-out N° 2.
[6]   P16: teacher code; S: group session. I.e., this was expressed by teacher N° 16 in session N° 15.

Recognition of weaknesses and strengths in an environment of trust. «I've realized that I've felt that I don't have enough time and ended up doing the simplest thing, which is to teaching in a frontal way» (P7, T-O 2[7]). Teachers in these work sessions continuously highlighted what they were doing right or wrong in their respective practices, which generated an atmosphere of trust that allowed everyone to see both their shortcomings/strengths, enabling the teachers to face them or strengthen them, respectively. In this way, different classroom situations —including negative ones— were exposed and made clear instead of being hidden. With regard to the lack of motivation towards student learning, one teacher notes: «...so I feel like in my classes I'm failing at this. How do I awaken this desire? What need do my students have to learn science with me? Or how can I instill or create spaces where these needs are awakened? » (P6, S2[8]).

In the case of strengths, this involved a re-valuing of some practices, increasing the sense of self-efficacy, based on external recognition (by their own colleagues) of the concrete practices of the profession.

> What he did seems very important to me, because while maybe none of the children are learning biology, physics or chemistry at that moment, the interaction that was generated provokes what we have said here on this panel, that based on that activity there is a contextualization that makes everyday life not only relevant, but also improves the boy, socio-culturally speaking (P19, S11[9]).

Listen to and learn from the experience of others/take risks. «I learn about other experiences that can help me to propose other strategies and also help me question my practice» (P3, T-O 3[10]). Along with the recognition of strengths and weaknesses, the group dynamic allowed for the sharing of numerous classroom experiences. Discussing these experiences allowed participants to innovate in areas where they did not venture before, as exemplified by one teacher in the group:

> For me, what has really made an impression, when I've tried doing activities where children can build knowledge through creativity, is that sometimes I end up learning more than children, I mean, I feel so ignorant of what they actually know, because when you really leave these activities open, you realize that sometimes they know more than you think (P6, S6[11]).

It appears that the above occurs primarily with less experienced teachers who have no chance to share their experiences with other teachers in their same department in the school. Thus it is the group that validates and recognizes what the teachers do in practice as an innovation, by coming together and agreeing on certain strategies to examine together. Similarly, listening to colleagues produces a greater sense of confidence, which contributes to the valuing of one's own experience: «I also believe that here I've learned to appreciate that the experiences or ideas that we have are really valuable to us as teachers» (P10, S15[12]) and having more confidence in the work itself: «Working in this group creates a feeling of support at the personal level» (P1, S15[13]).

Explanation and discussion of the practices. «Collaborative work allows us to work together and get new ideas and visions for classes. It allowed me to see how my colleagues address different problems and what solutions they find, and to analyze their results and their different applications» (P20, T-O 4[14]).

One element that was present in all of the sessions was the writing and/or analysis of «classroom stories», i.e. a written account of the activities that each teacher implements in his or her classroom, accompanied by reflections on the results of these activities.

Teachers saw these classroom accounts as another style of teacher reflection that allowed them to share and be aware of their actions. In addition, the data they were able to extract from their practices led to an awareness of how posing a problem and seeking a solution requires evidence and certain scientific rigor, which helps them professionalize the investigation of their own practices:

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[7]   Teacher 7, ticket-out No. 2.
[8]   Teacher 6, session 2.
[9]   Teacher 19, session 11.
[10]   Teacher 3, ticket-out 3.
[11]   Teacher 6, session 6.
[12]   Teacher 10, session 15.
[13]   Teacher 1, session 15.
[14]   Teacher 20, ticket-out 4.

It is important to see that teachers actually have evidence... I mean, this isn't a situation that we can't get anything out of. I think that having the fact, the simple fact that the teacher notes what is recorded in the notebook, that's pretty strong evidence, independent of the situation that you're in (…) When there is a problematic situation we want to look at, we have the evidence, perhaps the only thing we could try is to see if there is a way to find more evidence (P4, S3[15]).

The impact of reflection: teachers' transformation and his or her practices

From the teacher's point of view as a *professional* (and not as a *technician* who repeats or implements proposals of external experts), the transformation of teaching practice is accompanied by a profound transformation of the teacher and his or her beliefs and attitudes, as one teacher in the group says: «… this has made me understand, or re-understand, that science teaching should encourage the thinking (of) the students and help them to develop... » (P7, CSC[16]). Also, on a personal level, teachers have been able to strengthen less conservative beliefs and ideas about teaching thanks to the collaborative work: «I've managed to bring together certain elements that maybe I wasn't so sure about, because there has been a high level of interaction with my peers...» (P4, CSC[17]). Furthermore, this collaborative thinking has enabled the start of transformations in the communities where the teachers work. The different levels of transformation are described below.

Teacher transformation. This area is where the biggest transformations can be seen. The analysis of this aspect was done using the areas proposed by Bell (1998) for teaching development in science teachers: *professional* (knowledge and conceptions, as well as visualization of practice effects on students), *social* (valuing collaborative work and the work context) and *personal* (feelings, motivation, availability and teacher's commitment) (Mellado, 2001).

Professional development.
Now I've gotten the urge to improve as a teacher; before I was used to always doing the same thing and I didn't dare to innovate. Now I've tried to introduce creativity into the classroom by giving my students challenges and seeing how they are able to handle them in the classroom (P11, T-O 4[18]).

Teachers report having more tools to better inform their practices in this area: «...I'm always thinking about and questioning my teaching methodology, so that the way in which I convey the message is different and really sticks with the students» (P7, T-O 1[19]). Teachers are exposed to a greater variety of teaching strategies, report having made a change in teacher/student roles, and in some cases, deepen their disciplinary knowledge. Similarly, they are more focused on what happens with their students:

…The issue is that here at the university we believe that things should work; there is a laboratory and they should learn. The thing is that maybe this type of laboratory is not the type that allows students to learn (P3, S2[20]).

Social development.
More than a new reflection, it was like it sparked a conviction that I held implicitly, which is now explicit: the meaning we ultimately give to science teaching. I realized that this goal/meaning must be to transform society (P1, T-O 3[21]).

Collectively redefining the goals of science education, moving from a content-focused vision to the concept of 'scientific literacy,' leads to changes in the teachers' professional identity. Similarly, they value the sharing of classroom experiences and begin to view collaborative work as essential to the task of teaching, extending it their communities: «The contribution [of collaborative work] can be found in the different stages and factors in the teaching and learning process. For example, activities, plans, etc. » (P9, T-O 3[22]).

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[15] Teacher 4, session 3.
[16] Teacher 7, Questionnaire on the Use of Socio-Scientific Issues (CSC - Cuestionario sobre el Uso de Cuestiones Sociocientíficas).
[17] Teacher 4, Questionnaire on the Use of Socio-Scientific Issues (CSC - Cuestionario sobre el Uso de Cuestiones Sociocientíficas).
[18] Teacher 11, ticket-out 4.
[19] Teacher 7, ticket-out 1.
[20] Teacher 3, session 2.
[21] Teacher 1, ticket-out 3.
[22] Teacher 9, ticket-out 3.

What we have done is to reflect on our own practice and the problems each of us face in our own facilities (...) this group of people who come together to think about these issues helps you better address these difficulties, by looking at them with a more open philosophy (P17, S1[23]).

Personal development. «My view on teaching has changed. Now I take into account elements like the development of student activities for learning. Centering 'teaching' on 'learning'» (P7, T-O 7[24]). Overall, it was possible to see a greater degree of reflection, inspired by a deeper questioning of practices, as seen in the questions of one teacher examining the strategies we addressed: «...what is the question? What is the right question that I should ask about skills to better deal with this thing that I'm not realizing?» (P3, S4[25]). The result is a greater awareness of the teaching act, a more attentive observation of what happens in the classroom and a greater awareness of the student development level:

…One thing I can do is «share control» with the students, that is, make room for the possibility of them co-constructing the class with me. For example, working together to create criteria for evaluating a project. I think that this also helps creativity (although I don't know if it helps scientific creativity, specifically) (P1, T-O 4[26]).

Similarly, teachers display a more positive and confident attitude regarding their practices, a greater willingness to improve, better themselves and stay up-to-date, increased willingness to listen to their students and greater self-confidence, which is expressed in a greater willingness to take risks and take on challenges. This is illustrated by one teacher, who decides to ask to use the laboratory for an adult course:

I was able to do activities where they could apply their creativity, maybe something simple, an electrical circuit, but in the end they were thankful for it, they were so happy. Maybe it's the first time they used the laboratory, as the adult group. Maybe if I hadn't been [in this group], I wouldn't have ever thought to speak up and ask for use of the laboratory (P12, S16[27]).

Lastly, it is possible to see some changes in relation to certain beliefs about teaching, where the focus is more on the student and less on the teacher.

Classroom practice transformation.

I have been working in the same school for three years and I was stuck in a rut, always the same thing, and it was a chance to say: «No, I have to break through, break this barrier and do something different», which for me worked really well with my students. It was a really nice opportunity they gave me and I'm very grateful for it (P11, S16[28]).

Teachers recognize, to a greater or lesser degree, a transformation of their practices through elements such as the use of new strategies in the classroom, which may include the use of ICT, group work and strategies designed to promote creativity, among others, which should be accompanied by new forms of assessment: «...more than questioning, new challenges. For example, how do you assess creativity? » (P16, T-O 2[29]). In addition, they modify their lesson plans and redefine the curriculum based on the students' contexts: «I've focused my work on making students think about different things that provide insight into science based on the everyday experience. Also, I've focused more on skills and not just on content» (P7, T-O 2[30]). All these changes in the classroom have an impact on students:

The participation of children in fifth and sixth grade has changed significantly; I'm not there giving, instead I'm receiving, and that helps me reformulate the class. Sometimes I have everything I'm going to do written down, but in fact, it changes, we have other really interesting experiences, and I make room for that (P10, S15[31]).

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[23] Teacher 17, session 1.
[24] Teacher 7, ticket-out 7.
[25] Teacher 3, session 4.
[26] Teacher 1, ticket-out 4.
[27] Teacher 12, session 16.
[28] Teacher 11, session 16.
[29] Teacher 16, ticket-out 2.
[30] Teacher 7, ticket-out 2.
[31] Teacher 10, session 15.

Community transformation. «I think that I have to motivate my colleagues, to carry out some given activity, and also my close colleagues who have time, or give them work ideas» (P10, T-O 6[32]). Several teachers said they have fostered instances of collaborative work with other colleagues in their educational institutions:

> Within the two places where I teach classes there are no formal opportunities; however, teachers (from different areas) got together and started doing some things together, helping with classes and acting *in block*, in terms of using common strategies (P4, T-O 1[33]).

An example of this is that one of the teachers (P5) began inviting colleagues to create a community notice board in order to contextualize, disseminate and integrate learning from different disciplines. This community board demonstrates to the school directors the teachers' effectiveness and proactivity when conducting interdisciplinary activities. After this success, the teacher proposes to the directors the idea of holding reflection sessions to address educational issues. The proposal was well received and started being implemented periodically. In this case, the teacher's process of enrichment in his personal and collaborative reflection is so significant that he recognizes how it has affected not only his professional area, but also his conceptions about teaching. This reflection can motivate and convince colleagues and school directors to engage in interdisciplinary reflection activities in order to improve their practices. Similarly, other teachers have gotten the school community involved in local community issues, such as the pollution from a nearby river and the rescue of an endangered plant species. Lastly, changes are also being generated in university education. The participating university professors shared their experience in the group, such as the use of learning evidence and the discussion about their own practices, with other university colleagues.

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[32] Teacher 10, ticket-out 6.
[33] Teacher 4, ticket-out 1.

Discussion

Collaborative work, in the framework of a professional development process in the form of a CAR, «actively engages teachers in professional reflection, validates educators as producers of knowledge and recognizes their role in professional development and decision making» (Burbank & Kauchak, 2003, p. 499), which, in our experience, contributed to the transformation of the pedagogical practices of the participating science teachers. As Vescio, Ross and Adam (2008) state, through collaborative inquiry teachers explore new ideas and review their current practices and student learning evidence, using processes that respect them as experts in determining what is necessary to improve their practice and improve student learning, thus encouraging them to connect their professional, academic and personal knowledge and of their colleagues (Ponte, 2010).

This collaborative research entailed a formalized and systematic process of reflection on the personal practices of the participating teachers, who were able to consciously structure situations and problems (and they believe it is important to do so), used certain standard questions in structuring their experiences (for example: What happened? Why? What did I do wrong?), could easily respond when asked what they wanted to learn and were able to describe and analyze their own performance in interpersonal relationships, which according to Korthagen and Wubbels (2001) is the part of teacher thought that is defined as *reflective*. Combining present events with a thoughtful approach leads teachers to change the basis of their thinking, moving from anecdotes towards critical professional thinking, from routine or habitual action -often intuitive- towards an action based on self-assessment and greater social, cultural and political awareness as well as greater flexibility and creativity (Mitchell, Reilly, & Logue, 2009). Similarly, during the process of collaborative action research, one can observe a development of knowledge about the educational context that becomes crucial for understanding and awareness in the teaching process, as demonstrated in the various moments of reality recognition in the schools and institutions of the participating teachers. Similarly, one can see a strong influence of what could be called *affective aspects*, such as personal beliefs about self-efficacy gained or developed during the collaborative process (Garritz, 2010; Park & Oliver, 2008).

As a result, teachers begin to modify their practices to be more student-focused, increasing collaboration, empowerment and continuous learning (Vescio et al., 2008), contributing to the construction of teachers' knowledge and self-confidence (Chou, 2010). In the case of our research, there was also a redefining of the meaning of science teaching, or in Bell's words (1998, p. 683): «the reconstruction of our collective understanding of what it means to be a science teacher», which is a first step towards innovation of practices (Bell, 1998).

Finally, one of the most interesting aspects of the project is that collaborative inquiry allowed for a bridge between theory and practice to be established. It did so by promoting the use of the teachers' tacit knowledge to collaboratively identify and implement strategies to address pedagogical issues, which, when combined with formal knowledge (such as that found in the literature), fostered the improvement of education (Albers, 2008). For those of us in the group who also work in initial/ongoing teacher education and investigate the nature of the professional development of science teachers, participation in the group offered us a special opportunity to make this connection between theory and practice. While there are numerous studies about the nature of teachers' beliefs, knowledge and practices that are aimed at understanding the factors that help to improve the quality of science teaching, these are mostly conducted by external researchers and the teachers participating are not necessarily the ones promoting the research (Loughran, 2007). This changes when teachers themselves are investigating their own practices in diverse contexts. The fact that we ourselves are both objects and subjects of the research, and the act of sharing our university, primary/secondary school and teacher education practices at the same level, allowed us to gain a broader view of what is involved in the teacher training process, including our own process of learning to teach.

Finally, we predict that:

…The day will come that collaboration between academics and the classroom teacher will be a commonplace in the science teaching profession. The hope is that both groups can work together, so that research and practice influence one another in meaningful ways (McGoey & Ross, 1999, p. 120, as cited in Loughran, 2007, p. 1055).

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