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LESSON STUDY IN PRE-SERVICE PHYSICS TEACHERS' EDUCATION: A CASE IN BRAZIL

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Abstract

Lesson study (LS) is a teaching improvement process that began in Japan more than 100 years ago. As the LS is still a new approach in the Brazilian context, this paper will discuss how it could be implemented in the pre-service physics teacher training. To accomplish this, a group was created with 6 pre-service teachers who held 11 meetings, which integrated two LS cycles. The data for this research were collected through field notes and materials produced by pre-service physics teachers. The collected data were analyzed by Bardin's content analysis. According to the results obtained, it highlighted that pre-service teachers had gaps in knowledge about the basic contents of Physics and LS showed that collective work with peers could promote reflection and enable classes that were closer to the students' reality, minimizing the difficulty and rejection by Physics in basic education, improving the students' learning.
Keywords: *lesson study, Physics teaching, pre-service teacher, supervised internship, teacher education*

Introduction

Lesson Study (LS) is a centuries-old Japanese collaborative methodology of teaching. Its origin dates back to the 1900's (Makinae, 2010). This methodology consists of meetings where teachers study contents in a collaborative format. They plan lessons with one teacher chosen to teach the lesson, which is named "research lesson" while the others observe to discuss and participate in the unfolding lesson plan. This strategy to synergize the teacher's formation of research lessons is being used in several countries throughout the world including the UK, USA, Portugal, Australia, Spain, China, Malaysia etc. (Baptista et al., 2012; Baptista et al., 2014; Department for Children, Schools and Families, 2008; Saito & Atencio, 2013; Soto Gómez & Pérez Gómez, 2015).

The LS process can realize some small differences such as the number of steps (Department for Children, Schools and Families, 2008; Fernandez & Yoshida, 2004; Norwich, 2014), but generally it is executed with a very similar form. Fernandez and Yoshida's proposal (2004), for example, uses the LS process with three steps: a) First step – to plan collaboratively the research lesson; b) Second step – to observe the research lesson being taught in the school; c) Third step – To discuss the research lesson taught.

There are other steps that are optional. They are: d) Fourth step – to review the lesson; e) Fifth step – to teach the reviewed lesson; and f) Sixth step – to share reflections about the new version of the lesson. Fernandez and Yoshida (2004) stated that it is common to designate a group member to take notes during the meetings of LS, especially during the study's reflection meeting so that all of the ideas generated in the collective work would

be made available for later reference. Some researchers choose to record in video the various meetings (planning, lesson observed, and meetings after class) to not lose any data (Baptista et al., 2012; Baptista et al., 2014).

The LS, being different from the traditional way classes are taught, puts the focus on the students and their learning mechanisms (Pedder, 2014). This change of focus creates the stimulus to start the reformulation of the lesson plans. The teachers, by way of the LS meetings for planning and evaluation, can become more conscious of how and what learning occurs and therefore optimize their actions accordingly.

In Japan, the place where LS was developed, the method was highlighted in the results of the first two editions of the Third International Mathematics and Science Study – TIMSS, 1995 and 1999, and the first edition of the Program for International Student Assessment - PISA, in 2000. Similar success has occurred within other countries using LS, especially in Mathematics, but also including Science and Language. The repeated success of the program has brought renewed attention to LS. The effect of it has been that now several countries have introduced this methodology to their teachers.

In Portugal, the math teachers predict hardness, anticipate questions, and think of strategies to navigate students to answers before the lessons are taught. This data is then compiled to prepare class observation guides (Baptista et al., 2012). Among the results of the LS application, it can be highlighted what Baptista et al. (2014) and Quaresma et al. (2014) presented: the LS produced new professional based teaching methods in the format and application process resulting in changes to the students' proposed tasks, teaching practices based on learning awareness, valorization of collaborative work, and the development of a stronger reflective capacity.

To Ponte et al. (2015) and Quaresma and Ponte (2015) stated that the LS enabled a more active role from the students. The teachers started to see and evaluate the needs and motivations of their students (Dudley, 2013). This evaluation can be realized in the moment because of prepared learning expectation from the planning exercises.

The LS also was applied in the pre-service teacher education and it shows interesting results. Conceição et al. (2016) found pre-service teachers learn aspects of the teaching practice in accordance with the demands of science teaching. They can know several types of activities and valorize what shows a bigger possibility, identifying the students' reality and understanding the difficulties of the students making room for them in the learning process. The result is the teacher shifts the focus of learning onto the learners.

Coelho et al. (2014) observed that LS offers the possibility of getting specific and professional knowledge which is developed practically from real classroom experience. Mitchell (2014) affirmed the pre-service teachers that worked with LS during their formation developed more than the others that did not. This was observed by planning high quality classes and showing great resourcefulness, a by-product of LS. Parks (2009), meanwhile, said the pre-service teachers in some meetings did not want to disagree with their colleagues and so they agreed with the speech of them. In this case, the beliefs and attitudes did not modify.

Lewis et al. (2012) have stated the LS develops competence, causing the teacher to improve their abilities with the students and generate the "human connection". This modifies the sight of "my" lesson and "my" students to "our" lesson and "our" students in a professional community that waits and valorizes the contribution of each member. However, Fiji (2016) has said that out of the Japanese and Chinese context, the goal of the LS is to produce good lessons, not to comprehend the learning process or modify the teacher's practices.

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Other difficulties and challenges listed were the time required by teachers, the flexible schedule needed to watch the lessons of the colleagues, and the need to open the classrooms to other teachers to observe the lessons (Fernandez, 2002). This author lists: the need to elaborate central questions, plan the lesson, and identify the evidence to be collected, and interpret and generalize the results.

One of the great challenges of the implantation of the LS is its adaptation to different contexts in which it is inserted (Grimsæth & Hallås, 2015). In the USA, the teachers did not use the specified time to do the lessons in the Japanese handbook. With this, they have not changed the way they worked a lot (Lewis et al., 2011). Stingler and Hiebert (2016) have stated it (LS) is not an import of cultural routine from one country to another. Though the people may have interest in testing it, if it hasn't had the desired effect immediately, it is often abandoned and replaced with other ideas to be tested. Another difficulty is the collaborative work in both pre-service (Conceição et al., 2016; Mitchell, 2014) and in-service formation (Quaresma & Ponte, 2015). At the University and in the effective teacher workplace there is not the culture of plan collaboration in peers. Among the other big challenges is the lack of knowledge about LS in places where it would be implemented, and the problem of how to develop the necessary competences to support its development (Takahashi, 2014).

Although the LS faces some difficulties and challenges, the results obtained with its use can be an effective learning method for both teacher and student. As the use and the knowledge about the LS in Brazil is practically non-existent, in this paper one seeks to understand how the LS can be used in the training of Physics teachers in Brazil. Thus, in this research one intends to verify if pre-service Physics teachers had mastery of content; verify if the inquiry-based lesson plans produced by the collaborative approach were done to promote the students' learning; analyze if the collaboration was effective in studying content; study the elaboration of lesson plans; and comprehend how the school's students and their teachers received the lessons. Therefore, a research question emerges: would the Lesson Study be a valid strategy to be used in pre-service Physics teacher courses in Brazil inserted locally during the supervised internship?

Research Methodology

General Background

This study is an exploratory and qualitative research. Exploratory because it seeks to examine and discover a still unknown reality using mainly qualitative research techniques based on observations and interviews (Selltiz et al., 1987). The observations and audiovisual records of the formative meetings were used in a field diary, as well as the analysis of the material produced in these meetings.

According to Liebscher (1998), to learn qualitative methods it is necessary to learn how to observe, record and analyze real interactions between people, and between people and systems. This research was carried out with pre-service physics teachers, who were enrolled in the supervised internship discipline of teaching physics at the Federal University of Piauí (UFPI), located in Teresina, a city in the Northeast of Brazil. This research included pre-service physics teachers at the University and in-service physics teachers at the secondary school. The project was only possible with this interaction between the university and the school, so that the implementation of the LS occurred in

real schools and with the participation of physics teachers as partners. Thinking about the possible sustainability of the project since LS was also a novelty for in-service teachers.

Sample Selection

In general, in pre-service physics teacher training courses, there are many dropouts, and few finish the course. As the supervised internship discipline is allocated at the end of the course, there were 13 enrolled students in this class, who were invited to participate voluntarily. Afterwards, a small group of 6 students was formed who agreed to participate voluntarily and over 2 withdrew.

Once the group was constituted, 2 members were selected who would be responsible for teaching the physics classes that would be planned collectively and that would be studied. For that, the criteria used to select the 2 members were: teaching the physics contents in the supervised internship and that the internship should be carried out in an accredited school in Teresina. Some students do the internship in classes in Natural Sciences, but not in Physics specifically, and there are also others who do the internship in nearby cities. The other members of the group participated in the activities of LS collaborating in the planning, in the observations and discussions.

In addition to the pre-service teachers who were in training, two in-service teachers were also part of the group, who were physics teachers in accredited schools where supervised internships took place. In-service teachers were invited voluntarily to participate in this research, since the State Department of Education had authorized the participation of schools in research under the responsibility of the University, such authorizations are necessary in the Brazilian context.

Instruments and Procedures

The steps of LS to the pre-service Physics teachers were the same planned LS with the teachers, based on the Quaresma et al.'s (2012) proposal. The sessions that took place throughout the process are presented below: Session #1 had the goal of showing the teachers (in-service or pre-service) the LS (only to the first LS cycle), Sessions #2 and #3 aimed to deepen the knowledge about a specific Physics topics and prepare a research lesson about this, Session #4 was to observe the regency of the research lesson and in Session #5 the reflection of the lesson as well as an observation of the whole LS process. When one cycle finishes, another one starts.

The meetings (for each of the sessions described above) took place during one academic semester, weekly. The data collection instruments used in this research were the records in field diaries during the meetings and also materials produced by the participants (in and pre-service teachers) such as: lesson plans, class notes and evaluation report on the process and results obtained.

The LS cycles occurred only twice because the academic calendar was different from the school calendar (as there was a strike at the university shortly before the research and the classes at the university started after the classes in the high schools started).

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Data Analysis

Considering these described materials, the corpus analysis was performed, using Bardin's content analysis (2016). The data analysis process itself involves several steps to give meaning to the collected data, which are organized by Bardin in three phases: 1) pre-analysis, when the material is organized with the aim of making it operational; 2) exploration of the material, when the definition of categories and identification of the registration and context units in the documents occurs; and 3) treatment of results, inference and interpretation, when condensation and highlighting of information for analysis occurs, generating moments of intuition, reflective and critical analysis.

Research Results

In the sequence, the results of the research will be presented in table 1. The information of the meetings about the sessions held during the process were summarized. As mentioned earlier in this research, two cycles of LS were implemented, the first cycle of sessions 2 to 6 and the second cycle of sessions 7 to 10. Session 1 was an introductory session on the teaching methodology LS, as well as for the organization of groups, happened at the University. The last session was considered for evaluation, by the members, of the process experienced of the implementation of the LS in the context of the teaching of physics.

Table 1
Meetings Held to Implement LS Activities and their Respective Places of Occurrence

Meeting	Activities	Place
1	What is the lesson study? History, some results and future perspectives. Choose the pre-service Physics teachers who would teach the lessons.	University
2	Definition of the contents and work strategies	University
3	Study meeting about kinematics	University
4	Construction of the research lesson plan about kinematics and definition of the items to be observed at class	University
5	Application of the first research lesson (kinematics)	School #1
6	Discussion of the kinematics research lesson	University
7	Study meeting about waves	University
8	Construction of the research lesson plan about waves and definition of the items to be observed in class	University
9	Application of the second research lesson (waves)	School #2
10	Discussion of the waves research lesson and comparison with the results of the kinematics classes	University
11	Evaluation of the method and discuss the influence in the Physics/ Science pre-service and in-service teacher education	University

Comments at the beginning of the meetings 1, 2, 3, 4, 7 e 8 are being shared. The other meetings are going to be discussed in the end of this section. The first meeting participants received explanation of the Lesson Study method. It was emphasized the method's origin, results obtained from Brazil, and results obtained from the world. Challenges and perspectives are also shared for the future of LS. At these meetings, the pre-service Physics teachers that would teach the research lessons and plan collectively were chosen. Participants were able to question about the proposal and to have a better understanding of the LS, this interaction was important to clarify the core of LS and the possibility to adapt to physics classes.

The second meeting consisted of elaborating on the meeting schedule, defining the subjects to be worked on, and defining the research lessons to be planned collectively. From the meeting discussion, internship planning, with the two selected pre-service Physics teachers, the subject matter content was chosen for the lesson. The subject matter was to be kinematics and waves, according to the in-service teachers' program at the school. Strategies and action steps were specified to be developed at the meetings to study the content in order to plan, teach, watch and discuss the unfolding lessons.

An important result that occurred in the study meetings of the class on kinematics (3rd meeting) and on waves (7th meeting) was evident that the teachers in training in formation did not have mastery of the contents of the discipline. For example, in the study of kinematics, a question arose, "whether the trajectory would be equal to the distance covered, and whether this would be the same thing as displacement?" The pre-service physics teachers in training were confused and responded with an unrelated concept. That is, they had no mastery of the physics content.

In the study meeting about waves it was perceived that the students knew how to classify the wave in longitudinal and transversal, but they were not able to classify the waves present in other areas (sound wave, sea wave, etc.). However, the waves produced by a string, a spring, or an electromagnetic wave (examples common in textbooks) were classified correctly. When it was worked with sound waves it was questioned how different musical instruments could play the same musical note and have sounds that differed from each other. During the discussion, the role of intensity and sound frequency was unclear until it was discussed about timbre. The timbre was fully understood after the reading and discussing from the context of higher education books. Timbre allows differentiating between sounds of the same frequency and intensity originating from a different source. These distinctions occur because the waves produced have different shapes.

After the study meetings, the group met to elaborate the research lesson plan and to define the aspects which were then analyzed in the observed classes of the 4th and 8th meetings. At the beginning of the construction of the research lesson pre-service plans, the pre-service teachers wanted to propose expositive lessons without opportunities to dialogue with students and without problematization. In this moment, the LS method was emphasized and reaffirmed the goal in the learning of the students. The focus of the questions was the pre-service teachers, who were selected in the group to be responsible for teaching the classes.

Initially they were asked to comment on the virtues and difficulties of the classes. From this, the importance of classes focused on student participation and using examples from students' daily lives was discussed. And then, the virtues of collaboration in the classroom were explored. For in a first moment they present proposals focused only on the transmission of content without moments of interaction or participation of the students.

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In the School #1 class, the students showed interest in current events from the news and technology. Since the school did not provide the use of a media room or a projector, it was proposed to calculate the average speed of a volunteer that walks or runs from a designated place to another classroom. The volunteer would go through a determined number of squares (the floor of the classroom was formed by several squares of $1m^2$) at a determined time which was also measured via a mobile phone.

In School #2 class, the pre-service Physics teacher would teach waves, especially sound waves. It was suggested that the teacher call two volunteer students and have them stand on the whiteboard's opposite side of where the other was standing. One volunteer student would then put his ear on the whiteboard while the other student would not put his ear on the whiteboard. Upon doing this, the pre-service teacher would give a very little beat (tap) on the whiteboard, so that the student with the ear touching the whiteboard heard it and the other student did not. The intent was to work with the sound speed concept and the factors that change it. In addition, an acoustic guitar was used (made available by the school) to work with the concepts of frequency, timbre and intensity.

Concerning the items to be observed during the lessons, it was emphasized that the observation aimed to verify the students learning, not to evaluate the pre-service teacher that taught. Then, the items to be observed during the research classes in the classes of the two schools were indicated while the students interacted during the classes. If there was a moment when the interaction was longer than the other moments, write it down and asked why? Did the planning prove adequate to class reality? Were the goals of the lessons achieved?

In the fifth and ninth meetings and the later meetings to discuss them (6^{th} and 10^{th} respectively) the research lessons provided very interesting results. The teachers that taught these lessons were pre-service Physics teachers, therefore, class domain and method were not expected to be completely controlled.

The supervisor teacher (in-service teacher) remained in the classroom at all times. This organization facilitated the application of the research lesson. The school students actively participated in the class at the school which worked on the subject of wave. There was not a loss of material in relation to the content that should be taught, as this stayed in accordance with the annual planning of in-service teacher. However, there was a greater reflection about the lessons being taught.

The students (both from school and university) were used to a more mechanical and minimal reflective lesson style. When the pre-service teacher began to work in the classroom in a different way, the school students began to wonder. But as they interacted, it created a positive collaborative format. When students were given examples of daily situations to explain the physical phenomena, the content was understandable to them because it was connected to their everyday experiences.

An illustrative example for this was when one of the students at the school was asked to put his ear against the whiteboard and another to go to the opposite side. A third student stood next to the one with the ear on the board, without touching the board. The student who was on the opposite side was asked to touch the board very lightly and the one with the ear leaning against the board heard and the person standing next to him could not hear anything. For example, student said: "Wow, I understand now because the Indians (Brazilian natives) put their ears to the ground to know if the cowboys were coming", said the student near the whiteboard. Student realized that the sound propagates differently (speed) in the different media.

The duration of the internship at the schools is about three months, so care was taken not to change the subject in a class. Also, care was taken to use only resources available at the school and to focus on relevant activities that belonged to the student's daily life. The use of the squares on the floor to explain the motion allowed the students to understand better than to use only the textbook, for example. A student who was for the second year in this class (fail the first time) commented he understood the subject, and the colleagues who walked and/or ran over the squares on the floor made this happen.

When the Physics contents was taught in a conceptual format as the main focus rather than a mathematical and abstract approach only, the students' resistance to Physics declined considerably. Also, the impact of the University incursion on the format of the classroom was interesting. This was because the teachers at most schools do not have a current classroom connection with Academia. This was an auxiliary observation that causes one to ask what deep opportunities may exist with a greater connection.

When the pre-service teachers commented on the taught and/or observed lessons, they specifically highlighted the fact that they reflected on what they were going to do and also on what they did in the classroom. The pre-service teacher who taught the class about sound waves said he didn't think about using the guitar or doing the beat on the whiteboard. For him, thinking about the class and being able to check the result of this intervention in the classroom was an interesting thing and he will try to keep it in his future teaching practice. The fact that no pre-service teacher to know about timbre was the most highlighted event cited by them to emphasize the need to reflect and study before teaching classes. The observation was that they could easily think about the subject matter in class in each step. This allowed enough time for absorption rather than the need to manage the whole subject at once. They used the lesson plans not just as a group of facts to be learned, but more as a road map that directed their question and actions in the classrooms.

The collective research lessons surpassed the students and pre-service teachers' expectations. Even when using simple materials and non-technological strategies, it was realized this innovative teaching format was effective. The LS teaching method served to awaken the interest of the students and broaden their understanding of Physics especially as it relates to their everyday life.

Another fact that deserves to be highlighted is about the teaching practice. Different aspects such as positioning in the classroom, voice imposition or organization of the whiteboard were checked by colleagues who went to watch the research lessons and suggestions were given: "I realized that your handwriting was small on the whiteboard and the students who were sitting at the back of the classroom had difficulty in understanding what was written", said one of the colleagues who went to observe the class. In addition to this example, some suggestions were made about the class, such as: "The question the student asked about the acceleration of the rocket should have been further explored. It could generate a good discussion and without leaving the subject", commented another colleague about the kinematics class.

The LS' evaluation concluded with participant discussions on the last meeting (#11) along with analyzing the lesson plans and internship reports. During the LS activities it was perceived the students' lesson plans were changing. These plans revealed greater school student participation and did more than just transfer contents. It could be noticed the beginning of Professional Development (PD) by the pre-service teachers. This was because they thought about the class learning experience from developing and executing the lesson from the students' perspective as opposed to just using the textbook in planning the lesson.

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When the evaluative reports were analyzed, it was observed the pre-service teachers were involved more intently with the in-service teachers from school and the whole class. The pre-service teachers' speeches reflected it too because they commented that the classes were designed to promote student learning and they were more involved with the activities, as these were more understandable and closer to students' reality. "In my speed and acceleration class, there was a student who never took off the earpiece that sat in front and answered the questions", said the pre-service teacher who taught the research lesson at School # 1. She commented this generated admiration even in the class teacher who started to talk more with her and seek more student participation. This enabled the internship time to develop a deeper involvement between the university and the schools. Thus, it can be stated that the internship time was more pleasant and fruitful for all the participants.

During the process, the necessity of study was evidenced before teaching the subjects at the schools. The pre-service teachers, almost ending the training, sometimes were confused with simple concepts and the lack of confidence to teach basic contents. The collective work, although sometimes complicated in making a consensus, showed the advantage of sharing experiences from different viewpoints. The diversity of the expansion of the learning experience also occurred in the classroom environment.

The pre-service Physics teachers were satisfied with the results, even in such a short period. They commented that the LS activities were important to the point of impacting their entire teacher trajectories because before these activities they were only concerned with the content. "Before the LS activities I thought to teach Physics I should work a lot on the content to finish the whole textbook. I was wrong. I need to think about the student knowledge!" said a pre-service teacher who didn´t teach any research lesson, but he was a member of this group that designed collectively the lessons. There was no real concern for learning and LS changed that.

Discussion

According to the results, the pre-service teachers had low knowledge about basic concepts in Physics, their specialization field. In a way, this conceptual difficulty of pre-service teachers was not unexpected. Since the students' difficulty with the concepts of Physics, regardless of the level they are at, is already reported in the literature (Darroz et al., 2015; Faria & Takahashi, 2019).

In the beginning of this research the lesson plans were very simple and made it difficult for the students to think. This fact also occurred in other contexts such as Saudi Arabia (Alanazi, 2019), Germany (König et al., 2020), Italy (Gabriele et al., 2019), Netherlands (Janssen et al., 2019), etc. In the final stage of the research lesson planning, it was noticeable how meetings produced a greater knowledge collectively in the daily development of the subject content and the students' domain of the material. This process provides an enhancement and enrichment to the students' learning and retention. How the pre-service teachers were working at the schools could be observed quite effectively. As such, the lesson plans could be targeted according to the class level and class interest all while taking into account the available school resources, that are limited. These results were quite similar to the results presented by Boz and Belge-Can (2020), Coelho et al. (2014), Danday (2019), Lee (2019) and Mitchell (2014).

According to Fiorentini and Crecci (2013) there are, at least, three different recurrent types of practices considered potentially catalysts for Professional Development

(PD): reflective practices, collaborative practices and investigative practices. The authors stated that a professional community is where the PD tends to obtain greater success in the continuous process of transformation and constitution of the subject. The LS allows these three practices occur, as it provides collaborative action between partners during the investigative approach and allows partners to reflect in a group. The teaching and learning process and the PD result from collective ventures that may involve a partnership between university and school, rather than individual initiatives, on either side.

Dixon et al. (2014) commented that the fact that teachers allow colleagues to observe their classes and make comments in the end (feedback), enabling collaborative work, with shared classes, can improve the practice of these teachers. This was clearly noticeable especially in the 6th and 10th meetings, as the colleagues who attended the classes were able to suggest some simple things, such as writing in a bigger letter, speaking louder or different ways of integrating with the class in question, as it was presented previously on result section, the comments came from all the members of the group, collectively in a sense of community. Feedback is one of the most powerful tools to increase student learning (Hattie, 2009), in accordance with the results presented on this study, based on the observed lesson and discussion sessions.

The "new set of eyes and ears" (McConnell et al., 2012, p. 272) offers different perspectives about evidence in the classroom or indications of research articles to be read. So, based on the results, Lesson study (LS) demonstrated to be an important teaching improvement process to training the pre-service Physics teachers involved in this project. This may be a new way of improving teacher education in Brazil and making the pre-service teachers develop professionally. It is clear that it would be necessary to enlarge the number of participants in the next studies about LS in teaching training, taking into account the diversity of the Brazilian context. According to Baptista et al. (2012), the results from Portuguese context were promising for the first-grade teachers of mathematics, as well as the results from this study for pre-service Physics teachers. Also, Conceição et al. (2019) highlighted the positive contribution to improve the classroom communication among chemistry and physics pre-service teachers in Portugal. In this sense, LS could be considered for different school subjects.

Conclusions

The Lesson Study in the pre-service Physics teachers' education according to these results can be an important educational strategy. During the process it was perceived the pre-service teachers presented lack of theoretical background on Physics basic contents like movement and waves, for example. The activities of the study group achieved good results in the LS process because the pre-service teachers awarded these difficulties and they mobilized to dominate the contents.

The research lesson plans were built collaboratively, and the results from the schools were very good. The students participated more during the classes and their understandings related to the concepts were better because the Physics taught was near their daily lives.

Although the pre-service teachers (like the in-service teachers) did not use to work collectively, but during the LS meetings effective participation occurred by the pre-service teachers in study, planning, and classroom discussion activities. The LS activities provided real reflection of teachers in action at school and emphasized the significant role of the lesson plan in their practices.

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Based on these facts, it is highlighted the LS is an adequate teaching methodology as strategy to train pre-service Physics teachers, as reported. When the class aims at students' learning, and not just the transmission of content, it is necessary to consider who these students are and their previous knowledge. This was the starting point to implement lessons that could more easily achieve the intended learning outcomes.

More research is needed to better adapt this method to the Brazilian context, due to high diversity for this continental country. The pre-service teachers in this study managed to put themselves in the shoes of their students, developing empathy. This demonstrates that LS helped them to develop professionally and that they became more apt for teaching, as they reflected on their actions and prepared classes aimed to students' learning.

Although this research was carried out with a small group of pre-service Physics teachers, it was demonstrated the potential of the Lesson Study method in Physics education and teacher training of pre-service teachers. The research showed very promising results as a teaching improvement process. It is recommended to do more studies with the LS method in regards to pre-service and in-service Physics teacher education in Brazil, taking into account the country diversity, as well as better understand the impacts that research lessons have on elementary education students.

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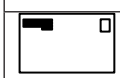

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