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Lesson Study Methodology in the Training of Future Mathematics Teachers

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Abstract

This article deals with a pedagogical practice carried out in the Exploratory Teaching in Mathematics Classes discipline of the undergraduate Mathematics course at a Brazilian university. The Lesson Study methodology is part of the course plan for this discipline. Based on our theoretical studies about this methodology, we decided to try it out in practice. To this end, using a schedule of activities that included the phases of the aforementioned methodology, we developed a lesson plan on fractions for 6th grade students in elementary school II, which was taught by one of the undergraduate students, who was a teacher at a private school. The lesson plan was designed by the undergraduate students collaboratively and based on activities aimed at meeting the students' learning needs, according to the guidelines of the classroom teacher, in this case, the undergraduate student in Mathematics. With the consent of the school principal, on the scheduled day we observed and made notes about the class, which supported our discussions in the class following this experience. It was then possible to notice the closeness between classmates, providing very interesting conversations about the concept of fractions, mathematics teaching methods and the importance of developing a good lesson plan. This teaching practice allowed future mathematics teachers to understand that a collaborative school environment and developing a good lesson plan together with their peers can lead to a favorable environment for everyone because everyone will benefit from good pedagogical and educational results.

Keywords: Lesson Study, initial teacher training in Mathematics, class plan, methodology

1. Introduction

The Lesson Study methodology originated in Japan and has been used as part of educational public policies there. Other countries like England, China and Portugal have also conducted research on this theme. However, there have been few investigations and practices focused on Lesson Study in Brazil, as shown in studies by Bonato *et al* (2019), Carvalho *et al* (2019), Baldin *et al* (2018) and Coelho (2014).

The plan for the Exploratory Teaching in Mathematics Classes course offered by the Mathematics Institute within the Mathematics Teaching degree program at Federal University of Alagoas (UFAL) encompasses discussions on the concept of exploratory teaching and the Lesson Study methodology. The goal is to provide future teachers with a comprehension of classroom didactics and practice so that they can teach mathematical contents and concepts in basic education because although the aforementioned degree program should focus on teaching skills, it prioritizes mathematical contents aligned with the bachelor's degree.

As some of the students in the group were already performing teaching work, I proposed a practical exercise based on the Lesson Study methodology. Three students were interested in the experience and asked for authorization to conduct the study at the schools where they were teaching. Nevertheless, only one of the schools allowed the teacher (an undergraduate student) to have us present in the classroom with a group of 6th-grade middle school students.

Having been authorized by the school board, we organized an activity plan in order to promote the stages proposed by Baldin (2009) and Ponte *et al* (2015), who discussed how to prepare a lesson plan from the perspective of Lesson Study. At the same time, we deepened the discussions on the methodology by reading and reflecting upon the texts included in the course bibliography.

2. A little about the Lesson Study Methodology

The Lesson Study methodology has been integrated into Japanese mathematics teachers' practice with a focus on students' difficulties, that is, it highlights "*learning* within the school context, with an emphasis on studying 'how' students learn" (Silvestre, Jacinto, 2016, p.13).

According to Baldin (2009), educators who search for solutions to mathematics teaching and learning difficulties turn to the Lesson Study methodology. In fact, in the international context, there have been several publications and research groups focused on this theme. However, in Brazil, it is possible to notice that there have been few studies on the methodology, as stated by Coelho (2014) and Carvalho *et al* (2019). Research conducted by Bonato *et al* (2019) identified 346 productions, among which there were nine dissertations and one thesis. Therefore,

> recent studies tend to perceive and understand LS as a continuous spiral process, with stages that evolve with each new iteration, progressing to new levels of knowledge and understanding. This tendency presents itself as a reconfiguration of what was initially proposed by Japanese and American authors. Thus, with a constant spiral process encompassing *perceiving, proposing/planning, executing and assessing,* teachers reconfigure didactics knowledge and contribute to their professional development. (Bonato *et al*, 2019, p.18, our translation)

As highlighted by Baldin (2009), Lesson Study is characterized as a methodology organized into four procedural stages:

1) Lesson Planning – the lesson plan should be aligned with a mathematical content and crafted while considering students' central role in the mathematical learning process. It should encompass problems that challenge, promote exploration and enable students to search for strategies because "there is no point in developing tasks that students are unlikely to embrace" (Ponte *et al*, 2015, p.25, our translation).

2) *Lesson Execution* – in this stage, one of the teachers in the team executes the plan, while the other teachers who helped craft the lesson plan observe it and take notes of the

teacher's and students' actions, but they do not make interventions during the execution of the lesson. These records will be used in the third stage of the Lesson Study methodology.

3) *Class Analysis* – in the third stage, the group that devised the lesson plan gathers to discuss their observations – the lesson, its execution, students' learning – and especially to improve the plan "by making alterations to it so that it can be applied to other groups of students" (Coelho, 2014, p.33, our translation).

4) *Revisiting* – in this stage, the lesson plan will be reorganized based on the discussions held in the previous stage.

Based on the aforementioned principles, researchers have conducted investigations while adapting Lesson Study to the reality of their countries. Given the space constraint in this article, I will cite some recent works.

In Brazil, Fonçatti and Morelatti (2019) conducted an investigation within the Mathematics Teaching Supervised Practice course aiming to apply the principles of Lesson Study and exploratory teaching in order to provide undergraduate students with a different experience in their supervised practice while challenging the logic of traditional training based on technical rationality. According to the authors, considering a type of supervised practice that contextualizes LS and allows students to experience school life "[…] aims to promote reflection, collaboration among peers, rotation, a closer relationship between school and university and some types of learning, such as pedagogical content knowledge (Shulman, 1986)" (Foncatti and Morelatti, 2019, p.14, our translation).

In Portugal, Ponte *et al* (2016) expanded the analysis of the data produced by Quaresma *et al* (2014) by investigating a lesson study while aiming to understand the processes of training and professional development of a group formed by five 5^{th} and 6^{th}-grade teachers from a school in Lisbon. Their goal was to observe "what teachers learned about students' difficulties and reasoning processes (generalization and justification), as well as how to promote them in the classroom".

The researchers concluded that even though these teachers were initially uncomfortable with the methodology – because they were not used to exploratory activities –, the research sessions allowed them to reflect on students' strategies, which was new for them, especially in the discussions held in the meetings after the activities had been executed with the students in the classroom. According to the researchers, "this experience clearly shows the great potential of Lesson Study as a training process and suggests that it would be much more effective if they became an established practice in the educational system, as is currently the case in Japan" (Ponte *et al,* 2016, p.14, our translation).

In South Africa, Adler and Alshwaikh (2019) investigated the Lesson Study methodology in a training project in order to provide teachers with moments of reflection about mathematics lesson plans for teaching algebra. In general terms, the researchers concluded that during a proposed activity involving algebraic simplification, for example, there were opportunities for "discussion and reflection on the relationship between arithmetic and algebra, as well as possibilities for developing an algebraic sense of symbols and their meanings" (Adler e Alshwaikh, 2019, p.338, our translation). Moreover, they highlighted teachers' concerns about their students' learning when applying the activities. In the researchers' view, the discussions on the Lesson Study methodology based on the activities that were developed gave meaning to teachers' voices regarding teaching and learning quality.

Therefore, in light of what has been shared so far, applying the Lesson Study methodology, both in the initial and continuing training of educators who teach mathematics, could

contribute to the development and improvement of pedagogical practices centered around students' learning while aiming at the improvement of mathematics teaching.

(1)

3. Schedule Organization

The fieldwork, which started after the school authorized the aforementioned activity, used the first two classes to discuss texts, helping students better understand the theme and how to make it feasible in practical terms.

In the third class, we started with a conversation with the undergraduate student/teacher that was going to have his lesson observed based on the plan collectively constructed by the group. At that moment, the undergraduate student/teacher reported his students' learning difficulties and expressed his concerns. The student explained some aspects of his experience with the 6th-grade middle school student group and voiced a concern about arithmetic operations, because although the students knew the operations and the multiplication table, they had difficulty in explaining how they think, especially when it comes to rational numbers.

Then, the other undergraduate students in the group asked questions and took notes: what was their difficulty with rational numbers? With fractions or decimals? Did they perform operations with fractions? The student also said that most 6th-grade students could perform canonical operations and operations involving fractions with different denominators mechanically: they added both the numerators and the denominators. For instance, in the operation *1/2 + 1/3*, they presented *2/5* as the result.

I made targeted interventions while observing how the undergraduate students behaved and participated in a situation in which they questioned middle school contents. Furthermore, I proposed the hypothesis that the children could only understand the concept of fractions through the idea of part/whole.

From all the notes taken and clarifications provided by the undergraduate student/teacher, we agreed that we should propose an activity to explore fractional numbers. We decided that everyone should bring activity proposals the following class to discuss them and choose the ones that should be included in the activity plan.

In this stage, I mediated the discussions held by undergraduate students so that they could better comprehend 6th-graders' difficulties with fractional numbers and then define the learning goal of the lesson, because "a lesson can have several learning goals, but it is important for it to have a well-defined main goal" (Ponte et al, 2015, p.27, our translation). After that, they should develop activities in order to meet the proposed goal.

In the fourth lesson, we started to craft the activity plan and, in order to facilitate communication, the future teachers created a WhatsApp group to exchange information on the type of activity that would be more suitable for 6th-graders. In this class, the undergraduate students presented proposals containing problems involving fractional numbers. I understood that they chose mathematical problems as a reflection of our studies about exploratory teaching and problem solving because "as with problems, in an exploratory approach, students are invited to tackle tasks for which they do not have an immediate solution method, so they have to develop their own methods" (Ponte, Quaresma, Mata-Pereira, Baptista, 2015, p. 114, our translation).

Among the several activity proposals that were suggested, the group and the undergraduate student/teacher agreed on the following plan:

> A mother used half of a roll of string to tie up a package. Of the remaining string, the eldest son took half to go fishing. Then, the daughter used two-fifths of what was left to tie her hair. Next, the father used half of the remaining string to fix his suspenders. Finally, the youngest son received 30 cm of string. How many meters were originally in the roll of string?

The student that proposed this problem found it in a continuing education process offered by her local education department. Next, we started to discuss an appropriate strategy to execute the activity with the 6th-grade group.

In the fifth lesson, after the problem to meet the proposed goal was chosen, we started to craft the lesson plan while trying to anticipate possible questions and answers that could be presented by the students, as well as possibilities for the teacher to make interventions (Coelho, 2014).

When the problem was presented during the discussion, the different parts of the text (the problem statement) were highlighted in various colors.

> A mother used half of a roll of string to tie up a package. Of the remaining string, the eldest son took half to go fishing. Then, the daughter used two-fifths of what was left to tie her hair. Next, the father used half of the remaining string to fix his suspenders. Finally, the youngest son received 30 cm of string. How many meters were originally in the roll of string?

The group of undergraduate students had mixed opinions about how to present the problem to the students. Some considered the colors interesting because the statement was long, and they would facilitate reading. However, most students, including the student/teacher, argued that if the text were highlighted in colors, the problem would have its potential reduced, and it would not be possible to observe how the students would create their own strategies to solve it.

Another point that was discussed was what didactic resources should be offered in order for students to solve the problem. At that moment, I made only targeted interventions because I noticed that the undergraduate students, including the student/teacher, were reproducing the model of class that they had had in their undergraduate degree program, that is, the professor presents the problem, and the students solve it with pencil and paper. I suggested that 6th-graders could use manipulatives to solve problems, which could facilitate their understanding of the problem.

There were various suggestions, and some of the highlights were “frac soma”, a roll of string and Cuisenaire rods. However, the undergraduate students, supported by the student who was going to teach the lesson, decided to print the problem on paper and provide sixth graders with a sheet of grid paper so that they could use it to solve the problem.

4. Lesson Observation

We met at the school on the scheduled day, and the coordinator welcomed us. We noticed that the teacher was anxious, which I see as natural because his teaching work was going to be observed by his peers and his professor. It was a private middle school, and there were 30 students in the 6th-grade group. The children were curious about our presence even though the teacher had already informed them about the activity.

The children were organized into trios and instructed to read the problem and search for a way to solve it – a way they considered correct. We observed that they made an effort to solve the problem, but my hypothesis was confirmed: the students had difficulty interpreting the

problem statement. Some trios exchanged information in order to understand the statement, while others asked the teacher for guidance. Nevertheless, few students used the grid paper to "draw" the problem statement. Most children tried to solve the problem by applying algorithms, and few managed to solve it.

As we had anticipated the questions students would likely ask regarding the interpretation of the statement in the lesson plan, the teacher reorganized the children and read the statement with them. After this reading, most students felt more comfortable with the problem, but they kept ignoring the sheet of grid paper while trying to solve it.

It was a 50-minute class and, following the collective crafted lesson plan, the teacher invited the students to explain how they solved the problem. Two groups offered to present their solution on the board. They solved it correctly by applying algorithms. When the teacher talked to the students about their peers' solutions, it was evident that some of them had difficulty doing operations with fractional numbers with different denominators. Finally, we collected the activities in order to assess them the following class.

5. Lesson Assessment

The seventh class was dedicated to assessing sixth graders' activities, discussing the student/teacher's lesson and reflecting on the experience everyone had had. The undergraduate students enjoyed the experience because there was a clear goal for us to be in that space, so they did not consider it to be "a disconnected event", and they were observing their undergraduate peer's class.

As for the undergraduate student/teacher, he was nervous because his peers and professor were observing his class, which we considered normal. After all, it was the first time he experienced this type of situation. It is important to remember that it was an exercise of the Lesson Study methodology in Brazil, where the first studies on it are being conducted now, while in Japan the method has been part of public policies, that is, teachers are used to having their peers observing their classes there.

Next, I handed out the students' activities so that the undergraduate students could comment the solutions presented by the children. I asked them to make one comment about each activity.

> Text interpretation problems. They have little notion of fractions, that is, it is hard for them to find the fraction that represents a specific figure or even its construction. When they were trying to solve it, we noticed that the teacher needed to solve an enigma, that is, he had to find something that corresponded to some aspect of the question. It is evident that the students have difficulty interpreting texts. (Undergraduate student 1)
>
> Besides some observations about text interpretation and some difficulty related to students' content learning, it was possible to observe that one way to stimulate the solution to the proposed challenge in the classroom could be to offer grid paper containing the outlines of the fractions mentioned in the statement. (Undergraduate student 2)
>
> It was possible to notice a bad use of grid paper and absence of calculations, which may reflect that they didn't understand the problem statement. (Undergraduate statement 3)
>
> Analyzing their answers allowed me to notice the difficulty the students have in organizing their ideas, which could facilitate problem

> solving. Moreover, they didn't systematize their calculations. (Undergraduate student 4)

By analyzing some undergraduate students' comments, we observed that interpreting the problem statement was a point of convergence. Carvalho (2010) argues that, in kindergarten and in the early years of elementary school (1st and 2nd grades), some teachers are still resistant to exploring problem solving because their students are not fully literate. However, mathematical problem statements support literacy development and, consequently, interpretation.

As a result, we have a generation of students in which most cannot interpret texts, so they understand that, in order to solve problems, it is necessary to apply algorithms. 6th-grade mathematics teachers, in turn, cannot solve this issue because they expect to receive fully literate students able to interpret statements.

As for students' difficulties with "fractions", it had been anticipated in the plan. However, the undergraduate students pointed out sixth graders' bad use of the grid paper, and at that moment, I made an intervention by asking: do students have access to this type of resource during classes? How is the content developed? Then, I mentioned an activity in which one of the trios explained:

> *2/5 = 30cm*
>
> *30:2 = 15*
>
> *15: 5 = 3 cm*
>
> We understood that if we divided the 30 cm by each number of the fraction, which was *2/5,* we'd have the result, but the calculation went wrong.

From this answer, I asked the undergraduate students how they would revisit this content. They observed that using "frac soma" could have been more appropriate because the children would have translated the statement into something concrete and, thus, understand it.

In this assessment, we aimed to propose the stage of the Lesson Study methodology in which the objective is to improve the plan by proposing alterations, according to Coelho (2014). This moment was also used to assess the course and the activity as a whole because it was the end of the term.

6. Conclusion

In this article, I presented an experience with the Lesson Study methodology in a course within a Mathematics teaching degree program. Since the activity was proposed within an elective course, the methodology stages were adapted at several points, but the goal was surely achieved. Besides studying the methodology, the undergraduate students experienced the development of a collectively constructed lesson plan, observed their peer's class, made comments without veering into criticism and understood that thinking collectively favors the quality of mathematics teaching and learning, which corroborates the research studies mentioned in this article.

As previously stated, few studies on the theme have been conducted in Brazil, while other countries have pointed out the efficiency of the Lesson Study methodology both in initial and

continuing teacher training. Nevertheless, I understand that we cannot hope to transform this methodology into a solution to all problems related to mathematics teaching because there is not a magic solution to be used in the classroom, but targeted actions infused with didactic and conceptual knowledge, through which teachers will know how to interpret their students' difficulties and make decisions in order to overcome them.

As a professor in a Mathematics teaching degree program, I believe that the more pedagogical practice teachers have and the more teaching methodologies they know, the higher the quality of teaching will be, and Lesson Study can be one of these methodologies.

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