LESSON STUDY AS A PROCESS FOR DEVELOPING THE PEDAGOGICAL CONTENT KNOWLEDGE OF PRE-SERVICE PHYSICS AND CHEMISTRY TEACHERS

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Abstract

This research aimed to understand what physics and chemistry pre-service teachers learn within pedagogical content knowledge in a lesson study with the topic speed of sound, 8th grade. Participants were three pre-service teachers. This was a qualitative and interpretative study. Data were collected from participant observation, individual interviews and individual written reflections. Results showed that the participants developed their pedagogical content knowledge, when they identified the students' prior knowledge and when they discussed strategies to help students overcome their difficulties.
Keywords: *initial teacher education, lesson study, pre-service teachers, professional development, science education.*

Introduction

Pre-service teachers need to know how to support students in learning science. To achieve this goal is the key since what is taught and how it is taught impacts on what students learn (Darling-Hammond, 2000). Therefore, in initial teacher education, pre-service teachers should develop pedagogical content knowledge (PCK), that is, the knowledge they need to make scientific concepts understandable to students (Shulman, 1986). The nature of this knowledge has been the object of attention for several authors. In this research our vision of PCK is in line with the results of PCK Summit (Gess-Newsome, 2015), i.e., PCK is the teaching knowledge and skills required to plan and teach a lesson about a topic, to a specific group of students, and how these are put into practice in order to improve students results. The education literature acknowledges that PCK is dynamic and develops as a consequence of teacher involvement in lesson planning, lesson delivery and subsequent reflection on the teaching methods used and what the students learned (Nilsson, 2008). Nilsson and Loughran (2012) have justified that this knowledge is difficult for pre-service teachers since they still miss the ability to see beyond what they observe. Another inhibitor to the development of the PCK of pre-service teachers is that they tend to value a teacher-centred approach, preferring closed tasks to having students work collaboratively (Uşak, 2009). Nevertheless, there is an evidence that an organised and well-structured combination of the teacher education course syllabus alongside school activities will translate into significant professional

development (NRC, 1996; Zeichner, 2010). However, this combination is complex and it is not always feasible. As such, this is one of the reasons why some teacher education programmes are not very successful (Zeichner, 2010). Consequently, pre-service teachers do not develop in-depth PCK (Feiman-Nemser & Parker, 1990) and they are not able to use what they know to help their students learn (Gess-Newsome & Lederman, 1993). Accordingly, teacher education programmes need to promote effective collaboration between the university and the school and assist pre-service teachers to understand what is behind the difficulties experienced by the students, how these impact on lesson planning and delivery and what these teachers can do to help students learn. In lesson study (*jugyo kenkyuu*, in Japanese), educators, teachers and researchers support pre-service teachers to solve problems related to student learning and to reflect on the impact of the teaching decisions put into practice in the classroom. Research results on the use of lesson study as a teacher education process for pre-service teachers have been promising (e.g., Munthe, Bjuland, & Helgevold, 2016; Zhou, Xu, & Martinovic, 2016). However, there is scarce research regarding their potential in the development of PCK, even scarcer in initial teacher education. This research aims to understand what physics and chemistry pre-service teachers learn within PCK when they participate in a lesson study in the teaching of the speed of sound, 8th grade, in a lesson lectured by a cooperating teacher.

Research Methodology

This research was qualitative and interpretive based on naturalistic observation (Erickson, 1986) and was carried out during a curricular unit of the master's degree in physics and chemistry teaching, with all students attending the master degree - first year, 2nd semester (Caroline, Philip and Sarah). This lesson study had two cycles of twelve sessions. The planning phase took place over eight sessions, followed by the research lesson (session 9) and the post lesson reflection (session 10); the second cycle included the second research lesson (session 11) and the respective post lesson reflection (session 12). In addition to the three pre-service teachers, the project leader of lesson studies (João Pedro) also participated in the sessions, the teacher of the curricular unit (Mónica), the cooperating teacher (Carla) and the researcher (Teresa). The two research lessons were taught by the cooperating teacher and the remaining participants in the lesson study were observers. Data were collected from the participant observation of all sessions using field notes and video recording (VR). Moreover, data were collected from individual interviews (I) conducted with pre-service teachers at the end of the lesson study, and from individual written reflections (IWR) by pre-service teachers carried out at the end of the lesson study.

Research Results

Pre-service teachers' learning progress regarding the teaching of the topic. During the planning sessions, there were discussions on how to help the students learn the speed of sound. Such discussions were a very productive learning opportunity for pre-service teachers to develop PCK. For instance, drawing on their reflections on the students' answers to the diagnostic task, the pre-service teachers were able to share what

students already knew on distance variable: "As positive aspects were highlighted the following strategies used by the students to determine the distance travelled by the ball as some of the students multiplied 2 m × 6 units, and others added up" (Caroline, VR), and "many of them have an adequate reasoning. Almost everyone calculated the distance travelled by the ball." (Philip, VR). As acknowledged by the pre-service teachers, the students showed understanding about distance variable. Accordingly, Sarah commented that "if the students already know what the distance is, they can calculate the distance of sound propagation by themselves"(VR). When considering the distance variable as an anchor for students to understand the concept of the topic, teachers developed their PCK in teaching the topic.

Pre-service teachers' learning progress about students' difficulties. In the post-lesson reflection session, the analysis of the students' results evidenced learning difficulties. According to Caroline, "the students calculated the speed of the sound dividing the distance of sound propagation by time interval, but they didn't understand its meaning" (IWR). Sarah, also mentioned "To calculate the speed of sound was not difficult for the students. I think, the most difficult was to understand what means 340 m/s" (I). As such, the strategies that may help the students were discussed. One of these strategies was suggested by Philip, when he said that "after the students calculated the speed of sound, the cooperating teacher could start a collective discussion by asking the following questions in the classroom: In 1 s what is the distance covered by sound? And in 1,5 s? How long does it take the sound to travel 340 m? And twice? These reasonings are an opportunity to encourage students to explain the meaning of the speed of sound and recognize the constant value of the speed of sound in the air" (VR). Caroline agreed with Philip when, in the interview, she mentioned: "to discuss the meaning of the speed of sound in the classroom was a good strategy. Because when students explain their reasoning, is easier to help them, is much easier" (I). So, the teachers' strategies to help students overcome their difficulties, showed that they developed their PCK about students' difficulties. Indeed, student background knowledge and difficulties had impact on pre-service teachers' instructional decisions.

Conclusions

Pre-service teachers of physics and chemistry need to develop their PCK. So, it is important to stimulate PCK in initial teacher education. This is achievable, as shown in this lesson study. Over the course of twelve sessions, pre-service teachers learned how to devise a lesson plan on a topic, considering issues related to student learning, to analysing learning results, and to identifying problems and how to solve them. These findings show the potential of lesson study in the development of the PCK of these three pre-service teachers. More studies are necessary with a larger sample to generalise the potential of this teacher education model in initial teacher education. Moreover, in this study, pre-service teachers observed research lessons taught by an experienced teacher. However, since teaching is a very complex activity, we consider important to carry out other lesson studies in initial teacher education with pre-service teachers teaching a lesson.

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