Continuing Professional Training of Mathematics Teachers: Learning through Mathematics investigation. [1]

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Abstract

This research studied the knowledge revealed by Pre-school teachers in a Continuing Professional Training Course, in which those teachers got involved in investigation activities based on mathematics geometric contents, reflected about their own teaching practices and conducted this type of activities with their students. This is a qualitative research in which the data was collected trough video-recordings and its transcriptions, as well as through an observation diary made by the researcher. In this case, the observation conducted was a participant observation. The analysis of the data focused on aspects that made us re-think the teaching practices and the professional knowledge of the teachers. From the analyses conducted it stands out the establishment of a new relationship with mathematics as well as a deeper knowledge of the mathematics contents. This allows us to re-structure the content knowledge needed in teaching as well as the teacher's role of a mediator and/or of participant in their student's activities.

Introduction

This research is based on the relevance of teaching geometry in the Pre-school levels and the possibilities of a Mathematics investigation in the teaching and learning of Mathematics. This research study considers the teachers as the primary agents of its professional development and constructers of its professional knowledge, as well as the learning revealed by the teachers that teach mathematics to 6 years old children, during their Continuing Professional Training Course.

Teachers Knowledge

By understanding that the teachers knowledge in a continuing process, including their Pre-service training, we can also consider that a teachers knowledge should be based on a reflective daily activity in order to improve their knowledge, understanding and teaching skills, so that the awareness of that knowledge can act as a trigger for its own development as Ponte

[1]This paper is part of a research conducted by the second author as part of her Master Thesis supervised by the first author.

(1994) and Nacarato and Paiva (2006) state. Therefore, it is pertinent to understand the teachers knowledge in the sense of how they perceive the knowledge used and required in teaching:

> Reflexive knowledge, plural and complex historical why, provisory, contextual, affective, ethical-politician (as its work objective are human beings), cultural forming a web, more or less coherent and entrenched, of scientific knowledge- rooted in science education, in the specific subject knowledge, in the subject curricula- and knowledge based on experience as well as pedagogical tradition. (Fiorentini, Nacarato & Pinto, 1999, as cited in Fiorentini, 2000, p. 190).

Still, as referred by Saraiva and Ponte (2003), when citing Serrazina (1998), the reflection that a teacher does about his experience is essential for being aware and able to analyse the assumptions that make sense in the teaching practices and therefore, to improve its practices and deepen its understanding.

So, according to theoretical evidence presented in the next chapter as well as to our methodological choices, by conceiving the possible learning that a teacher does in a teaching-learning process, we consider that a mathematics investigation can be a trigger for discussion, problematization and enlargement of a teachers knowledge.

Mathematics Investigation and Geometric Teaching.

The mathematics investigations used during the Continuing Professional Training Course were designed taking into account what Fiorentini (2006, p. 29) considers as investigation classes:

> those that trigger, in classroom settings, tasks and open activities, exploratory and not guidelines to the students thought and that have multiple approaches, strategies and solutions (...) Depending on the way these classes are developed the activity can be restricted to a exploratory and problematization stage. However, if during the development of the activity questions and conjectures are made that can trigger a testing process, where attempts are made to demonstrate or prove those conjectures, then we have a mathematics investigation.

In a mathematics investigation, those that have developed the activity, through a critical

observation of a given situation, make the presentation of a problem. As Freire and Faundez (1985) state knowledge begins with a question. As the ability to make questions is the foundation of knowledge, it is considered the first mathematical activity. A mathematics investigation in a classroom tends to be compared to the mathematical activity of professional mathematicians (Abrantes, Leal & Ponte, 1996; Ernest, 1996), specially those connected to their attitudes and the nature of the activities, filled with curiosity, questioning, raising hypothesis, elaboration and testing of conjectures, justification, reasoning and socialization of the work conducted. These type of activity allows for error, emphasizes the problem solving process and, as D'Ambrósio (1993) states, a student hardly testifies it in a classroom.

In the case of geometry, Abrantes (1999) re-states the connection of this area of Mathematics with a mathematics investigation, which allows for the discovery of new concepts and problem solving strategies through the emphasis on intuition and visualisation. These types of activities do not require a huge number of prerequisites which contributes to a mathematics that goes beyond algorithms and recipes.

Teaching geometry, so that the students are able to understand space, placement, dislocation, development of abilities of perception and orientation, is key for the understanding, adaptation and exploration of the world around us. This is why geometry is so important at all levels of teaching.

Methodology and Procedures

This is a qualitative research. The subjects were four teachers: Laura, Guilhermina, Ana Júlia and Bianca. They all teach in public schools in an average size city, in São Paulo state, Brasil.

The data was gathered through field diaries, written records of the teachers and video-recordings done during a Continuing Professional Training Course aiming teachers that were teaching mathematics to 6 years old children. In this course the researcher acted as participant observer in which the observer is part of the situation observed, "through a direct and personal observation" (Laville & Dionne, 1999, p. 180).

In the Continuing Professional Training Course several investigation tasks with geometry contents were proposed to the teachers. Along with the investigation tasks performed by the

teachers, they had, also, to discuss aspects connected to the Pre-service and Service training as well as their own teaching practices. The teachers made efforts to implement investigation tasks in Mathematics teaching for 6 years old children, designing implementing possibilities and developing these type of activities in their classrooms.

The analysis was performed considering the theoretical framework related to teachers knowledge, geometry teaching and mathematics investigation in Mathematics teaching.

The data were grouped taking into account the main research question: *What are the knowledge revealed by Pre-school teachers when discussing geometry and it's teaching in an investigation context?* In this research paper, we contemplate analytical aspects such as Re-think teaching practices: re-construct teaching knowledge.

Re-think teaching practices: re-construct teaching knowledge.

The data gathered reveals that it is important during teachers training to provide moments in which the teacher can construct their own knowledge regarding mathematical contents. The teacher should perceive that production as a creative action that allows them to establish a new relation with mathematics that "calls for imagination, intuition, emotions, the ability to make conjectures, to compare, to accept an hypothesis until an explication is reached" (Freire, 1996, p. 88).

In one of the dialogues recorded, the teachers stand out the attitude of the trainer in not give ready responses, but, instead, in provoking them to find out, to think, stressing that this is also desirable to be done with children:

> Bianca*: I was provoking you... (...) The way you led things. (...)*
> Guilhermina: *She made you prove!*
> Bianca: *Not in a direct way, talking and explaining (...) but in a way that we were pushed... pushed to find out.*
> Laura: *pushing us, in fact.*
> (...)
> Laura: *to think!*
> Guilhermina: *That is what we are supposed to do with children.*
> Laura: *She didn't gave us a straight answer at any moment.* (Lamonato, 2007, p. 142).

This possibility pointed out by the teachers, where the tasks are open, challenging, in

which the teacher pushes the students to make discoveries, to justify them, became the main concern during the development of the course. It became a challenged for which the teachers still had no answers. Guilhermina presented her own discontent with her teaching as she considers that she over conducts her students instead of allowing them to discuss, think and come up with different responses:

> Guilhermina: *I can not think of an activity, (...) I am not happy (...) I don't know how not to lead the students, how to let them think, discuss and come up with different responses.* (Lamonato, 2007, p. 198-199).

The activities in Mathematics teaching in which the students can discuss, argue, have different responses, make new discoveries and not expect ready replies converge with the meaning of the mathematics investigations that the teachers were involved during the period in which the data was gathered.

At a later date, the same teacher – Guilhermina – conducted a investigation activity with her students. With a set of packages, the children discussed and decided how they could make a toy– the bilboquê[2]. In Guilhermina report, we stand out that the children raised hypothesis and tested them to decide which of the packages could be used to make the toy, as well as decisions connected to the proper size of the toy. Instead of doing what she used to do, the teacher did not lead the students or gave ready answers for the students to reach the same answer that she did. Instead, they were given chances to discuss, raise and test their hypothesis as well as to justify their choices.

> *Guilhermina: (...) I liked it because they were able to raise hypothesis. When I proposed the task, I placed 3 types of packages: a box of soap, a water bottle and a toilet paper role. They had to explain their choice Then they had to raise and hypothesis and justify. Then we did it. Afterwards they had to raise a hypothesis regarding the size of the toy. Again they raised hypothesis (...) The good was that they could actually see if their hypothesis was real or not.* (Lamonato, 2007, p. 210-211).

Guilhermina dynamics in this class reveals one of the ways of investigation tasks in pre-school teaching: *the teacher researches with the students*. This type of knowledge was developed

[2] Its a toy made of two parts, attached to one another by a string. When you do certain movements with your hands it is intended that one end of the string, a sphere for example, would fit on a whole on the other part.

by the teachers in the Continuing Professional Training Course in which they experienced, first hand, this type of activity and its advantages making them want to include them in their teaching practices.

Beyond the progresses revealed by the teachers in their teaching practices and dynamics, they also revealed specific content learning that were present in their reflections and worries related to their teaching skills and practices, as it was said by Guilhermina in a dialogue with Laura. These teachers considered squares and rectangles as polygons that belonged to different groups, that is, they did not perceived a square as a rectangle. After doing one of the activities of the Course this concept became clearer.

> Guilhermina: *When we saw it there, "the square is a rectangular", then I said: How am I going to differentiate them for my students?* (Lamonato, 2007, p. 189).

As Mizukami (2004) states it is not enough for the teachers to have intuitive or personal knowledge of a concept, principle or particular theory. The teacher should know the ways of transforming the contents according to the purpose of teaching. Still, the teacher should be coherent in terms of the knowledge related to a specific content of a specific area, including facts, concepts, procedures as well as ways that the knowledge is validated and constructed within the specific area. (Shulman, 1986; Mizukami, 2004).

Conclusions

The data gathered by Lamonato (2007) suggests that the mathematics investigations developed by the teachers during the course has enabled the reconstruction of knowledge related to geometry contents as well as a restructure of the teachers role and its actions in the classroom. The teachers role must enable the students to construct their own knowledge through experiments, questioning, raising hypothesis, making conjectures and through validation or rebuttal tests together with the discussion and argumentation of the ideas presented. These processes are common in a professional mathematical activity but diverge from the lecture and learning of ready-made ideas usually present in a school setting.

By increasing his knowledge about mathematics investigations, the teacher was lead to question its own teaching practice which had very positive results as it was revealed by their

worries and changes made in their practices.

In conclusion, we can state that the factors that act as triggers for improving their professional knowledge are:

-the open structure of the tasks and the consequent investigation,

- the shared reflection based on the practices and the training,

- bringing the research closer to the teachers training,

- a small training group that allows for all the participants to hear and be heard allowing for the teacher to act as its own agent of development.

References

ABRANTES, P. (1999) Investigações em geometria na sala de aula. In VELOSO, E., FONSECA, H., PONTE, J. P. & ABRANTES, P. (Org.). *Ensino da Geometria no virar do milénio*. (pp. 51–62). Lisboa: Departamento de Educação da Faculdade de Ciências da Universidade de Lisboa.

ABRANTES, P., LEAL, J. & PONTE, J. P. (1996), Introdução. In _____. (Org.). *Investigar para Aprender Matemática.* (pp. 1–4). Lisboa: Grupo "Matemática Para Todos - investigações na sala de aula"(CIEFCUL) e Associação de Professores de Matemática.

D'AMBRÓSIO, Beatriz S. (March, 1993). Formação de professores de matemática para o século XXI: o grande desafio. *Pro-Posições*, 4 (1). 35–41.

ERNEST, P. Investigações, resolução de problemas e pedagogia. (1996). In ABRANTES, P., LEAL, L. C. & PONTE, J. P. (Org.). *Investigar para Aprender Matemática*. (pp. 25–48). Lisboa: Projeto Matemática para Todos – investigações na sala de aula e APM.

FIORENTINI, D. (2000). Pesquisando com professores: Reflexões sobre o processo de produção e ressignificação dos saberes da profissão docente. In MATOS, J. F. & FERNANDES, E. (Eds.). *Investigação em Educação Matemática: perspectivas e problemas.* (pp. 187–195). Lisboa, Portugal: APM.

FIORENTINI, D. (2006). Grupo de Sábado: uma história de reflexão, investigação e escrita sobre a prática escolar em matemática. In FIORENTINI, D. & CRISTÓVÃO, E. M. (Org.). *Histórias e investigação de/em aulas de matemática*. (pp. 13–36). Campinas, SP: Editora Alínea.

FREIRE, P. (1996). *Pedagogia da autonomia: saberes necessários à prática educativa*. (31th ed.). Coleção Leitura. São Paulo: Paz e Terra.

FREIRE, P. & FAUNDEZ, A. (1985). *Por uma pedagogia da pergunta.* (5th ed.). Coleção Educação e comunicação: v. 15. Rio de Janeiro: Paz e Terra.

LAMONATO, M. (2007). *Investigando geometria: aprendizagens de professoras da Educação Infantil*. Dissertação (Mestrado em Educação) – Universidade Federal de São Carlos. São Carlos, SP.

LAVILLE, C. & DIONNE, J. (1999). *A construção do saber: manual de metodologia da pesquisa em ciências humanas.* Porto Alegre: Editora UFMG / Artmed.

MIZUKAMI, M. G. N. (2004). Aprendizagem da docência: algumas contribuições de L. S. Shulman. Revista Educação, 29 (2). Retrieved December 08, 2005, from http://www.ufsm.br/ce/revista/revce/2004/02/a3.htm.

NACARATO, A. M. & PAIVA, M. A. V. (2006). A formação do professor que ensina matemática: estudos e perspectivas a partir das investigações realizadas pelos pesquisadores do GT 7 da SBEM. In: _____ (Org.). *A formação do professor que ensina matemática: perspectivas e pesquisas.* (pp. 7–26). Belo Horizonte: Autêntica.

PONTE, J. P. (1994). O desenvolvimento profissional do professor de matemática. [Electronic version]. *Educação e Matemática*, n.31, p. 9-20.

SARAIVA, M. & PONTE, J. P. (2003) O trabalho colaborativo e o desenvolvimento profissional do professor de matemática. *Quadrante*, v. 12 (2), 25–52.

SHULMAN, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Reseacher*, n. 15(2), 4–14.