TEACHERS' PROFESSIONAL DEVELOPMENT IN A STOCHASTICS INVESTIGATION COMMUNITY

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The aim of this work is to reveal how the formation processes adopted by this investigation community have enabled teacher's learning and, consequently, the professional development of all of the involved ones; and how Stochastic favours investigations in basic school teachers' pedagogical practice. It refers to a longitudinal study carried out by the investigation community composed by professors and basic school teachers who have Stochastic as their object of investigation. The group prepared sequences of teaching which were developed by the teachers at their classrooms, using audio and/or video recordings, besides students' written notes. This material, along with teachers' narratives, was taken as an object of discussion and analysis of the group. The results indicate how teachers have learned from their own experience and others' by analysing videotapes of the classes.

INTRODUCTION

This research was conducted within Grupo Colaborativo em Matemática (Grucomat — Mathematics Collaborative Group) linked to Universidade São Francisco. It consists of school teachers and academic professors. The group meets weekly and was devoted to a research on Stochastic for three years, collaboratively preparing tasks on Statistics and Probability to school students. These tasks were developed in the participating teachers' classrooms and were audio or video recorded. This material, along with the teachers' reports, was used as the object of discussion and analysis by the group, culminating in the systematization of these practices.

Stochastics was an object of study since it was inserted in Brazilian Elementary School (6 to 13 years old) curriculum by the last curriculum document created, the 1997 Parâmetros Curriculares Nacionais (National Curriculum Parameters). Ten years later, Costa's studies (2007) pointed out that within the region where our institution is inserted, few Mathematical teachers showed confidence to work with such content. So, taking Stochastic as an object of study, in order to analyze the teachers' learning, was a challenge for the group.

While school teachers recorded, arranged and analyzed their practices, the university professors analyzed their learning and professional development. For such analysis, the studies of Cochran-Smith and Lytle (1999) and Jaworski (2008) were used as theoretical basis. Those authors help us analyzing how the group constituted an investigative community. The aim of this paper is to demonstrate how the formative processes adopted by this group have enabled learning experiences for teachers and, thus, the professional development of all involved. It demonstrates as well how Stochastic has proved satisfactory to investigations in pedagogical practice of Elementary School teachers.

METHODOLOGY

Research was done by a qualitative approach of collaborative nature. The idea was to conduct a co-generative research (Greenwood; Levin, 2000). In this type of research, professionals and researchers work collaboratively. The researchers' role is to offer to the group knowledge from Educational sciences and other sources that may contribute to reflect and solve issues arising from practice. School teachers, knowing the problems and needs of the *locus* in which they operate, assist the researchers by defining the research object and obtaining and analyzing data. This type of research — based on the interaction between local and professional knowledge —, enables one to overcome barriers between academic research and pedagogical work, solving school's practical problems and generating new knowledge. The material for this analysis consisted of: audio recordings of the group's meetings, during which we have analyzed teachers' videos and written records, in which school teachers developed the sequences of teaching created in the group.

In Grucomat, the negotiation of functions is a constant practice. There is a previously established agreement about researches: this is a field for coordinators' academic research. During

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work, researches are developed in two axes: 1) the practice axis, where Elementary School teachers and/or postgrad students investigate issues related to the discussed topic under in its multiple dimensions: school students' stochastic thinking, the use of different platforms (games, software programs, videos), investigative environment in classroom, among others; 2) the teacher's training axis, where university professors investigates teachers' knowledge and learning teaching and the educational processes that enhance their professional development. When both axes converge, our concern focuses on the Mathematics teaching and learning processes, aiming to the construction of theoretical-methodological system of references about pedagogical practices and teacher's training.

THE ESTABLISHMENT OF A RESEARCH COMMUNITY

We believe Grucomat is an investigative community (Cochran-Smith, Lytle, 1999) that goes beyond addition Mathematics and Stochastics specific content. The formative processes adopted in the group were essential to the establishment of this community, particularly the use of videotaping as a way of documenting research. This was done in order to use classes as an object of analysis and discussion.

In this approach, teachers learn together about teaching by planning and examining actual classes. This exercise of analyzing classes, specifically in this Stochastics project, has allowed some learning as well as theoretical and methodological progress: identifying students' stochastic thinking and the role of probabilistic language in conceptual elaboration; adoption of methodological resources to teach in the classroom and methodological procedures for documenting research. Indications of such learning have derived from discussions held while watching the videos or in specific meetings called to analyze the video contributions for our professional development and to students' learning.

This investigative community, according to Cochran-Smith and Lytle (1999), doesn't try to establish dichotomies as formal knowledge and practical knowledge, or schools teachers' knowledge and university professors' knowledge. Instead, it is about understanding that school teachers, through intentional and systemic investigations carried out in the classroom, are able to extract theories from the produced knowledge. Such theories are made in local communities, where teachers work collaboratively, soughing to build a significant local knowledge, and the investigation is seen by the group as a way to transform teaching, learning and the school.

Teachers' systemic investigation implies recording, discussing and sharing classroom practices. In this sense, Grucomat, since its beginning, has encouraged teachers to record their activities, whether by freely reporting them or writing articles. Statistics and Probability contents have been proved suitable to analyze possibilities and solve problem solving from an investigative and critical perspective, whether for the group of teachers as for school students.

RESULTS AND DISCUSSION: TEACHERS' LEARNING IN STOCHASTICS

Writing is a practice of the group's participants. Each sequence developed in the classroom, teachers produce narratives of these classes. Narratives are initially oral, during videotapes analysis; afterwards they are written down in order to systematize and publish the results. Nevertheless, we highlighted as being fundamental to the professional development process the moment when teachers organized their experiences. Those moments happen when the prepare lectures or write papers to a magazine and/or a chapter for a Grucomat book (Nacarato, Grando, 2013). By writing about his/her own experience and sharing with his/her coworkers, the teacher experiences an intense time of reflection and perception about his labor. Besides, this write derives from a practical knowledge (Cochran-Smith; Lytle, 1999), taken as analysis subject; therefore, this writing is permeated by the reflections produced along the way. The teacher is no longer a consumer of theories produced by people strange to the classroom; now he/she plays the researcher's role.

In most of those systematizations, group assists its participants to write the text. Whilst Elementary School teachers, uninvolved with academic research, bring their practices to be analyzed, the coordinators collaborate with research's methodological tools. Everybody learns from it. We have assumed, therefore, what Cochran-Smith e Lytle (1999) denominate as "investigation as a way of life." Teacher Paulo's report indicates this movement:

> *I've learned a lot since 2003. I feel comfortable to open my classroom to trainees and Scientific Initiation researchers. I always ask them, "What are you writing down?" It is very important to my "teacher's being." As for the videotaped activities, I confess all felt unconfident before the new, I feared not using the right language. The collective construction was interesting*. (Teacher Paulo)

We therefore understand that this way of life was collaboratively built, and the teachers classes' videotapes were certainly an essential tool to achieve it. As related Teacher Paulo, "*We can bring to analysis the classroom reality's itself, and not a lab activity*." (Teacher Paulo)

This valorization of the teacher as a researcher within his/her own labor has enabled those teachers to acquire different behaviors within classroom, giving opportunities to the students to speak and listening to them, enabling students to create richer and bigger mathematical investigation possibilities. Teachers have been risking themselves more often and searching for a teaching method guided by discussion. Therefore, they overcome their insecurity, as declared Teacher Jaqueline:

> *Everything has been important, specially planning activities together. But when you go to the classroom and it doesn't work… Reflection and analysis are very important. For many times, teachers leave it aside and don't use that activity anymore. I've came to the group frustrated, but it gave me strength to go on. (Teacher Jaqueline)*

It shows the insecurity feeling that has impressed teacher before the adoption of new subjects in schools curriculum.

The weekly meetings are an opportunity for exchange, sharing, searching for help for doubts and uncertainties. All of them had a chance to speak and were listened to. The things a teacher from the group had to say were of all's interest. So, we built an investigative community (Jaworski, 2008).

In order to exemplify the investigation community's movement, we present an extract of Teacher Paulo's class and the subsequent analyses made by the group.

When concluding an exercise sequence that explores the Probabilistic language, the group created the following exercise: *There are 19 students at a 7th grade classroom, made up by 11 girls and 8 boys. If someone writes down their name in pieces of paper, put the pieces of paper in a bag and randomly chooses a piece, the most probable is: a) to get a boy's name; b) to get a girl's name; c) it is equally probable to get a girl's or a boy's name; d) I don't know. Justify your answer*. We expected to evaluate if students have grasped the idea of probability, and if they would solve the situation only in the theoretical field. But one of the classroom's groups, made by 4 girls — called 'Rebeca's group' — did the experiment without the teacher noticing. When Rebeca herself reports to the class the answer and its justification, the teacher notes that they have done the experiment. They answered the question by choosing Alternative C, justifying that there is an equal probability to get a boy's name as to get a girl's name. Teacher Paul asks for an explanation. Rebeca again, speaking in the name of the group, says that the probability is the same because they have placed in a pencil case 11 girl's names and 8 boy's names and have choose 4 names which were 2 boy's names and 2 girl's names. Such experiment has enabled the group to conclude that the probabilities were the same. At the time, the teacher asked the students to write down their conclusions, but he wrote the answer on the blackboard. Once all groups have showed their conclusions, the teacher resumed their answers, which were on the blackboard, and discussed them with the students.

After concluding that the correct answer was Alternative B, once there was more girl's names, Rebeca's group disagree, saying that the difference between them was of only 3 names. The teacher uses the context to explain to the class that Rebeca's group did an experiment. He asks the group about the process of choosing the pieces of paper. Were they put again in the pencil case? The girls say "no", the pieces were left aside at each time. They say that the first piece contained a girl's name, the second contained a boy's name, the third, a boy's name and the fourth, a girl.

This situation at the classroom continues as teacher Paulo asks the students to evaluate the validity of the group experiment. After several interventions of the students and doubts about the validity, the teacher leads the class in a debate about how numerically represent each piece of paper

chosen from the bag, returning it to the bag or not. At the end the classroom decides that the piece of paper should be returned to the bag.

When this videotape of teacher Paulo's classroom was played at Grucomat, the debate among the participants was very rich. Starting from the question of Rebeca's group, it was possible to analyze it pedagogic an epistemologically. We present here some of the group's inquiries and conclusions:

1) Tasks must bring to surface some beliefs students have in relation to Probability. The planned/applied tasks by Grucomat and executed by students, especially those related to language, have created opportunities to them to express their beliefs and to discuss it with their teachers.
2) Tasks dealing with probabilistic language, when done before the resolution of problem-situations, will provide students with a linguistic repertoire that will help when explaining the found results. Some words were not intuitive to students at the beginning, such as probability, possibility, chance, probable, possible, certain. It required the creation of several contexts in which the words would make possible the processes of signification. Some results demonstrate how the understanding of terms such as "chance," "randomness" and others could both facilitate the expression of a probabilistic thinking and can lead to misinterpretation and meaning mistakes.
3) Tasks must include contexts in which students can conduct randomized experiments, because the former seem to be the basis that the latter can understand the equiprobability of an event. However, it is necessary to go further in relation to empirical probability, what can be possible in an environment of dialogue between teacher and students and among students, by sharing their ideas and allowing the circulation of meanings.
4) The empirical, subjectivist and frequentist conceptions of probability coexist in the movement of students' thinking (Shaughnessy, 1992). Hence, diverse tasks must be proposed, enabling students to reach the classical conception.
5) Statistical tasks must be meaningful to students, inserting them into the movement of scientific research, which is, preparing their own research project, creating the tools, implementing it, organizing data and communicating results, according to Lopes' ideas (2008).
6) The timing to insert theoretical probability will depend on the group and on the students' understanding of notions of randomness. Regarding to the situation described above, Teacher Paulo used probability calculation to legitimate a mistaken idea of Rebeca's group.
7) The exercises' propositions should be carefully created. Regarding to the situation described above, the exercise's proposition should inform that the piece of paper choosen from the bag should be returned to it. On the other hand, an open exercise may enable richer debates within the classroom, enabling the students' beliefs to come out. Conducting debates at the classroom will depend on teacher's attitude. As to Teacher Paulo, he had already developed this investigative attitude in his students, which was evident on the videotape: students get involved on debates and always have good ideas to share.
8) From teaching methodology standpoint, Teacher Paulo videotape, as well as others shared at Grucomat, enables us to learn how to deal with ideas divergence that arises in face of an exercise. How to return the question to students, so they can solve it by themselves; how to write on the blackboard the different answers given by students in order to ease the visualization and further debate?
9) From the research standpoint, participants have learned about using videos at the classroom; their potential and limits.

For the group as a whole, it was a moment of collective learning, as summarized by Teacher Paulo, "*I was pleased to see my students solving issues that are usually presented in textbooks of Mathematics, especially the High School ones, after an exercise on Probability, with a quite different approach.*" Others participants of Grucomat have also learned by Teacher Paulo's video, as stated by Daniele, a student that will be a teacher and participant of Grucomat in the future:

> *Here we sit, discuss, work together. As I am out of the classroom, the video helps me. I see how the teacher works, I see the students. Teacher learns from experience. I didn't have Statistics classes. I like the way Paul teaches, how he interacts with the students. He commands confidence. (Daniele)*

Since the video captures the behavior of the teacher, his dialogue with students, how he conducts collective work and organizes the sharing, it allows "teachers become more aware of their behavior in the classroom. They can reflect on their actions and then consider and discuss with others if those actions are effective or not"(Maher, 2008, p. 67). As Maher says, videos allow teachers to prospectively engage in the development of new teaching strategies, ensuring a more effective teaching of Mathematics for a greater number of students. We agree with her that videos have an incalculable potential to develop awareness of the way students mobilize their mathematical skills and build new ones.

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