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Observatório da Educação: an Investigation of Teacher Professional Development of Mathematics Teachers

Angélica da Fontoura Garcia Silva[1], Tania Maria Mendonça Campos[1], Ruy Cesar Pietropaolo[1]

1) Universidade Bandeirante Anhanguera UNIBAN, Brazil.

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Angélica F. Garcia Silva
U. Bandeirante Anhanguera

Tania Maria M. Campos
U. Bandeirante Anhanguera

Ruy Cesar Pietropaolo
U. Bandeirante Anhanguera

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Abstract

This paper aims to present the results of an investigation regarding the professional development of teachers who worked in the early years of basic education. The qualitative research involved teachers who participated in the *Observatório da Educação* project (MEC/CAPES). Because of the data amount, we choose to present the data analysis based on the work of only one teacher, who is considered as a legitimate representative of the whole group. All data were collected through direct observations, recordings, questionnaires, interviews and reflective *relatorios* on the implementation of the activities to their students. Data analysis was based on Ponte, Garcia, Shulman and Serrazina' studies, researchers that study the development and professional knowledge or reflection. This study reveals that the experiences during the training process favoured the redefinition process of mathematical content and teaching beyond reflection on practice.

Keywords: Teacher education, teacher professional development, teacher professional knowledge

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Observatório da Educação: una Investigación sobre el Desarrollo Profesional del Profesorado de Matemáticas

Angélica F. Garcia Silva
U. Bandeirante Anhanguera

Tania Maria M. Campos
U. Bandeirante Anhanguera

Ruy Cesar Pietropaolo
U. Bandeirante Anhanguera

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Resumen

El propósito de este artículo es presentar los resultados de una investigación sobre el desarrollo profesional de los docentes que trabajan en los primeros años de la educación básica. La investigación fue cualitativa, los profesores implicados participan de la formación en el marco del Proyecto Observatorio de la Educación (MEC/CAPES). En función de la magnitud de los datos obtenidos, se decidió presentar el análisis de los datos de una profesora, considerándola como representante legítima de todo el grupo. Los datos fueron recogidos por medio de observaciones directas, grabaciones, cuestionarios, entrevistas y relatos sobre la aplicación de las actividades a sus alumnos. El análisis de datos se basó en estudios de Bridge, García, Serrazina y Shulman sobre desarrollo y conocimiento profesional. Este estudio revela que las experiencias durante el proceso de formación favorecen la reinterpretación de los contenidos matemáticos y de su enseñanza y aún más la reflexión sobre la práctica.

Palabras clave: Formación del profesorado, desarrollo profesional del profesorado, conocimiento profesional docente

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This article aims to present a study conducted during the training of a teachers group in the early years, developed in a Graduate Program in Mathematics Education. This research was developed within the *Observatório da Educação* –a research and training project funded by CAPES.

The purpose of this project is to establish a collaborative group of researchers, graduate students and professors who teach mathematics, whose purpose is to analyse the changes in teaching practice and teachers professional development who teach for the early years of elementary school, when these are imbued to promote curricular innovations in their classes. Fifty-one public school state-wide teachers were involved in the project so far.

The continuous formation process referred this research has so far developed three modules in the period from 1st April 2011 to 3rd July 2012. Each module was divided in eight sessions, three hours each.

The first training module –Mathematics in the early years: Troubleshooting Conceptual Additive Field– aimed to promote reflection about the teaching processes and learning concepts regarding this issue, taking into account the theory and analysis of Vergnaud and also the students production involved in the training process. The following two modules –Mathematics in the early years: Space and Shape– aimed to encourage the reflection about the geometry importance for the students training and also about strategies for teaching concepts related to this theme, especially the characteristics and properties of three-dimensional and two-dimensional shapes.

For this article, we chose to analyse the professional development of only one teacher, who was named as Teacher Margarida, because she was the legitimate representative of the participants majority in these three modules.

So, as most of these participants, this teacher is an Educator and has over 15 years of teaching. It is worth mentioning that the teacher participated in the modules, and was engaged in implementation of the suggested activities in her classroom and brought the performance results of the students for the group discussions. As the other teachers, she admits having difficulties in learning and teaching mathematics.

We sought to identify different factors that may have interfered in this teacher professional development when she was part of a formation process

whose purpose was the reflection over practice. Therefore, we present an analysis of her participation in this process that included a reflexive memorial and interviews given to researchers during different stages of training.

Hereafter, we present the theoretical foundation, the methodology research and a summary of the data analysis obtained through the interviews and activities undertaken by Teacher Margarida, the main subject of our study.

Teacher Professional Development

The Professional Development of Teachers began to get the researchers interest from the 1980s. Since then, this research area has been developed due to its importance for the educators.

In the 1980s, Fenstermacher and Berliner found that professional development is related to group work and training processes. For these authors the professional development:

> (...) Has become an activity that includes more than one teacher acting as an individual (...) a subject of teachers groups that often work with specialists, supervisors, administrators, counselors, parents and many other people who are connected to the modern school. (Fenstermacher Berliner, 1985, p. 282)

In the 90s Fullan & Stiegelbauer and Sparks & Horsley also related the professional development to training processes, since they emphasize the expansion of knowledge, skills or attitudes. To the authors professional development is defined as:

> (...) any activity or process that seeks to improve skills, attitudes, understanding or action in current or future roles. (Fullan & Stiegelbauer, 1991, p. 3)
>
> (...) process that improves the knowledge, skills or teachers attitudes. (Sparks, Loucks & Horsley, 1990, pp. 234-235)

This rapprochement between formative processes and professional development is not supported by all researchers. Ponte, Guimarães, Canavarro, & Abrantes (1997), for example, shows the distinction between these two concepts. The author also states that formal training (initial, continuing, specialized and advanced) should be considered only as a necessary support for the professional development. According to Ponte et

al, this concept is broader than that of teacher training, as it corresponds to a growing process:

> (...) of its jurisdiction in terms of teaching and non-teaching practices in restraint of its activity as an educator and as an active element of the school organization. Professional development relates to the aspects of teaching, but also to the general educational activities, personal and relational aspects and interaction with other teachers and the community outside school (Ponte et al, 1997, p. 44).

However, this author does not deny that there is an approximation of the training concepts and the professional development:

> (...) many jobs that currently take place on training are based on the idea of professional development. In other words, the idea is that the teachers training is about to perform their professional activity in a process that involves multiple steps and that, ultimately, is always incomplete (Ponte et al, 1997, p. 2).

In our study, we consider this dimension of professional development. Besides Ponte, we also considered the ideas of Garcia (2009) which presents an overview of the relation between professional development and professional identity construction. The author states that studies have considered professional development as a long-term process, which integrate different types of opportunities and experiences systematically planned to promote teachers' growth and development (Garcia, 2009, p.7).

Thus, the author articulates two aspects: the personal and the collective, which can involve the experiences in the workplace, on a formal and informal way. He thinks of professional development as a process that is constructed by teachers experience, wisdom and professional awareness (Garcia, 2009, p.11).

We observed that, during the research, which the author called personal and collective aspects as training sessions, whose focus was to reflect on their own practice, had an overall size to the extent that the whole group discussed these practices.

To better understand how the teacher thinks and acts we support the studies of Schön (1983) that influenced the spread of the reflection concept by arguing that professional knowledge is translated into a set of practical skills marked by reflection on different levels: *the action knowledge, reflection in action and reflection on action*.

Besides Schön we also consider Zeichner (1993) studies. For this author the understanding and transformation process of teaching presupposes a reflection about the practice. The author states that this process:

> (...) should begin by the reflection on his own experience and that kind of knowledge entirely taken from the experience of others (even from other teachers), at best, poor and at worst case, an illusion (Zeichner, 1993 , p.17).

Thus, our study took into account the experiences of the teachers who participated in the project. During training we try to examine the replies submitted by the students of the teachers involved. It is important to note that in all modules teachers volunteered to do researches in the classroom, which allows to extend the group discussions during the training process.

Regarding the relation between the reflection and the teaching and learning processes of mathematics, we use Serrazina (1998, 1999, 2010) studies. The author, while researching the reflection ability of mathematics teachers, noticed that there is a close relation between the ability to reflect on their own practice and their confidence. To Serrazina the reflection occurs:

> (...) when teachers gain confidence and are able to reflect on their practices. This requires a high degree of awareness that helps them to recognize their faults and weaknesses and take a strong desire to overcome them (Serrazina, 1999, p. 163).

Accordingly, we also consider the spaces for reflection on action led our study participants an opportunity to deepen the reflections occurring in action.

We considered Serrazina' studies, because it also gives the reflection a central role in teacher professional development, since

> (...) as they increase their teaching and mathematics knowledge, teachers can deepen their reflection (...) [and] the reflection causes action, because when teachers reflect they become more reliant on their ability to deal with mathematics differently. At the same time, they feel the need to learn more math to be able to propose different tasks in the classroom and engage students in a different mathematical activity. (Serrazina, 2010, pp.11-12)

We believe that the analysis of these aspects was essential for carrying out this study, once to investigate the professional development of teachers, we analysed the reflective memorials, testimonials collected during the training process and interviews at different times in training. Thus, we seek

to collect more than just a description of teachers' procedures, but data that might support the reflection of the participants, especially those related to vocational training and practice.

Another aspect investigated was the Professional Teaching Knowledge. For this, we rely on Shulman (1986) and Ball et al (2008) previous works. Shulman argues that teachers need to develop specialized content knowledge, the construction of which is protagonists –Pedagogical Content Knowledge. For this author, it is a combination of content knowledge and knowledge to teach it. That knowledge:

> (...) embodies aspects most relevant of the content to be taught. Within the category of pedagogical content knowledge I include, for the most regularly taught topics in a specific area of knowledge, the more useful representations of such ideas, the most powerful analogies, illustrations, examples, (...) conceptions and preconceptions that students of different ages and repertoires bring to learning situations (Shulman, 1986, p. 9).

According to this author teachers need to have different types of knowledge including Specific Knowledge, Pedagogical Content Knowledge and Knowledge Curriculum.

The categories established by Shulman (1986) were refined by Ball et al (2008) on common content knowledge and specialized; content and students knowledge and, finally, content and teaching knowledge. Thus, we observe the various aspects of professional knowledge to understand the teaching learning process.

Methodology

The research described here is qualitative, in the sense defined by Bogdan and Biklen (1999). We reiterate our option to present in this article, the professional development of just one teacher –Teacher Margarida– who work in the early years of basic education, participant of the training modules linked to the Observatório da Educação of the Graduation Program. We reaffirm that the teacher in question can be considered as representative of most participants, not only because of the standpoint of her initial training, but also because of her involvement in the proposed activities and conceptions about teaching mathematics in the early years. We justify this choice considering a principle shared by some researchers as Chizzotti

(2010), that a case study should be significant and well representative, so as to be able to support a generalization, allowing inferences.

The data were collected during 24 meetings for training, which were filmed. In addition, there were two sessions devoted to interviews. These data allowed us to observe the teachers' knowledge about the different mathematical content and the processes of teaching and learning, and the reflections made during the training process.

During the interviews, we investigated the perceptions and reflections of Teacher Margarida on her experiences during the participation in the training process. One of the interviews was conducted at the end of the second module and another twenty months after the beginning of the Project.

Our research subject has more experience with the 4^{th} and 5^{th} years of elementary school, so children 9-10 years. It is important to reiterate that the teacher graduated in pedagogy with an emphasis on early years education.

Presentation and Data Analysis

Initially, we present the data about the application of a problems list involving the Conceptual Additive Field and reflective report presented by Teacher Margarida. We also analyse her testimonies collected during the training process and interviews.

The Role of Reflection in the Process of Teacher Margarida Changing Practices

We reiterate that throughout the first module offer the group of teachers participating in the training, the opportunity to reflect on the Theory of Conceptual Fields (Vergnaud, 1990), especially the Conceptual Additive Field. We also encourage this reflection by analysing the output of the teachers' students involved in the training process. During this module teachers developed twelve issues and selected three of them to be offered to their students, so that all participants discussed these resolutions. Each teacher should also submit a reflective report.

Teacher Margarida described in this report the strategy used in her class and who later came to be the object of reflection. According to her, the first strategy was to discuss the problems in small groups of students, the teacher's explanations and finally individual resolutions.

After analyse her strategy, she concluded that her explanations went beyond simple systematization of discussions held in groups, since the individual solutions were identical and looked exactly her explanations. According to her, the students "realized the resolution in my speech and understood as the only way." This fact can be evidenced when the teacher says:

> I do not know if that was to be done, I believe the fact that the students have solved problems using only the operations, without using other strategies, hampered the perception if my class really knew how to do it and I didn`t find out how they thought to solve the problems. (Teacher Margarida)

When checking the incident, the teacher decided to hold the activity again with new problems, but this time, according to her, "trying not to give clues to the students." We observed both in the preparation of the report reflective, as the discussion in the training session, some signs that happened what Schön (1983) considers *reflection on action*.

It is worth noting that Teacher Margarida recognizes that her strategy limited the possibility of presenting different solutions when students solved the problems. It is possible to say that her decision-making, after reflection, ran from her awareness of the process. Accordingly, we agree with Serrazina (1999) that there is an intrinsic relation between the process of reflection and self-confidence. For the author this process helps the teacher to "recognize their faults and weaknesses and take a strong desire to overcome them." (Serrazina, 1999, p. 163)

It is important to say that Teacher Margarida, when shared her experience with other participating teachers, favoured the collective reflection of the whole group.

The new direction given by the teacher was important since she could identify a wider variety of strategies of her students to solve problems and better understand the process of learning concepts related to the Conceptual Additive Field. The following protocols can exemplify this fact.

By analysing the incident we observed that the students used different strategies to solve the situations presented and as Vergnaud (1990) has predicted.

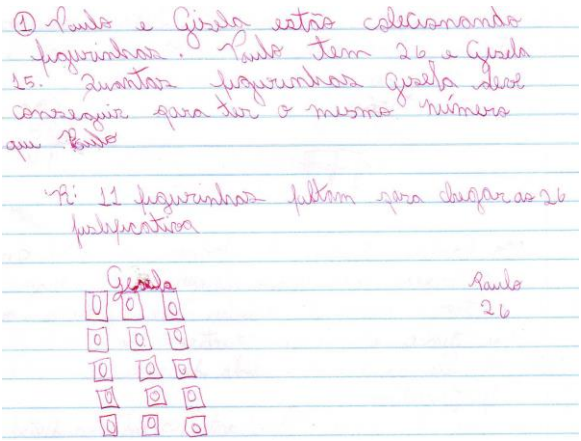

Figure 1. Student's strategy in the second application[1]

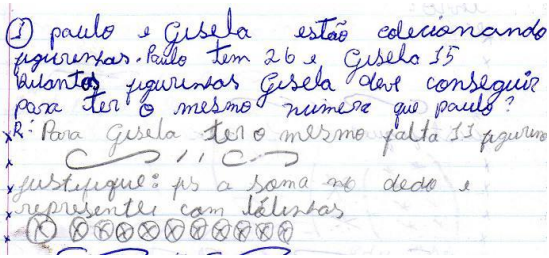

Figure 2. Student's strategy in the second application[2]

It is noteworthy that, after the fact, Teacher Margarida presented a new report, which presents the following reflections:

> The application of this work in the classroom not only promoted students' learning, but also contributed significantly to reflect on teaching practice, as well as directed a pedagogical observation on the construction process of new knowledge and the importance of presenting challenging situations that promote reflection and the search for new strategies during different activities involving scientific concepts. (Teacher Margarida)

Thus, the analysis of the discussions that occurred in the training sessions and THE analysis produced by the students, as well as the accounts

given by the teacher, allowed us to observe signs that the reflective process influenced the teaching practice.

This fact leads us to Serrazina (2010) who believes that reflection plays an important role in the professional development of teachers. We observe, therefore, that the reflections that occur individually and in groups apparently supported Teacher Margarida's professional development.

Another important source of data considered in this study was Teacher Margarida's testimony, collected in an interview two years after the participation in the *Projeto Observatório.* Hereafter, we present an analysis of data in which the Professor tells her vision about the training process.

In her testimony, the teacher describes the formative process and highlights its importance to the reflections on her own practice. This fact confirms what Schön (1983) calls as *reflection on action*.

Another significant point to consider was on her experience developing problems for students:

> In the first [module] we saw problems; I think it was crucial to understand how to develop these problems (...). Because sometimes we create a math problem and think everything is fine and actually it's not, for example, sometimes the question itself gives you the answer, sometimes we produce several problems involving the same idea, I worked a lot with prototypical problems, especially those who point out the parts and ask the whole [referring to the composition 1] (...) I think this was a very significant point. (Teacher Margarida)

The teacher's reflections certainly bring discussions about the *scheme concept* of Vergnaud (1990) and the prototypical problems of the Conceptual Field Additive, ranked by Magina et al (2008) as less complex. Also related to the study of the Conceptual Fields Theory, the teacher says:

> To understand a little bit about Vergnaud was very important. We will not tell the student that is a transformation problem (...) but understand what the problem is theoretically and after that, work in the classroom. I think the theoretical part is very important for the teacher. It is fundamental to understand the concept and then work on it. I guess the more good will that I had; I was missing a little bit of this theoretical scientific knowledge. (Teacher Margarida)

Professional Knowledge and Professional Teacher Development

In the second and third modules we have developed themes related to geometry. In her statement the teacher discusses her interest on this subject and suggests that her initial training was not adequate to teach geometry. For the teacher:

> The geometry modules interested me a lot and broadened my horizon, I had many doubts about some concepts, especially when it comes to methodology and didactics, it was a little tricky for me. I think I learned many things. It made the work with the students easier, but it doesn't mean that we did not work before, we even used to work trying to know how we could find the way, but we did not have that pedagogical look (...). (Teacher Margarida)

Regarding this point the teacher explained the difficulties related to the specific knowledge about geometry:

> The geometry that I had learned, the little bit that I had seen was more connected to the geometric drawing. I did not know how to observe and how to look at the properties. The square and the geometric shapes were presented in general, but the observation of the properties became clearer during our discussions in the course. We had the opportunity to work on the polyhedral and analyse round forms. It was a cool experience because it also developed the pedagogical part. I did not have this experience, so it was hard to work with the student. (...). (Teacher Margarida)

In fact, it was possible to realize the teacher's difficulties in relation to the specific geometry content. The following example shows the lack of knowledge about planning a polyhedron, or, at least, unawareness of the meaning of "planning."

In an interview conducted one year later, the teacher made the following analysis of her representations:

> At first I think I meant to represent a box, I did not think the box was composed of geometrical figures [referring to the polygons that form the faces]. In the first planning I made two drawings [referring to the representations], the first one I only drew the sides, I realized I had to draw the bases, but when I did it, I realized I drew only one of the bases (Teacher Margarida)

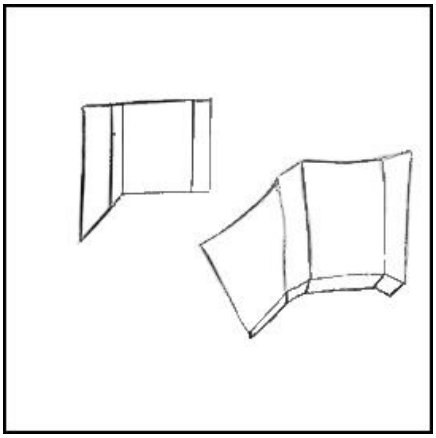

Figure 3. Representation of planning presented by Teacher Margarida

This analysis leads us to infer that the difficulties are beyond the teacher's representation of planning the figure in question –her considerations also suggest questions regarding the classification of geometric figures and solids.

We asked her to analyse the second representation, after attending the sessions in which we discussed the planning of prisms and pyramids. The representation of planning is given below:

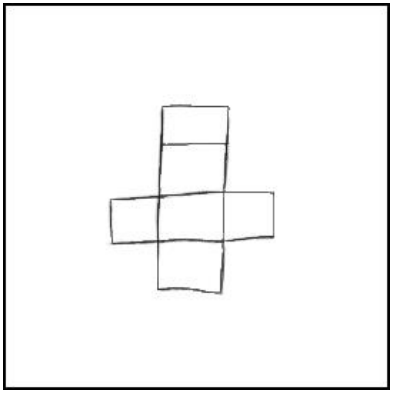

Figure 4. Representation presented by Teacher Margarida at the end of the 2nd module

When the professor analysed this representation, she said that at that time she learned how to do the planning during the course and, according to her perception:

> I already knew what was to be done, because in the course we had worked on eleven ways to plan the cube, for example. At first I did not plan it correctly, I drew a folded box and did not draw the bottom, but when I tried again I drew another one with few more corrections. (Teacher Margarida)

The testimonials given by Teacher Margarida allows us to infer that the activities developed during the training process not only expanded *content knowledge* of the planning solids, but especially the *pedagogical content knowledge*, considering the orientations, the proposed programs and the discussions on the results of the applications to students. This experience proved to be important for the teacher's pedagogical practice since it also states:

> In the second module, what caught my attention were the discussions about the geometry teaching. I started to look at geometry in a different way. I realized that geometry was present in our lives; it has meaning, because it has this structure. Then I started working geometry with my students. (Teacher Margarida)

We can also observe that Teacher Margarida started to value the proposals that encourage active student participation, what can be noticed on the following statement:

> The classroom helped me to work with the planning, I knew that the cube could to be planned, for example, but I didn't know there were other ways to do that [referring to the eleven ways to plan the cube]. Here in the classroom, for example, I presented one way. Now I let them to try as many possibilities they could find to plan the same cube. So they went to the blackboard and had the opportunity to do the experiment and I think it was very meaningful to them. Then they assembled and disassembled the cube: then they made the cube with the rods, and they saw the edges, vertices, and faces. So it became very clear. (Teacher Margarida)

This fact also can be observed in the Professor's pictures and presented during the interview:

Figure 5. Photos taken by the own teacher during the three-dimensional shapes lesson

When it comes to the students' performance, the teacher said that the students were involved and the learning was satisfactory.

> I'm sure my students liked much of math classes, because when I developed the project in the classroom, after finishing it, I noticed the positive feedback from students. Also, I heard them tell me about their findings in relation to this content. They learned, I can tell that. (Teacher Margarida)

We observed that the perception of teacher the learning of that specific content resulted in the expansion of knowledge for teaching:

> The choice for the teaching strategies is essential, and in my point of view, the practices favour the construction and search for solutions. It makes the teaching and learning process more harmonious and satisfactory and consequently keeps it safer. (Teacher Margarida)

This statement leads us to the studies of Shulman (1986) and Ball et al (2008), which discuss the teacher's need to develop the knowledge of specialized content for teaching. The following statement reiterates the need for mastery of content to develop and implement innovative strategies:

> Our main difficulty is when we don't know very well the content, because it prevents us from planning strategies that can enhance learning. I could done an interesting kind of work with my

> students, because I knew the content, I learned the content. Now, I can analyse a proposed activity in the book and make adjustments for my students. My teacher practice has improved. (Teacher Margarida)

From these testimonials we noticed the teacher's perception of the importance of the content knowledge being taught and its relation with the reflection on practice. This takes us to Serrazina (1998, 2010) who relates the professional teaching knowledge and the reflection to the teachers' professional development. For the author, when the mathematical and teaching knowledge extends, teachers can deepen their reflection.

Another strong point that the training process and research on the practice triggered the professional development of Teacher Margarida is that she is interested on a future participation in the selection process of the Master's Program in Mathematics Education. Thus, during the interview we asked her to comment about her interest:

> The biggest influence and what makes me want to keep studying and probably to participate in the next selection process of the Masters in Mathematics Education is the fact that I am taking the Observatório da Educação course. I thought that I was not competent to teach math because of the way I was taught ... I did not like math (...) Talking about this today is exciting ... because I found myself here. At the Observatory I had a great support to learn what I didn't know, I started to have a pedagogical point of view to teach mathematics. The discussions about geometry caught my attention, because I started to have a different point of view about geometry (...). Then I started to work geometry with my students. The gap that exists in the teaching of geometry in relation to official documents, such as Curriculum Proposal, National Curriculum Parameters and the guidelines contained in the documents of the *Secretaria* are rich documents and often are not considered by teachers and we think the problem is our education. I see that because of my own experience: I had a disability in my graduation, even though I've always wanted to work, if I don't have the knowledge of the subject I don't feel secure to create activities, to develop methods that interest my students. But is not only to learn the content, at the degree we must also discuss methods, researches. We must learn to teach mathematics. (Teacher Margarida)

It should be noted what Teacher Margarida expressed in this testimony are quite similar to other participants of the *Observatório* Project.

Conclusion

The analysis of this testimony indicates that Teacher Margarida got experience, developed a professional knowledge and by reflection, acquired what Garcia (2009) calls the *professional conscience*. This fact leads us to what Ponte (1998) and Garcia (2009) call Teachers Professional Development.

We defended that Teacher Margarida is in the full process of professional development because of the opportunities offered in the *Observatório*: at this place of training and research, she was able not only to learn math, but, above all, reflect on her practice, discussing researches and innovative teaching methodologies. The reflections made by the all the participants about the students' performance in activities at school, certainly contributed to possibilities of changes in teaching practice.

The analysis of Teacher Margarida's speeches also allows us to say that when the teachers select, organize, develop and direct learning situations, they should have learned the content. However, we cannot think that all training courses should have only this guideline. It is necessary that teachers develop mathematical knowledge for teaching and it involves mainly didactic knowledge.

In summary, we defend in this article that in the training process is fundamental to present theories and research results that favour the reflection of teacher practice, in other words, is not just to promote reflection on what is already being done –which is essential– but also to study the possibilities to experience changes in this practice on the light of research and theory.

Notes

[1] Question: Paulo and Gisela are collecting stickers. Paulo has 26 and Gisela has 15 stickers. How many stickers Gisela must buy to Have Paulo's amount? Answer: Gisela must buy 11 stickers more to have 26.

[2] Question: Paulo and Gisela are collecting stickers. Paulo has 26 and Gisela has 15 stickers. How many stickers Gisela must buy to Have Paulo's amount? Answer: Gisela must buy 11 stickers more to have 26. I used my fingers to count and represent with circles.

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Angélica da Fontoura Garcia Silva is associated professor at the department of Pós Graduação Matemática, in Universidade Bandeirante Anhanguera UNIBAN, Brazil.

Tania Maria Mendonça Campos is associated professor at the department of Pós Graduação Matemática, in Universidade Bandeirante Anhanguera UNIBAN, Brazil.

Ruy Cesar Pietropaolo is associated professor at the department of Pós Graduação Matemática, in Universidade Bandeirante Anhanguera UNIBAN, Brazil.

Contact Address: Direct correspondence concerning this article, should be addressed to the author. Postal address: Universidade Bandeirante Anhanguera UNIBAN, São Paulo, Brazil. **Email**: angelicafontoura@gmail.com