Chapter 5
Fitting Lesson Study to the Portuguese Context

João Pedro da Ponte, Marisa Quaresma, Joana Mata-Pereira and Mónica Baptista

Abstract The adaptation of lesson study to different national contexts raises problems that are attracting the attention of researchers. In this chapter, we show how we have conducted lesson study in Portugal, taking into account the national educational context and our perspective on the teaching of mathematics, the exploratory mathematics curriculum approach, with particular attention on the development of students' mathematical reasoning. We present two examples of lesson study, one conducted with in-service teachers of grades 5–6 and another in initial teacher education with prospective teachers of grades 7–12. We reflect on what we have identified as the main obstacles to the realization of lesson study in these contexts due to cultural factors and teachers' concerns. We conclude with a summary of the adaptations that we have made in this teacher education process, with a view to the suitability and potential of lesson study in our country.

Keywords Lesson study · Professional development · Initial mathematics teacher education · In-service mathematics teacher education

5.1 Introduction

There is, nowadays, an active international movement concerning lesson study, centering around WALS (World Association of Lesson Studies), its well-attended international meetings (the last one at Exeter, United Kingdom, in September 2017)

J. P. da Ponte (✉) · M. Quaresma · J. Mata-Pereira · M. Baptista
Instituto de Educação, Universidade de Lisboa, Lisboa, Portugal
e-mail: jpponte@ie.ulisboa.pt

M. Quaresma
e-mail: mq@campus.ul.pt

J. Mata-Pereira
e-mail: joanamatapereira@campus.ul.pt

M. Baptista
e-mail: mbaptista@ie.ulisboa.pt

M. Quaresma et al. (eds.), *Mathematics Lesson Study Around the World*,
ICME-13 Monographs, https://doi.org/10.1007/978-3-319-75696-7_5

and its specialized journals (notably the *International Journal of Lesson and Learning Studies*). Originating in Japan, where lesson study assumes an important role in professional development and in the introduction of curriculum innovations (Takahashi & McDougal, 2014), this model has become well known in the United States and all over the world since the publication of *The teaching gap* (Stigler & Hiebert, 1999).

The positive discourse about lesson study tends to hide the fact that this is a demanding process. In fact, its dissemination across different countries has shown that planning and conducting lesson study may become problematic in many situations. Japanese authors such as Fujii (2014) claim that the introduction of lesson study in a number of countries has been based on misconceptions of how it is practiced in Japan. However, we must note that even in Japan there are quite diverse practices regarding lesson study, depending on the entities that promote them (schools, regional, national bodies, associations) and on its purpose (professional development of a group of teachers or demonstration "jumping in" lesson by a veteran teacher) (Fujii, 2016). From Japan to other countries, many transposition difficulties derive from deep differences in educational systems and in the teachers' professional culture. In addition, in Japan lesson study is a generalized practice, carried out in a large scale with the support of the educational authorities, whereas in many other countries it is a marginal practice, undertaken only in small scale, and mostly in an exploratory way.

Without downplaying the import of investigating the ways in which lesson study is carried out in Japan, we are mostly concerned in knowing how this professional development process may be adapted to the Portuguese context in a productive way, especially in mathematics education. As Stigler and Hiebert (2016) note, a given cultural practice (in this case, a practice of teacher education), that originated in a given culture, may enjoy a wider diffusion in other cultures, but must undergo an inevitable process of transformation and adaptation given the specific features of the different cultural contexts. In this process, many significant aspects of the original cultural practice may be lost, but other aspects may emerge, yielding robust and flexible practices in the new environment. This is our concern in Portugal, were the first lesson study experience was carried out by our group in 2011. In this paper, we seek to provide an account of the main adaptations that we have undertaken within lesson study that we conducted, taking into consideration the concerns and interests of Portuguese teachers, as well as our own perspectives about mathematics teaching.

5.2 Lesson Study as a Professional Development Process

5.2.1 Main Features of Lesson Study

Lesson study has been the object of many descriptions, often non coincident (Fuji, 2014; Lewis, 2002; Lewis, Perry, & Hurd, 2009; Murata, 2011). In a general way,

in lesson study, a group of teachers work together, beginning by identifying difficulties that students usually have in a given topic or issue related to a curriculum aim. Then, they prepare a lesson that may provide an important contribution to overcome those difficulties. In order to do this, they read the curriculum guidelines and review the available teaching strategies and materials regarding the chosen topic or issue.[1] They also make a diagnosis, as precise as possible, of students' prior knowledge and foreseeable difficulties and seek to know the results of related research on this topic. Based on these activities, the group prepares, in great detail, a lesson on the given topic or issue. The lesson, termed a "research lesson", is taught by one of the teachers and observed by the remaining teachers who focus their attention in the work of the students, their strategies and difficulties, and not in the activity of the teacher. Afterwards, the group of teachers carries out a joint reflection about the way the students worked, the processes that they used in solving the tasks, the responses that they gave to the teachers' questions, and any difficulties that they displayed. Sometimes, the teachers write their reflections and share them with other teachers in the school or at professional meetings. In this process, the teachers define an issue to inquire, work with curriculum documents and materials, collect data from their students, carefully analyze and interpret quite diverse information that is relevant to teaching and learning the chosen topic, and seek to systematize and report on their conclusions. Therefore, this is a process very close to a small-scale research carried out on teachers' professional practice, in a collaborative context (Ponte, 2008). At first glance, this may resemble the "classroom observations" carried out in teacher education during the practicum or in teacher evaluation processes. However, there is a substantial difference that in lesson study the main focus of observation is not the teacher's actions, but the work of the students. This is in line with the lesson study aim to understand how students' learning develops.

5.2.2 *Lesson Study in the Portuguese Context*

Our team at the Instituto de Educação (IE) of the Universidade de Lisboa, whose core group is the four authors of this chapter, has pioneered lesson study in our country. Our work as mainly a research purpose. We seek to understand what teachers learn in this professional development process and also to identify the characteristics of lesson study that may underpin its value in providing learning opportunities for teachers. Usually, we invite a group of teachers of a school to get involved in a lesson study. The first two groups with whom we conducted lesson study were made of teachers who participated in the Project "More School Success" of the Ministry of Education, from two schools in the region of Lisbon, one in a

[1]How this preparation may be carried out is presented in Ponte, Quaresma and Mata-Pereira (2015).

nearby suburb and another in a rural region 70 km away. We already had an ongoing working relationship with the teachers from these schools which was important for them to trust our proposal. One group comprised grade 4 teachers and another group grade 7 teachers. Two years later we made another invitation to three more groups of teachers from another school in Lisbon, one for grade 3, another for grade 5 and another for grade 7. This invitation was made in response to a request of support from the principal of the school, to support their own project of improving mathematics learning. Later we carried out a lesson study in initial mathematics teacher education, with activities undertaken in another school in Lisbon. In every case, the leadership of the lesson study group was assumed by our team, albeit seeking to value the role of the local leaderships that already existed in the participating groups of practicing teachers. Usually, one of the members of our team had the responsibility to conduct and facilitate the lesson study sessions. The other members of the university team participated as observers and, sometimes, they also provided contributions for the development of the session. The whole team prepared the structure and content of each session and carried out an ongoing reflection. We made video or audio recordings of all sessions and transcribed them. A member of our team kept a research journal describing the main aspects of each session as well as some initial reflections, with the entries receiving comments from the other team members. During the conduction of the research lesson, all teachers in the lesson study group, of our university team, and a special guest (for example, the deputy principal of the school) also participated as observers. In this chapter, we refer to two cases of lesson study, whose participants we will present later, drawing on data from working sessions and participants' interviews.

Common to each of the lesson studies that we carried out, was the strong attention that we gave to the planning phase, including the preparation of the research lesson. The lesson study group analyzed the key concepts involved in the topic identified for study, as well as the tasks suggested to be proposed to the students, seeking to identify all their possible difficulties in solving them. This practice involves the undertaking of significant mathematical work in solving tasks that, sometimes, involve some degree of challenge for the teachers. It also involves significant work in terms of mathematics teaching, with in-depth discussion of teaching and learning issues. As it is usually done in lesson study, this planning takes into account the curriculum guidelines and the results of previous research concerning students' learning in the given topic. An important element of this planning is the diagnosis of students' prior knowledge and difficulties, notably in concepts related to the topic. The final part of this preparation phase is the actual construction of the research lesson, with strong attention to the formulation of the task that will be proposed to students. This construction involves the detailed planning of the flow of the lesson, including the identification of students' foreseen responses, teachers' actions, and indications for assessment.

Underlying each lesson study that we have carried out, as the main curriculum perspective, is an exploratory approach (Ponte, 2005), widely disseminated in Portugal with the former 2007 Mathematics Curriculum (Ministério da Educação, 2007). In this approach, students work on tasks in which they have to construct their

own solution strategies, using, with flexibility, different mathematical representations. Different from the usual classroom, in which the teacher begins by presenting mathematical concepts, representations, and procedures, showing examples and assigning exercises for practice,[2] in the exploratory approach the teacher proposes the students tasks that lead them to develop mathematical knowledge. Usually, the exploratory lesson develops in three phases: (i) launching the task, which may involve some negotiation of meanings and discussion of contextual elements, (ii) students' autonomous work, individually, in pairs, or in small groups, and (iii) discussion, with students presenting their solutions, contrasting with each other, and ending with a summary of the most important aspects to learn from the work carried out.[3]

This approach has two main features: the choice of appropriate tasks and the establishment of stimulating a classroom communication environment. Such environment must support students' participation and reflection, both during students' autonomous work in which they interact with their colleagues and in the whole class discussions, and value negotiation of meanings and argumentation. This approach emphasizes the construction of concepts, the modeling of situations and, also, the use of definitions and properties of mathematical objects to arrive at conclusions. It pays attention to computational aspects of mathematics, but does not neglect the conceptual aspects. The message to students is that it is important to achieve a correct mathematical answer, but even more important is to understand general strategy that was used and its justification. Given the key role that it gives to students in the process of knowledge construction, this approach shares some resemblance to what some authors call "inquiry-based mathematics teaching" (Artigue & Blomhøj, 2013), "guided reinvention" (Gravemeijer, 2005), "landscapes for investigation" (Skovsmose, 2001), "reform mathematics" (Cobb & McClain, 2006) or "structured problem solving" (Fujii, 2016).

Another important aspect of teachers' participation in these lesson study groups is their attention to students' mathematical reasoning (Lannin, Ellis, & Elliot, 2011), especially in what concerns the realization of conjectures and generalizations (inductive and abductive reasoning) and justifications using mathematical properties, definitions and representations (deductive reasoning) (Mata-Pereira & Ponte, 2012). This attention is enacted during lesson study planning and reflection sessions, through focusing on and analyzing the tasks and the examples of students' work (solutions of tasks and transcripts of discussion episodes) that involve reasoning processes.

[2]This is often termed as "traditional teaching" (as in Skovsmose, 2001). However, this expression conveys the idea that all past teaching followed this approach, which is an undue oversimplification. That is why we prefer, aligning with Fitzgerald and Bouck (1993), to term this as "direct teaching".

[3]This is similar to what some Japanese, such as Fujii (2016), describes as a typical problem solving lesson, with the difference that we include the discussion and synthesis, since often there is no clear division between these two lesson elements.

5.3 A Lesson Study with In-Service Teachers

Our first example of a lesson study carried out in Portugal involved grades 5–6 in-service teachers of a school in Lisbon in 2013–2014. From these teachers, three taught at grade 5 and two at grade 6. Three of the teachers (which we name with the pseudonyms Francisca, Inês, and Maria) had a very large experience (more than 35 years of teaching practice) and were tenured in the school. The other two teachers (Luísa and Tânia) had also a significant experience (about 10–15 years of teaching practice) but had just annual contracts. This lesson study involved 12 sessions and was certified as an official professional development program accredited by the national agency for teacher education with 25 h of face to face work.[4] We strived to adjust the lesson study to these national requirements so that the teachers could have an official certificate stating that they completed a recognized professional development program.

The year in which this lesson study took place corresponded to the introduction of a new mathematics curriculum in grade 5. This grade was selected for the lesson study. In session 1, despite the fact that they had been informed about the purpose and nature of lesson study, the teachers showed concern about this format of professional development. Finally, they accepted to participate. After considering several possibilities, the teachers chose to address the topic of comparing rational numbers. This topic was quite familiar to several members of our team, so it was possible to easily locate many tasks and materials to explore in the working sessions. Therefore, solving mathematical tasks and analyzing students' responses to those tasks (available from previous research) was an important activity in several sessions. The diagnosis of students' previous knowledge was also an important part of the work undertaken by the lesson study group, and was tackled in two sessions, first in preparing it, designing a small test (session 3), and after in the analysis of the students' responses in the classes of the three grade 5 teachers who were involved in this lesson study (session 4).

The decision of who would conduct the research lesson was made in session 5 and was another rather difficult moment in the group. Two teachers could not be considered for this role since they did not teach grade 5. The two tenured teachers that taught this grade refused that role. One of them argued that her pupils had not a proper behavior and the other that, as she said, she did not want to assume the condition of a teacher "under evaluation". After some negotiation in the session, it was decided that the class would be conducted by Luísa, a contracted teacher, who was the only other grade 5 teacher remaining. In the session, Luísa expressed some uneasiness with the situation, but her unease was in part resolved in this session and the next as the detailed planning of the class progressed. The student task incorporated in the research lesson was prepared under the leadership of Luísa, and ended up as a worksheet with three questions, each one with several sub-questions.

[4]Additional information about this lesson study, with focus on participant teachers' professional learning may be found in Ponte, Quaresma, Baptista and Mata-Pereira (2014) and Ponte, Quaresma, Mata-Pereira and Baptista (2015a).

After six planning sessions, the research lesson was conducted in session 7 and the post-lesson discussion was held in session 8.

An interesting aspect of this lesson study were the follow-up sessions (sessions 9–12). These sessions were first established to comply with the 25 h of duration required for officially accredited professional development programs, but turned out to be very interesting working moments. In these sessions, the five teachers prepared new tasks according to the ideas discussed during the former sessions of the lesson study to take to their classes, proposed these tasks to their students, and reported their reflections about the experiences carried out. As a consequence, in these final sessions there was wide opportunity to review and systematize many issues of professional practice identified in the initial sessions.

At the end of the last session, the participating teachers and the members of our team made jointly a global reflection regarding all the activity. We recalled the work carried out in each session and asked the teachers what they thought about it, in particular if they found it should be maintained or dismissed in a future lesson study. The teachers spoke of their experience, justifying their opinions.

The first point addressed was teachers' initial difficulty in understanding this model of professional development. All of them reported that they were expecting something quite different. Maria indicated that she did not understood how they would "lose all that time, to prepare a single lesson." Luísa said that she expected that "several topics could be tackled." Francisca stated that she would have preferred to work on geometry. Tânia indicated her initial disappointment because, contrarily to what was proposed, she felt the need to analyze the new curriculum guidelines for several topics.

After the lesson study, we asked the teachers if their investment in this professional development activity had been worthwhile. All of them responded in an affirmative way and mainly highlighted the joint work that they had carried out. Regarding this, Francisca said:

> Throughout the sessions we were seeing that this is really productive and that we learned to work in a collaborative way. For me, that was sufficient. This is so, that the teachers of our mathematics group, in this moment, are able to speak with each other with no barriers. I think that is added-value. For me, this aspect was the important one, we begun working as group.

We also questioned the teachers about how they viewed the activity of solving mathematical tasks. Maria indicated that she enjoyed being challenged and solving tasks that required her to think and have a living relationship with mathematics:

> Sometimes we ended up quite limited and if there is a new thing that forces us to think a little further, to go beyond 2×3, that is motivating. For me, it is motivating. I still design the grade 9 exam papers … Sometimes I need a little more mathematics, and I think that these sessions helped us with that.

Afterwards, we addressed the importance of the undertaking of the diagnosis of students' prior knowledge about the topic. The teachers indicated that this phase of the lesson study led to an important discussion about students' knowledge and also referred to their surprise about what the students could do, which was quite beyond

their initial expectations. Maria also reported that they were doing less of these diagnostic activities than they did in the past and that the lesson study allowed them to reflect on their need.

We also asked the teachers about the work carried out in analyzing the nature of tasks and students' mathematical reasoning. Tânia considered that this activity was important. She recognized that many students are able to carry out reasoning processes, such as generalizing and justifying, and criticized teachers for focusing too much on students with difficulties and putting unnecessary limits to the degree of challenge in questions posed to studens:

> I think this is useful, since … We have to enlarge the scope and, it is what we say, we have students that will be doing the exercises, exercise after exercise, but we also have to think that there are students that are able to do much more than that, and we do not have to just think about those that have more difficulties. Often we have classes in which students can do generalizations and justifications.

We also asked the teachers to reflect on the planning, the research lesson, and the post-lesson reflection. The teachers indicated that research lesson was a bit disappointing since the students' responses did not match their expectations and there was no time for the students to carry out all the questions proposed in the task. However, they indicated that there were also interesting student solutions to reflect on. The teachers focused particularly on these in the post-lesson reflection:

> It was helpful to all of us, since we could verify that when we are in a classroom situation sometimes things do not run as well as we expect. And in other issues, the kids surprise us with the solutions that they present … I think it was an interesting class… Different from usual… (Francisca)

Francisca highlighted the unforeseeable nature of the lesson events and mentioned the way that the students often surprise teachers with their solutions. We must note the positive way in which she speaks of the work of the students, which is quite different from her discourse in session 4, when she analyzed the results of the diagnostic test and focused mostly on their difficulties and mistakes.

For Francisca and Luísa, recognizing the value of whole class discussion was a major learning event which occurred during lesson study. This was echoed by their colleague Maria:

> We did not have the time to do everything in the board, but when they explained how they had got there… I think that it is always… Moreover, this was one of the things that I learned in this professional development: We need to bore the kids to death to make them explain how they thought … Now they explain everything bit after bit, and explain in detail. I think that was what this professional development brought to me…

Concerning the four follow-up sessions after the research lesson, the teachers reported that they could put into practice the learning discussed in the lesson study sessions in their own classes:

> I think that is the logical way. Because … This was not just rational numbers, we had rational numbers in the background and we were working more things and we applied now what we learned in the research lesson. We were seeing the possible difficulties, each one

> chose the expressions more adjusted to her classes to verify something… What I think is essential and that we all learned was the discussion. The discussion with our students is the key point of all of this. (Francisca)

Tânia referred that the joint preparation of the classes with her colleagues in the follow-up sessions allowed them to diversify tasks and Maria highlighted the importance of group work and sharing:

> Anyway, just to finish, I wanted to say one more thing: I think that all teachers should participate in a lesson study. Once in their life they should have the opportunity to prepare a lesson in this way, because it is really a different experience and leaves many small things that we take from one session, from another session, still from another session. And then, other thing from these sessions, is listening to other people … I like this interaction with people. Therefore, lesson study for all teachers!…

In their reflection, the teachers put a special value on whole class discussions. They also highlighted the collaborative work and the opportunity to become a working group that included the new teachers at the school, Luísa and Tânia. They pointed out solving mathematical tasks and exploring themes such as the nature of tasks and students' reasoning processes as the main factors that led them to get involved in the work.

In summary, despite some difficult moments in the beginning of the lesson study and in choosing the teacher to conduct the research lesson, the participants recognize its value as a professional learning experience. This includes knowing about the value of different kinds of tasks, looking at students' prior knowledge and difficulties with important concepts, valuing students' strategies for solving problems, generalizations and justifications. The teachers especially note the value of conducting the classroom following an exploratory approach, with emphasis on whole class discussions in fostering students' learning.

Other lesson study experiences that we carried out with in-service teachers followed a similar format, except for the follow-up sessions that only occurred in the three lesson study carried out in the Lisbon school. A very important characteristic of our work with in-service teachers is its collaborative nature (Hargreaves, 1998). As we address teaching and learning issues in lesson studies, focusing on students' learning, we strive to encourage teachers to collaborate with one another both in the working sessions and in small tasks carried out between sessions. We also strive to establish a collaborative relationship between the members of our team, especially the person responsible for leading the sessions, and the participating teachers, and this is recognized by the participating teachers in their reflections.

5.4 A Lesson Study in Initial Teacher Education

We now turn to lesson study carried out in initial teacher education, for prospective mathematics teachers of grades 7–9 and 10–12 that was carried out as part of a fieldwork course of the second semester. The participants in this study were seven

prospective teachers undertaking a Master's of teaching program,[5] the cooperating teacher from a school,[6] and three members of our team. Taking into account the school activities of the cooperating teacher, the lesson study took place in a grade 7 class composed of weak and very weak students.[7] The topic for this lesson study was 'similarity of triangles', which was chosen to take into account the general planning that our team had made for the different phases of the process, the annual subject planning of the cooperating teacher, the pace of her classes, and also the fact that this is a topic in which the students usually face serious learning difficulties.[8]

Taking into account that there were seven prospective teachers involved in this lesson study, it was decided to carry out a process which would involve two research lessons, taking place as consecutive lessons of the cooperating teacher. The lesson study sessions were led by one of the members of our team, who was also the instructor of the university fieldwork course in which the lesson study took place. The two research lessons were taught by the cooperating teacher. This was decided on the grounds that with course time constraints, it was not possible for all prospective teachers to conduct a separate lesson and this would provide an unfair opportunity for some of them. Another reason to make that decision was due to the fact that these prospective teachers were still in an initial stage of their teacher education program, and we considered that they were not adequately prepared to assume the role of conducting the class. So, the prospective teachers were involved in all stages of the planning and reflection process and played the role of observers in the lesson. The prospective teachers were informed that they would participate in the lesson study as part of this course. They had a positive stance but also showed some concern in informal conversations just before or at the end of the session that the time spent in the lesson study could prevent them from doing other activities that could be important in their preparation. As the lesson study progressed they met with all assignments that were established from one session to the next and at the end of the course, but sometimes complained that they were getting too much work to do and that they had several other courses also to attend to.

After an initial presentation of the whole process, the first sessions of the lesson study were dedicated to a deep analysis of the current curriculum guidelines for the study of similar figures and, most especially, of similar triangles. The prospective teachers compared different approaches from textbooks and solved several

[5]This is a professionally oriented degree, that prospective teachers may apply to after they completed a three year bachelors' degree in mathematics or with a strong mathematics component (at least equivalent to two years of study in mathematics).

[6]In fieldwork activities in initial teacher education, the school cooperating teacher receives the prospective teachers in his/her class and carries out activities with them according to a plan established with the university supervisor. This supervisor often participates in the fieldwork activities together with the prospective teachers.

[7]Most of these students had failed one or more years and were behind the expected grade level for their age.

[8]Additional information about this lesson study, highlighting professional learning of the participating prospective teachers may be found in Ponte, Quaresma, Mata-Pereira and Baptista (2015b).

mathematical tasks involving similar triangles, many of which were selected by them and brought to the working sessions. They discussed the characteristics of those tasks and analyzed the possible students' difficulties. As it happens with all our lesson studies, this corresponded to a rather deep mathematical work (analyzing several definitions and approaches to similarity and identifying connections with other topics) as well as didactical work (analyzing different kinds of task that may be proposed to students). The planning was carried out jointly by all participants, in sessions that took place in the university and also in the school, with strong participation from the cooperating teacher.

Two consecutive research lessons were then planned—we called this feature a "double research lesson". The first aimed to introduce the concept of similarity to students and to encourage them to formulate the criteria for similarity of triangles by themselves. The second lesson aimed to promote students' capacity to solve problems using these criteria. The prospective teachers were divided into two groups and all of them observed the two lessons, with each group responsible for analyzing one lesson for the post-lesson reflection. Both the cooperating teacher and the prospective teachers had active roles in planning the two research lessons and in the two post-lesson reflections. The cooperating teacher, who was responsible for the class, took the most important decisions regarding the adaptation of the mathematical content for her students. So, in the preparation phase, she decided to not present the formal definition for similar figures indicated in the official curriculum, as she considered this to be beyond her students' ability to understand. Instead, she presented a mathematically simpler definition which she considered more intuitive for students. She also decided that the criteria for similar triangles, which are the main tools that students have to solve problems on this topic, should be presented in an exploratory way. This contrasts with the usual approach of deducing these criteria from other mathematical theorems about relationships among line segments in parallel lines, as established in the curriculum, that she felt would be very difficult to the students.

The teacher took these decisions based in her knowledge of her students and in her commitment to make the curriculum adaptations that she felt necessary so that students could learn the most important ideas on this topic. The prospective teachers found it strange that the cooperating teacher had so much flexibility in interpreting the official curriculum guidelines but later, as they reflected on the research lessons, they recognized that these decisions were very appropriate to this particular class. In their final written reflections, the prospective teachers recognized that this work helped them to develop a better understanding of the processes of identifying students' difficulties and planning a lesson that strives to promote a strong student involvement.

In the last session of the lesson study, we sought to know how this was perceived by the prospective teachers. One of the aspects that they most valued was the rather intensive work carried out during lesson study in selecting and analyzing tasks. One prospective teacher considered that such work should have gone even further:

> I think it was necessary to work on the tasks. I think it was interesting, yes, I even think that we should have considered more of our tasks [the tasks that the prospective teachers selected], since that part was a little quick. We only underlined some exercises and maybe others had also interest and were put aside. (Cristina)

Another prospective teacher referred to her learning from her participation in lesson study and reflected on the focus of how to teach the topic of similarity. She considered that she knew well this topic, in terms of content, so she did not learn much about it. But she indicates that she learnt a lot regarding its teaching:

> Maybe it was the way of introducing the task more as an exploration… I think that it was more that … Because normally this is not the way we use to work. [It was not the way] we worked even when we were at school. (Amélia)

The prospective teachers highly valued their learning as a result of their participation in lesson study, particularly concerning the types of tasks which should be proposed to students. They also highlighted what they learned concerning the planning process:

> Concerning planning, so, [my view] changed very much. The part of planning was very good for me. And we all discussed, paid attention to small things, and included these in the plan, and prepared what we would do when that difficulty arose, if it were to, I found that very interesting. I was never was taught to planning as we did in this process. So for me, I found that part more interesting. (Amélia)

> That was the first time we constructed a lesson plan. So, I found that sometime we need to make one like this, detailed. And… And, for me, I think it was fantastic, but perhaps this was because it was the first lesson plan that we did. But it enabled me to see all the details that we have to think about. I never thought that our lesson plan would have five pages, not such, I thought that it would be one page. (Cristina)

The prospective teachers also valued the work undertaken during lesson study in order to figure out what different strategies could be used to solve the tasks and to identify the students' difficulties in learning the topic:

> We already knew something, isn't it, but I found interesting the way we made it as group … Anticipated the students' difficulties. And we thought of different strategies. As this was the first time that we did this, since generally we design an exercise, and we design it our way. And in this case there was a confrontation [of different strategies], and I think that we learned a lot, a lot in that confrontation. Because different ideas arose. (Cristina)

> What I found more important for me, in that phase, was not solving the tasks. It was to understand the general difficulties of students… (Amélia)

The exploratory approach, in which learning is based on students' work, was also valued by the prospective teachers that participated in this lesson study. For example, one of them stated:

> Because… Generally, all the books, what they say, is to present the criteria. And I think that… They [the students] learned better by arriving at the criteria, even if there was not much time. If there was more time… I think that this is a topic that in my future I will teach with the exploratory method. So that they are able to get it… (Cristina)

Another prospective teacher referred, in a positive way, to the organization of a lesson in three phases (launching, autonomous work, and discussion), which is characteristic of the exploratory approach:

> I can speak before and after the master's degree. Before, I never had thought how the moments that we now consider were important and did not see how the definition of these moments was very important to manage the lesson, the classroom, and the work that is carried out and the students' learning. I think… That is quite important. (Amélia)

The creation of a collaborative environment is more difficult in the case of lesson study carried out in initial teacher education than in lesson study with practicing teachers, given the differences in status among the participants (prospective teachers, cooperating teacher, university instructor) (Ponte, 2017). With regards to this issue, it is interesting to note the reflection of a prospective teacher:

> In the first session, we were a little quieter, because it was very strange, to get several tasks in front of us, and just have to discuss them. That was a little different. I think that afterwards, as time went on, we began to forget who were the teachers were. Sincerely, I forgot about the camera, it was more a large working group … I think that we then were more productive and better. Therefore, I think that it evolved in a positive way. (Cristina)

In summary, despite some reservations that they could have about this activity, the prospective teachers developed a sense for the importance of tasks in planning a lesson and in anticipating possible students' difficulties in solving them. They become much more aware of adjusting the curriculum orientations to the characteristics of the students and of the value of following an exploratory approach, taking into account the nature of the tasks and the features of classroom communication.

5.5 Portuguese Teachers' Concerns Regarding Lesson Study

For researchers and teacher educators, the features of lesson study make this a very interesting process of professional development. However, for in-service teachers, this process is very different from what they have seen in professional development and can initially seem quite awkward. The practicing teachers who participated in our lesson studies questioned why so many hours are dedicated to working on a single topic or curriculum aim, when there are so many topics in the curriculum that deserve attention—and this was especially strong when they felt pressured to know about recent extensive curriculum changes. The prospective teachers showed a similar concern. Concentrating all of the attention on a very specific issue goes against the usual way teachers look at professional development. In fact, lesson study is not suited to a wide coverage of many topics and curriculum aims, but rather for an in-depth study, taking into account the different aspects that are important in preparing and teaching a topic or curriculum aim—due to its relevance to goals for mathematics education, to the articulation with other topics and aims, to

the curriculum materials and assessment of learning processes. If teachers understand the value of such in-depth work, lesson study may suit as a process of professional development. However, if wide coverage of topics or issues is the major concern, lesson study is not the option to follow.

Other issues that raise teachers' concerns are related to the conduction of the research lesson. Many participants ask if the students get distracted with the presence of so many observers. Some teachers, used to have to deal daily with misbehavior, fear that the students will use the opportunity to show off in front of the observers. In fact, our experience has shown that, generally, after a brief initial moment of adaptation, students quickly get used to the presence of observers and completely ignore them. That does not mean that there may exist cases in which the class—or only one or another student—acts in a way to disturb the work, and so this is an issue that is not problematic in most cases but, of course, requires attention.

Teachers also raise the question of the role of observers being limited, without having the possibility to intervene in helping students. Teachers are used to interacting with students and the role of observer does not fit their professional identity. This role is defined in this way in lesson study, given the purpose of understanding the learning processes and the difficulties of the students in a natural environment. Such analysis requires a collection of data and careful reflection regarding what happens in the classroom during the research lesson and not an immediate intervention during class that, if made by different observers, would break the unity and coherence of the class.

However, the deeper concern that teachers tend to raise has to do with the evaluation of the teacher that conducts the research lesson by their colleagues. Despite the fact that lesson study assumes that the focus of attention is not the work of the teacher but the learning of the students, the activity of the conducting teacher is necessarily highly visible during the research lesson. For the teachers who have had negative experiences in their initial teacher education or in teacher evaluation processes, this is an emotional obstacle that is naturally difficult to overcome. For teachers who have had former positive experiences or feel more self-confident, the problem is not so complicated. This issue tends to be solved based on the confidence that teachers have (or develop) with one another and with the team that facilitates the lesson study.

For prospective teachers several other concerns also exist. In addition to the extra work that participating in a lesson study may require, this activity may also seem strange, especially if they still are in a very initial stage of their professional preparation, since the actual planning, observing and reflection of the research lesson may pose a quite overwhelming challenge.

Besides these issues, particular to lesson study, there are other reasons that tend to reduce the involvement of Portuguese teachers in professional development processes. In fact, in our country, contrary to others, professional development is usually carried out outside their regular teaching schedule, that is, in the free time of the teacher. Also contrary to what happens in other countries, teachers do not receive any reward for their participation in professional development activities,

neither of material nature nor for development of their careers. Frequently, they even have to pay the fees of the professional development. And, finally, the professional development providers, who are university teachers, are often seen as too "theoretical" and not knowledgeable of the concrete realities of the schools, and so what they do in professional development is very limited in its scope and applicability in practice. As we have shown in the two cases presented above, these are not unsurmountable obstacles, but they are contextual conditions that we need to pay attention to. Unless these conditions change in a deep way—by some change in educational policy, notably regarding teachers' career and teacher education—it is natural that they keep putting constraints on the development of this professional development practice in Portugal.

5.6 Conclusion

The most salient feature of lesson study that we have undertaken, in terms of curriculum, is the emphasis on the exploratory approach, with particular attention paid to the development of students' mathematical reasoning (Lannin, Ellis, & Elliot, 2011). In terms of organization of lesson study in the Portuguese context, the follow-up sessions in the lesson study with in-service teachers and the double research lesson in initial teacher education stand out as important factors in introducing this model to a new cultural context. Teachers and prospective teachers alike recognized the value of the exploratory approach, based on tasks that create opportunities for students to make generalizations and justifications and that underlines the value of whole class discussions for knowledge development. The follow-up sessions, despite the fact that they had a circumstantial origin, constituted important learning moments for teachers, leading them to take initiative and support one another in putting new ideas into practice. The practice of revising and introducing tasks in their own classrooms, that took place at this phase, deepened teachers' reflections about the issues tackled during the initial phase of the lesson study. The organization adopted in initial teacher education, in a fieldwork course, proved to be adequate in achieving the aims for these pre-service teachers' learning and has been also used in initial teacher education of physics and chemistry teachers.

In our approach to lesson study, we regard each group as a small collective carrying out research on their professional practice (Ponte, 2008). We begin with the formulation of a research question, carry out a systematic work to prepare an experience (the research lesson), reflect on the outcomes, and strive to apply the knowledge that results from this process to other situations. We do this through combining participants' experiential knowledge (from their past experience and their lesson study experience) with research knowledge (elicited from the activities and discussions carried out in the sessions). We seek to do this work with the teachers also in an exploratory and collaborative way, that is, instead of saying "how the teachers must act", we strive to create situations in which, through their

collective work, they are led to discover how to act. We also provide a clear structure, in which all the work develops, first towards the organization of the research lesson, and then to summarize the conclusions based on it. In summary, lesson study allows to combine exploratory work with a clear structure and to combine knowledge developed by research and teachers' and prospective teachers' experiential knowledge. As such, it stands as a formative format of professional development with high potential to promote participants' learning regarding issues related to students' learning, the interpretation of the curriculum, and also, in an indirect way, regarding issues related to their own teaching practice.

References

Artigue, M., & Blomhøj, M. (2013). Conceptualizing inquiry-based education in mathematics. *ZDM Mathematics Education, 45,* 797–810.

Cobb, P., & McClain, K. (2006). The collective mediation of a high-stakes accountability program: Communities and networks of practice. *Mind, Culture, and Activity, 13*(2), 79–99.

Fitzgerald, W. M., & Bouck, M. K. (1993). Models of instruction. In D. T. Owens (Ed.), *Research ideas for the classroom: Middle grades mathematics* (pp. 244–258). Reston, VA: NCTM.

Fujii, T. (2014). Implementing Japanese lesson study in foreign countries: Misconceptions revealed. *Mathematics Teacher Education and Development, 16*(1), 65–83.

Fujii, T. (2016). Designing and adapting tasks in lesson planning: A critical process of lesson study. *ZDM Mathematics Education, 48*(4), 411–423.

Gravemeijer, K. P. E. (2005). What makes mathematics so difficult, and what can we do about it? In L. Santos, A. P. Canavarro, & J. Brocardo (Eds.), *Educação matemática: Caminhos e encruzilhadas* (pp. 83–101). Lisboa: APM.

Hargreaves, A. (1998). *Os professores em tempos de mudança: O trabalho e a cultura dos professores na idade pós-moderna*. Lisboa: McGraw Hill.

Lannin, J., Ellis, A. B., & Elliot, R. (2011). *Developing essential understanding of mathematical reasoning: Pre-K-Grade 8*. Reston, VA: NCTM.

Lewis, C. C. (2002). *Lesson study: A handbook of teacher-led instructional change*. Philadelphia, PA: Research for Better Schools.

Lewis, C. C., Perry, R. R., & Hurd, J. (2009). Improving mathematics instruction through lesson study: A theoretical model and North American case. *Journal of Mathematics Teacher Education, 12*(4), 263–283.

Mata-Pereira, J., & Ponte, J. P. (2012). Raciocínio matemático em conjuntos numéricos: Uma investigação no 3.º ciclo. *Quadrante, 21*(2), 81–110.

Ministério da Educação. (2007). *Programa de Matemática do Ensino Básico*. Lisboa: DGIDC.

Murata, A. (2011). Introduction: Conceptual overview of lesson study. In L. C. Hart, A. Alston, & A. Murata (Eds.), *Lesson study research and practice in mathematics education: Learning together* (pp. 1–12). New York, NY: Springer.

Ponte, J. P. (2005). Gestão curricular em Matemática. In GTI (Ed.), *O professor e o desenvolvimento curricular* (pp. 11–34). Lisboa: APM.

Ponte, J. P. (2008). Researching our own practice. In B. Czarnocha (Ed.), *Handbook of mathematics teaching research* (pp. 19–35). Rzeszów: University of Rzeszów.

Ponte, J. P. (2017). Lesson studies in initial mathematics teacher education. *International Journal of Lesson and Learning Studies, 6*(2), 1–14.

Ponte, J. P., Quaresma, M., & Mata-Pereira, J. (2015). É mesmo necessário fazer planos de aula? *Educação e Matemática, 133*, 26–35.

Ponte, J. P., Quaresma, M., Baptista, M., & Mata-Pereira, J. (2014). Teachers' involvement and learning in a lesson study. In S. Carreira, N. Amado, K. Jones, & H. Jacinto (Eds.), *Proceedings of the Problem@Web International Conference: Technology, Creativity and Affect in Mathematical Problem Solving* (pp. 321–333). Faro: Universidade do Algarve.

Ponte, J. P., Quaresma, M., Mata-Pereira, J., & Baptista, M. (2015a). Exercícios, problemas e explorações: Perspetivas de professoras num estudo de aula. *Quadrante, 24*(2), 11–134.

Ponte, J. P., Quaresma, M., Mata-Pereira, J., & Baptista, M. (2015b). Lesson study and curriculum development. In *II European Conference on Curriculum Studies* (pp. 584–593). Porto.

Skovsmose, O. (2001). Landscapes of investigation. *ZDM Mathematics Education, 33*(4), 123–132.

Stigler, J. W., & Hiebert, J. (1999). *The teaching gap: Best ideas from the world's teachers for improving education in the classroom*. New York, NY: Free Press.

Stigler, J. W., & Hiebert, J. (2016). Lesson study, improvement, and the importing cultural routines. *ZDM Mathematics Education, 48*(4), 581–587.

Takahashi, A., & McDougal, T. (2014). Implementing a new national curriculum: A Japanese public school's two year lesson-study project. In K. Karp & A. R. McDuffie (Eds.), *Using research to improve instruction* (pp. 13–22). Reston, VA: NCTM.