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Characterizing one teacher's participation in a developmental research project

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This study was developed in the context of a developmental research project with eleven mathematics teachers and two university researchers working collaboratively during part of one school year. The paper analyses the participation of one teacher in the emergent inquiry community devoted to developmental research on tasks targeting students' statistical reasoning. Inquiry and modes of belonging to an inquiry community are present in the analysis of the data that were mainly collected in the collective meetings of the project. Preliminary results show that the teacher's participation is closely connected with an inquiry stance and critical alignment to her practice and in some instances to the project's goals.

Keywords: Inquiry community, statistical reasoning, developmental research.

INTRODUCTION

Assuming the important role of sound tasks and the use of technological tools to promote students' statistical reasoning, a developmental research project that seeks to deepen the understanding about the conditions for the development of that kind of reasoning in the classroom has been carried out by the two authors. Recognizing the teacher's central role in the classroom practice, the project assumed a collaborative nature, involving the authors, as researchers and a group of teachers who wanted to learn and share new ideas about the teaching of statistics in basic education.

The project was originally planned to be, simultaneously, a research and a teacher development project. Teachers had some previous contact with research in education and assumed the shared role of designers and researchers with the university researchers, as it happened in other developmental research projects (Goodchild, 2014). Our first reflections about the pro-

cess, made us consider the teachers' participation in the group and its nature, as we observed that some teachers expressed doubts, resistance and delayed the implementation of the tasks in the classroom. Addressing this issue is seen by us as an opportunity to question the dynamics foresaw for the project, as well as to understand the conditions for professional development that were created. Preliminary analysis of the work carried out in the group made us conjecture if implicitly were we trying to promote an inquiry community (Jaworski, 2008) since we intended that all participants would assume a role in the tasks' design and in reflecting about their use in the classroom. We did not have readymade tasks for teachers to apply and we did not intend to include them in the action only (Jaworski, 2008). In fact, teachers got involved in designing the tasks, making punctual or important suggestions or proposing alternatives. We, as university researchers, had many questions and few answers and wanted to learn from this experience. However, since this was a funded project, there were certain constraints to the collaboration with the teachers, namely: the sessions should follow a predetermined time schedule and the teachers' written reflections had to fulfil some conditions. All this made us question how teachers would conceal the interests of their teaching practice and the compromise they had with the project.

In order to understand the nature of the teachers' participation in an emergent inquiry community committed to developmental research on tasks targeting students' statistical reasoning, we started by developing an exploratory study focusing on one teacher in the group. Thus, this study is oriented by the following research question: how did one mathematics teacher's participation in an emergent community of inquiry evolve? With this study we also intend to reflect about the conditions created by this developmental project for teachers' professional development.

THEORETICAL BACKGROUND

This study comes from a developmental research project that assumes the perspective of co-learning among teachers and researchers as they design tasks and environments and investigate their students' learning. This is in line with many recent studies that see this collaboration as a favourable setting for developing teachers' knowledge (Potari, Sakonidis, Chatzigoula, & Manaridis, 2010). Specially, when implementing new approaches in their classroom teachers may benefit from working in collaborative settings that involve other teachers and researchers (Ponte, Segurado, & Oliveira, 2003).

In a developmental research project based on collaboration, teachers and researchers both learn in the process since they come together to develop teaching with the goal of improving students' experience of mathematics (Goodchild, Fuglestad, & Jaworski, 2013). Concerning the practice that evolves when teachers and researchers are collaborating, learning occurs through inquiring into it (Potari et al., 2010). According to Jaworski (2008) inquiry is "a mediational tool in social settings enabling development of knowing between people and hence the participative individuals" (p. 327). When inquiry is used as a tool for learning and development, we can talk about an inquiry community (Jaworski, 2008).

According to Potari and colleagues (2010) the difference between a community of practice as conceived by Wenger (1998) and an inquiry community is that in the later inquiry is part of the norms of practice and so it attributes great importance to critical reflection on the practice, as a form of meta-knowing. Inquiry is assumed as a stance in those communities which "means to challenge regular practice when it is ineffective, to reflect on the reasons why an approach might not achieve the intended outcome and to propose alternative approaches" (Goodchild, 2014, p. 313).

Goodchild, Fuglestad, and Jaworski (2013) consider that inquiry can be used "as a tool to be a form of critical alignment, that is engagement in and alignment with the practices of the community while at the same time asking questions, trying out new approaches and reflecting critically" (p. 396), and therefore critical alignment is crucial for the developmental process. Jaworski (2008) contends that in opposition to communities of practice that are more stable, the inquiry

community is emergent as "It does not avoid issues, tensions and contradictions, but deals with them as part of emergent recognition and understanding leading to possibilities for expansive learning" (p. 327).

In Wenger's work (1998), to belong to a community of practice involves three different modes: *engagement* – active involvement in mutual processes of negotiation of meaning; *imagination* – creating images of the world and seeing connections through time and space by extrapolating from our own experience; *alignment* – coordinating our energy and activities in order to fit within broader structures and contribute to broader enterprises. According to the author, when these modes work in combination in a community of practice, it can become a learning community. In terms of an inquiry community, critical alignment is also required as participants "engage in existing practices, aligning to some extent with those practices, but in a questioning or inquiry mode" (Jaworski, 2008, p. 314).

THE CONTEXT

The idea for the developmental project grew from our perception that statistics receives reduced attention from mathematics teachers in basic education in our country. They usually consider it an easy theme that does not require much time in its teaching. Recognizing the need to further understand how to develop students' reasoning using the technological tools at our disposal, specifically the *TinkerPlots* software, we envisioned that it would be more productive to involve teachers that are well informed and interested in this issue (Wells, 2007) in a joint enterprise of developing and testing specific statistical tasks in their basic education classrooms (5th to 9th grades), rather than to develop our theoretical ideas and then simply propose them to teachers. Previous experiences in collaborative research projects showed us that collaboration between teachers and researchers can produce important synergies (Ponte, Segurado, & Oliveira, 2003).

The proposal presented to the teachers concerned the participation in the developmental research project where two or three cycles of a sequence of task design, implementation in the classroom, analysis of results and refinement of the tasks would involve everyone in the group. To make collaboration possible in the multiple activities of the project we required that participant teachers were acquainted with research meth-

ods in education. Therefore the eleven mathematics teachers who accepted the invitation had diverse experiences in teaching statistics but all of them had a masters' degree in mathematics education or were attending such a course. However, the theme of statistical reasoning and the use of *TinkerPlots* software were new for the majority of the teachers in the group.

The work carried out was inspired in Design Based Research and followed a teaching experiment design (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003). The university researchers were responsible for the overall plan of the project and for conducting the research and the teachers for developing small scale teaching experiments in pairs. The university researchers also assume the ultimate responsibility for the tasks to be implemented in the classroom and the guidelines for teachers to elaborate the reports of the teaching experiments.

The project had financial support that facilitated the support of one research assistance to collect data and extended itself for eight months (from November to June), in a total of 13 meetings (three to four hours each). The first three meetings were dedicated to discuss big ideas concerning statistics reasoning and the required conditions to its development and to explore the software's potentials. The perspective of Garfield and Ben-Zvi (2010) of Statistics Reasoning Learning Environment (SRLE) was discussed within the group and the basic principles of Cobb and McClain (2004) for the design of the sequences of tasks were adopted.

The first cycle in the design research took place in the subsequent meetings. The tasks' characteristics were informed by the principles of SRLE, and they were designed with the intention of providing meaningful contexts in which students would be challenged to formulate questions based on real data, analyse data with the *TinkerPlots* and to make data based informal inferences. Teachers generally worked in pairs, planning the lessons, collecting data and reflecting about them. One or both teachers in the pair implemented the sequence of tasks in one's class, and were supported by the other in the classroom management and data collection. After finishing the sequence, the teachers elaborated a short written report about each task and shared their experience in the group meetings. The materials produced and the joint reflection in the group informed the tasks' reformulation and the conditions for their implementation in the subse-

quent cycle by other teachers. In the last two meetings the teachers presented, in pairs, the reports of the teaching experiments, and discussed them with the group. Finally, they produced a written report that extended their oral presentation and presented the main ideas on the experiment.

Retrospectively looking at this group, we start conceiving it as an emergent inquiry community, where co-learning inquiry occurs as researchers and teachers are learning together through inquiry (Jaworski, 2008) about challenging tasks, the students' activity with technology and the opportunities for promoting their statistical reasoning. We share Jaworski's perspective that in this group "teachers and didacticians are both practitioners and researchers" (p. 312). The collaborative engagement of all members, even though they assumed different roles and identities, made possible the development of insider and outsider research (Goodchild, Fuglestad, & Jaworski, 2013). The projects' extended live period also contributed to emergent relationships among the participants, mainly among the pairs, and among university researchers and teachers.

METHODOLOGY

This study represents our first attempt to analyse teachers' participation and their professional development in the project. Among the eleven teachers in the group, we choose to start by studying Maira's participation as an exploratory case study (Cohen, Manion, & Morrison, 2007), since we were surprised by her reluctance in applying the tasks that were being designed in the project in her class. She was one of the two teachers who had previous experience with the software, and showed more enthusiasm in getting involved with the project from the beginning. Nevertheless, for several weeks we doubted she would apply the tasks in her classroom. Finally, Maira decided to apply two tasks with one 5th grade class that she considered very problematic, and this gave us the motive for trying to understand how her participation in the inquiry community evolved throughout the project, which is our research question.

All group meetings with the teachers were audio-recorded and the teachers' written reports from their teaching experiments were collected which allows us to understand the teachers' participation in the emergent community of practice. In a case study

research, the identification of critical incidents or events is crucial for understanding the case (Cohen, Manion, & Morrison, 2007). Hence, after a careful reading of transcripts of all meetings, we looked for key moments in the project where Maira's discourse expressed more or less sense of belonging to the emergent community, and we used the notions of engagement, imagination and (critical) alignment (Jaworski, 2008; Wenger, 1998) to characterize her changing participation. According to the adopted methodology, the results are presented as a chronological narrative of events and combine description and analysis (Cohen, Manion, & Morrison, 2007).

RESULTS: THE CASE OF MAIRA

We identified four key moments related to Maira's participation in the project which define the four sections in the data analysis.

Discussing the theory

In the third meeting, the group discussed some theoretical principles concerning SRLE, based on one paper from Garfield and Ben-Zvi (2010). Maira connected the overall perspective about teaching of those authors with an episode from her classroom, which occurred a few days earlier. She expressed her difficulties in dealing with students' lack of interest in school, learning difficulties and disruptive behaviour in the classroom. Her decision to develop group work with these students produces evidence of her motivation to try new methods.

... this paper dates from 2010, but almost 20 years after my initial training course, we still debate the issue of the traditional teaching (...) Therefore there is a high resistance and I think it has to do with us ... I have been resisting but this week I promoted small group work [in that class]. I imagined it would be chaotic and this and that ... And again, I must admit: it didn't happen. The mistake is ours, because, perhaps, this was my best lesson since the beginning of the school year.

Conceiving her usual practice as different from the one reflected theoretically in the paper, Maira recognizes that there is a personal and general resistance to change, expressing *critical alignment* with it. The results gave her more confidence in assuming some risks with those students: "We have to belief and take

a chance even in [the perspective of] a chaotic lesson (...) and then, maybe, we really have surprises".

In this meeting, Maira also attempts to give meaning to some theoretical ideas by trying to think about their connections with the statistical knowledge she considers possible to develop with 5th graders. Speaking about possible tasks for promoting students' statistical reasoning, the main goal of the project, she considers that:

This kind of tasks that nurtures relationships is important, at least to develop their vocabulary and bring them close to this kind of argumentation, to the discourse that is used in statistical reasoning.

In the project's initial phase, Maira shows *critical alignment* to her practice, disposition to *engage* in the project, and motivation to *imagine* to do things differently. However, she is permanently thinking on the characteristics of the students and conjecturing about how those theoretical ideas (that the project seem to adhere to) might be adapted for her classroom (*critical alignment* with the project).

Thinking about the tasks

During the 5th meeting where one of the tasks for the 8th grade was designed, several discussions about the situations that could be adapted for the 5th grade occurred. In the next transcript, we observe that Maira shares her opinion about the tasks that she considers more suitable for her 5th grade class and the sequence in which they should be integrated.

They [the students] need to have data that are very close to them, so they can recognize them ... Because... this is a completely different representation from the ones that they are acquainted with. They are used to see graphic, pie graphics, bar graphics, at least in the press, isn't it? (...) But if we want them to manipulate those data with a deep understanding, what each one represents, I think that is has to be something closer to them, as in the first task [discussed] where they insert the data.

In this moment, the teacher expresses engagement with the project, making suggestions that reflect what she knows the students' needs in this school level, and the kind of work they will do with the software.

Later on, Maira begins to question the opportunity for implementing the tasks in her classroom. In the 7th meeting, she speaks again about the students' misbehaviour, lack of interest in school, resistance to learning and lack of autonomy. She rehearsed many strategies but none seems to succeed:

And also already tried to have a small text explaining what they have to do, [and asked them] "Let us read!" and "Let us do!", "No"! It's no use. (...) I really have to be by their side, even if it is only to read and to follow. So it will be an experience, perhaps... very difficult. (...) I have not been able to solve this.

It seems that in face of the circumstances, Maira starts questioning the possibility of developing the tasks as foreseen. It is still possible to identify her will to be engaged with the project, making part of the joint enterprise, but she also reveals a strong disbelief in obtaining any positive outcome from the implementation of the designed tasks with her students.

Discussing the lessons

Close to the end of the project, when teachers were presenting the results from their teaching experiments, Maira reacts to one comment of one of the two university researchers that she interprets as one of surprise for the lack of involvement of the students from a different teacher in the first lesson they used the software *TinkerPlots*.

I know it is hard to hear when we have software which we, as teachers, find fantastic, that "with this the students became more restless". But we have to think in a different way ... It is obvious that the software has great potential, and it would be great that this was a magic formula that when entering the classroom the kids would be attached and involved ... but that is not going to happen... However, I think we should not lose this enthusiasm!

It seems that Maira is interpreting the project expectations in a simplistic way: we presume to have excellent results with these tasks. Maybe she has assumed some disappointment in university researchers concerning the effort made in producing the materials for the classroom and having the students not so involved has they expected. It appears that she is also manifesting

her frustration by what she says next: "We have to consider that we have many obstacles".

Later in the same meeting, Maira reflects on the nature of tasks that have been designed and the difficulties her students had in dealing with their openness. She considers that such situation makes her reflect on the lack of opportunities their students previously had for working with such kind of proposals:

[Students say]: "I don't know how to do! What shall I do?". And they were a bit lost. And that is also due to the fact, maybe, that her teacher ... didn't work certain kind of situations that can be explored and not the traditional "Calculate ... Determine", isn't it? Hence, there is a lot to do, really. I consider that this make us [think].

In this meeting, Maira expresses her lack of engagement with what she considers to be one motivation in the project, as she interprets the expectation of the university researchers. However, the difficulties faced by her students in understanding the questions in the tasks made Maira question her own practice and therefore exhibiting also critical alignment with it.

Inquiry on the students' activity

In the subsequent meeting, when presenting the results of her teaching experiment, Maira shows a small video from one moment of the collective discussion in the class, to share with the group of teachers something she valued positively:

... I thought this is interesting because, if you notice, they are really discussing this issue. And this issue of being probable or not is not so obvious (...) Carlos seems to be surprised "How come you did not understand?" (...) But to her [another student] it was still confusing. And I think that the example given by Bianca was excellent and it was also very good that the other girl questioned that it was not the same thing, because in her representation a big difference was visible.

The interactions among the students are highly valued by Maira, as she identifies that they are discussing important statistical ideas, especially because this kind of social practice never occurred before in this class. In her final report about this experiment, Maira argues that the students' interactions that took place had "a noteworthy impact on improving the students'

argumentative discourse”, as well, allowed her to have “a clearer understanding of the informal inferences [that] emerged in groups and nurture a discussion of statistical ideas”.

However, Maira also questions her role in those moments, considering that she could have explored more deeply some statistical concepts:

... when he spoke about “more than 50%” ... I could have taken that situation but then I left it because, in the meanwhile, the other girl was trying to speak ... It might seem ease but that [discussion] was a bit confusing, and sometimes we cannot grasp all.

Another important remark concerning Maira and her colleague's reflection about the teaching experiments was their proposal of a new category to analyse students' statistical reasoning, because they felt they had interesting results which did not fit the framework it was provided by the university researchers (by Makar & Rubin, 2009). Maira explained that the category appeared as they observed that students made generalisations that rely on the context: “which are statements that they do that come from their personal experiences and beliefs”. In the final report, she refers explicitly the activity of her class and identifies different difficulties and limitations concerning students' statistical reasoning.

DISCUSSION

In this teacher's case it is possible to see elements connected with belonging to an emergent inquiry community. Maira engaged with the project in noteworthy ways since she expressed her ideas in the meetings, made an effort to understand the theoretical ideas conveyed, and was highly involved in reasoning about task design. Imagination was also present in her participation since she started to conceive the possibility of developing new approaches with the class even if this represented a big challenge for her. In an initial moment she appeared to believe that students could accomplish the project's expectations regarding the work with the designed tasks but as the project unfolds many doubts arise. We observe that Maira experienced a tension between the adherence to the joint enterprise of the group, with critical alignment to her established practice, and the non-participation in the

implementation of the tasks, assuming that those can only be applied in certain favourable circumstances.

Close to the end of the project, through her inquiry about the taught lessons with the tasks designed in the group, she came to express her critical alignment: there were difficulties and the results were not in line with what she had imagined according to the project's goal – developing students' statistical reasoning. From her point of view, the conditions for developing the lessons according to the adopted model were not adequate. It was her further inquiry on data from those lesson supported by some theoretical ideas that helped her to notice some positive results and to evaluate what happened in some instances of the teaching experiment in a different way. This made her question her attitude and role in the classroom, and the mathematical situations she usually proposes in the class. The critical alignment with her practice, presents “possibilities to develop and change normal states” (Jaworski, 2008, p. 314).

The analysis of Maira's participation in the project shows that some characteristics of an inquiry community were present in the practices of the group, being inquiry an important aspect to consider. The developmental research project created many opportunities for discussing ideas among the group, and stimulated the teachers to negotiate changes to practice. Therefore, inquiry emerges in the participation of this teacher as an attitude that informs her practice and that it is not reduced to a technique applied in some situations (Goodchild, 2014). The results concerning just one teacher reveal the project's potentiality for promoting teacher development through a cycle of collectively planning demanding tasks, experiment them in the classroom and reflecting collaboratively about the outcomes using one analytical framework.

However, when we analyse the tensions Maira experienced concerning her engagement with the project, it appears that her active involvement in the mutual process of negotiation of meaning about the joint enterprise and its purposes was absent in some instances. This requires further research to understand how this was experienced by the other participants, and the implications of this participation to their professional development.

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