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Restoried narratives on the agency and disputes of mathematicians and mathematics educators in the education of mathematics teachers

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We address agency and disputes of mathematicians and mathematics educators over a pre-service mathematics teacher education programme. The format of these courses has been debated (and disputed) within Brazilian academic communities over decades. We use a re-storying methodology (Nardi, 2016) to construct a fictional dialogue to present and analyze data from interviews with four retired lecturers affiliated with mathematics education, who played key roles in the development of the curriculum of the teacher education undergraduate programme in a large Brazilian university. We support our discussion through a framework that articulates teacher education and curriculum theory. Our analysis indicates that these disputes and agency take place within a landscape that transcends teacher education and reaches broader and more complex political and epistemological terrains closely related to the binarism of mathematics and mathematics education.

Keywords: university mathematics education, curriculum, mathematics teacher education.

Introduction: mathematics and mathematics education communities in the preparation of teachers

Nardi (2016) comments that the “relationship between mathematicians and mathematics educators has been the focus of debate since at least the 1990s” (p. 362), and adds that this relationship has been often portrayed “as at best fragile” (ibid.). Theories in the field of *curriculum* may help to unveil possible theoretical or political disputes in the terrain of undergraduate education in general, and undergraduate mathematics teacher education in particular. These disputes (Gabriel, 2013) tend to take place mainly because there are different knowledge areas involved, with differences in agency, acknowledgement by scientific community, and affiliation to scientific domains (mathematics in the Exact and mathematics education in the Social Sciences). The complexity of these disputes is highlighted by authors affiliated to post-critical curriculum theories (e.g. Lopes, 2013) and transcend a binarism that typically permeates this discussion. Our study explores this complexity.

The research we report in this paper is part of a broader study, which is the ongoing doctoral research project of the first author supervised by the second author and aims to investigate the curriculum of the undergraduate programme for pre-service mathematics teacher education in the Mathematics Departments at the Federal University of Rio de Janeiro, Brazil (UFRJ), since the 1980s, from the perspective of the institutional and political terrain in which successive curricular versions were conceived and developed. The study focuses on: (i) the institution, and its official

documents; (ii) the lecturers as actors who directly influenced these curricular versions; and, (iii) students (prospective teachers), whose professional preparation took place within this context.

In this paper, we report data and analysis from the broader study which address the disputes between Mathematicians and Mathematics Educators over the conception and development of these successive curricular versions. As previous research indicates (e.g. Nardi, 2008), teaching and management in undergraduate mathematics programmes, in particular curricula design, often involve negotiations and disputes between mathematicians and mathematics educators. This can be the case also when prospective mathematics teacher education is concerned. This is the focus of our paper in which we address the following research question: *How, and to which extent, do negotiations and disputes between Mathematicians and Mathematics Educators take place in the context of an undergraduate programme for mathematics teacher education?* We seek to answer this question through analysing the views of lecturers who are involved with this curricular design. Similarly to Nardi (2008), we characterise a participant as mathematician or mathematics educator according to their academic and professional activities, not necessarily their formal qualifications.

Research on pre-service teachers' education has been accumulating a significant theoretical corpus in the last decades, with strong influences from the field of Education, such as Shulman (1986), and Tardif (2013), and the field of Mathematics Education, such as Ball et al. (2008), and, specifically in Brazil, Moreira (2012), Moreira & Ferreira (2013) and Fiorentini & Oliveira (2013) on debates concerning the design of undergraduate programmes for mathematics teacher education. These debates are situated within broader considerations of research in university mathematics education, which, in recent years, has been consolidating significantly (Winsløw et al, 2018) and has been more attentive to institutional, disciplinary and curricular factors that, within broader political contexts, may influence the what, why and how of teacher preparation in undergraduate programmes.

In Brazil, there are separate undergraduate programmes in pure and applied mathematics (called "Bacharelado" and, in general, intended for future academic careers in Mathematics), and in mathematics teaching (called "Licenciatura", which legally certifies school teachers). The Brazilian Mathematics Education research community (e.g. Moreira, 2012; Moreira & Ferreira, 2013) has been advocating that undergraduate programmes for mathematics teachers should take more into account a professional-oriented perspective (Tardif, 2013), which should be informed by reflections on school practice, and should integrate more explicitly mathematical knowledge for teaching (Ball et al, 2008). In the Brazilian context, this debate is evidenced in the curricular reforms of undergraduate programmes for prospective teachers, at least since the 1980's.

For instance, Moreira (2012) critiques the influence of the "Bacharelado" over the conception of the "Licenciatura" programmes. This influence is mostly expressed by the "three-plus-one" model – three years on "mathematical content", followed by one year on "didactics" – which was dominant in "Licenciatura" programmes in Brazil until the early-1990's. In this model, pre-service teacher education consisted of two separate, non-overlapping clusters. According to Moreira, even though this organization has been progressively put aside in most Brazilian universities, its internal logic remains largely unchanged and still underlies current curricular structures, which are variations of

the “three-plus-one” model. One such variation is the inclusion of a third cluster of modules, the so-called “integrating disciplines”, which focus on mathematics teaching. However, mathematics teaching is often assumed to consist of practical knowledge (that is, an ensemble of techniques on “how to teach a certain topic”), with little overlap with other curricular components. Commenting on attempts to integrate these clusters of modules, Moreira (2012) argues that “the institutions do not manage to accomplish this task, because its accomplishment is impossible under the three-plus-one logic” (p. 1141). Fiorentini & Oliveira (2013) refer to this variation as a “quasi trichotomy”, alluding to an analogy with the dichotomic logic of types of knowledge (mathematical, pedagogical) needed for teaching. Moreira & Ferreira (2013) claim that, in teacher education in Brazil, there is an explicit clash between two strands – one that understands teachers’ knowledge to be plural in nature, with specificities emerging from school practice; and another that regards mathematical content knowledge as reference knowledge for teacher education and practice – and that in Brazil and elsewhere, there are disputes for “hegemony” over these two strands (p. 1001).

The Study

Context, aims and data production

As part of the broader research project, we conducted semi-structured interviews with four retired lecturers of the Mathematics Institute at UFRJ (IM-UFRJ), who played central roles in the curricular reforms over the last 50 years. Criteria to choose these participants included their degree of engagement with the undergraduate programme, including not only teaching but also academic administration positions during the above-mentioned timespan. The participants formally agreed with the study’s terms of confidentiality: their personal identities will be kept confidential, through the use pseudonyms, but the Institution (IM-UFRJ), which provides the context of this research, is known.

The interviewees are identified by the pseudonyms *Ana*, *Elis*, *Inês* and *Olga*. All have undergraduate and masters degrees in mathematics, and have worked as school mathematics teachers before becoming university lecturers. Ana has a doctorate degree in pure mathematics, Inês and Olga in mathematics education, and Elis does not have a doctorate degree. All have experience of research in pure mathematics, at least as masters students; and all migrated their affiliation to research in mathematics education during doctoral studies (Inês and Olga), or later, as lecturers (Ana and Elis). They are all currently retired, and were lecturers at IM-UFRJ from late 1960’s to early 2000’s (Ana from 1978 to 2017; Elis from 1964 to 1993; Inês from 1979 to 2010; Olga from 1976 to 1996). Their academic careers at UFRJ were marked by administrative positions in different levels, active participation in the design of successive curricular versions of the mathematics teacher education undergraduate programme, participation in the Projeto Fundação (a research and development programme on in-service teacher education, and development of instructional resources for the teaching of mathematics at elementary and secondary school). Furthermore, Ana and Olga participated as lecturers in the Graduate Programme in Mathematics Education since its creation in 2006; Ana until 2011 and Olga until now.

The interviews were conducted individually with each participant by the first and the second authors, and were fully transcribed. Interview questions aimed to better understand issues unclear

from the analysis of the official documents of the programme (which was part of a previous phase of the study); and, to explore participants' views on the relationships between Mathematicians and Mathematics Educators. The design of the interviews scripts was also intended to shed light on lacunar issues that emerged from the analysis of the official documents.

In this paper, we present parts of the interviews with focus on disputes over the undergraduate programme's curriculum. Thus, we focus on participants' responses to the two questions, stated below. As the interviews were semi-structured, these questions were not necessarily made to the interviewees at the same moment, and depended on the flow of the discussion with each.

Question 1: Do you believe that there are disputes between mathematicians and mathematics educators concerning the undergraduate programme for pre-service teacher education at UFRJ? If yes, for which reason(s)? If yes, how do these disputes take place?

Question 2: Do you believe that there is room for mathematicians and mathematics educators to work jointly in the design of the undergraduate pre-service teachers education curricula? If so, how?

We present data in a dialogic format (Nardi, 2016) which provides readers with an intimate look at contradictions and convergences in the participants' statements. We wish to allow readers different interpretations of the data, but we put in evidence the complexity inherent to the disputes that characterize the curricular terrain in which these participants have worked. We stress that the first and the second authors cannot be regarded as external or neutral observers. On the contrary, both are former students and are currently lecturers at UFRJ, working in departments (Application School and Mathematics Institute, respectively) with joint responsibility for the Licenciatura programme. They are therefore deeply involved with the institution under study. However, we do not see this as a compromise of the research, but as part of the research itself. That is, the results we report here are shaped by the perspectives, (shared) experiences, alliances and divergences of the interviewees and the researchers. What we report is a *restoried narrative* (Nardi, 2016) of the agency and disputes of mathematicians and mathematics educators in the undergraduate mathematics teachers education programme at UFRJ – that is, *a possible version of this story, through the lens of its actors* (participants and researchers) which gives prominence to participants' voices.

Data analysis method: From individual interviews to fictional dialogue among four lecturers

To put in evidence the voices of the participants, and to reveal points of agreement, disagreement, and possible contradictions, we gather the voices of the four participants in a fictional dialogue among the four interviewees, grounded on raw data extracted from the transcripts. Conducting the interviews individually was important to avoid inter-participant influence. By gathering them together, we aim to grasp the gist of their responses to the questions we wish to investigate. Such methodology is consistent with the logic that “narratives constructed from testimonials of actors who collaborated in educational research can provide access to the senses and emotions evoked at the moments of data collection, opening space for several interpretations” (Barbosa, 2015, p. 359).

In order to promote this interweaving of the participants' discourses, we use elements of the “narrative approach of re-storying” (Nardi, 2016, p. 362-3), a process for constructing a story from

original data, taking into account features, such as a problem, characters involved with a scenario in which they discuss and act upon the problem and its resolution. Here, we identify a common scenario evidenced in the interviews. This scenario, as presented by the interviewees, concerns the views on the relationships between Mathematicians and Mathematics Educators by the interviewees, who worked in the same institution, in a concomitant timespan, and with academic trajectories presenting similarities and distinctions. Each participant's utterances presented here correspond to their actual responses in the respective individual interviews. However, these interviews took place separately, and the order of these utterances was reconstructed by the authors in the process of composing the fictional dialogue. The interviewer's utterances are introduced in the re-storied dialogue in order to make sense of connections between interviewees' utterances, put together as a whole conversation. Thus, we offer a *re-reading* of the original data – as we believe to be the case for any kind of data description, including those that present full original transcriptions. The order of the utterances and the connections between them in the composed, fictional dialogue and the fact that the first and the second authors are deeply involved in the institution under study produce a particular interpretation of the story, one possible narrative¹. As Nardi (2016) points out, the proximity of the authors to the raw data, the transparency of the process that makes it “accountable and replicable” (p.364), and (specifically in this work) the possibility of establishing communication between Mathematicians and Mathematics Educators are important constitutive elements of the re-storying method.

To organize and present data, we firstly separated and classified the interviewees' statements regarding agreement or not about the existence of disputes between Mathematicians and Mathematics Educators. Then, drawing on the arguments posed by the interviewees, we constructed the sequence of responses and interactions between them, to create a fictional dialogue among five characters – the Researcher and participants *Ana*, *Elis*, *Inês* and *Olga* – in which the alternation of ideas and the views of the characters on the disputes at stake are present. Thus, we mean *fictional* in the sense that it is presented as a dialogue between five individuals but it is based on four conversations conducted with each one separately. Our design includes a respondent validation phase in which the participants read and comment on the fictional dialogue (at the time of writing, a preliminary part of this phase had been conducted through scrutiny of samples of the dialogue by critical friends in our research group). Our method resonates with that of Nardi (2008, 2016), where the composition of the fictional dialogue was based on interviews with groups of participants conducted separately and choices were made in the light of the study's theoretical underpinnings, literature influences and research questions. We now present a sample of the fictional dialogue resulting from this process.

A fictional dialogue among four mathematics lecturers and a mathematics education researcher

The *Researcher* asks whether there are disputes between mathematicians and mathematics educators concerning the Licenciatura programme. *Elis* says “No”.

¹ In order to allow readers to judge our composition and, possibly, even produce different interpretations, the raw data is in <https://drive.google.com/file/d/1BUm5gGCUQPvuyyhyuSag09WvNgnNXI16/view>.

Inês: I agree. Mathematicians have no interest in undergraduate teacher education.

Olga: As far as the Licenciatura programme is concerned, I don't know if there are disputes. But I believe there are disputes about hiring of new lecturers.

Researcher: What are the reasons for such disputes?

Ana: They want pre-service maths teacher education out of the Mathematics Institute.

Elis: I think mathematicians do not value teacher education. They think it's just not worth it, that it's a lesser thing.

Inês: But this happens because it's just not their interest. Their interest has always been the Bacharelado. It's to push good students to finish undergraduate fast, and put them in the pure maths graduate programme. It's not to prepare teachers, they never had that in mind. Their interest is to prepare researchers in pure maths.

The *Researcher* asks Olga why she thinks this dispute has to do with hiring new lecturers.

Olga: Those people with doctorates in pure and applied maths want to grab everything for them. They want all the new lecturers to them, everything to their fields, dynamical systems, algebra, differential equations. They think only that is mathematics.

The *Researcher* asks whether mathematicians from the Institute have really no interest in the curriculum of the Licenciatura programme at all.

Ana: They won't care about that. At most, they will say: "But why is there no Analysis at \mathbb{R}^n there?"; "Why is there no Calculus with Complex Variables?"

Elis: That's true. But it's funny how though they think Licenciatura has no importance, they yet believe that to be a maths teacher one needs to know a lot of maths.

Inês: People tend to keep retrograde positions: "let's not change anything". They stand against changes because they wanted Licenciatura under their own control. They stand against changes because they don't want to get involved with other programmes, only in the ones that they have interest in.

The *Researcher* asks whether there is room for mathematicians and mathematics educators to work collaboratively in the Licenciatura programme.

Olga: On the one hand, I think that it'd be very good, but I feel a little afraid of putting these lecturers with no link with mathematics education to teach modules in the first year, for example.

Elis: I think that, nowadays, maybe yes. For that, there must be more guidelines for lecturers, to try to get the mathematicians who are more committed more involved.

Ana: I think this is not possible. I'm too pessimistic, because I'm way apart from the Institute. But what I see is people with intransigent positions, which have no

factual support. There'll be collaborative work in the same way there is in the Engineering: we go there, teach our lectures, some do the job very well, other put a lot of effort for students to learn, other just don't care. This kind of "collaborative" work always existed, and will keep on existing.

Inês: I have no doubt joint work between mathematicians and mathematics educators is possible. But it has to be with lecturers who do not want to transform prospective teachers into prospective mathematicians. However, I think there are few people with this kind of mentality. I have managed to have very good partnership with a colleague with a doctorate in pure maths at the Institute. But that's rare.

Commentary on the dialogue and closing remark

Our interpretation of the participants' responses to *Question 1* suggests that they do not consider that such disputes exist, since there is no interest from the mathematicians with respect to teacher education. One of the participants conjectures that such disputes do take place when hiring new lecturers. The claim is that mathematicians appear to resist changes in the curriculum of the Licenciatura programme, and intend on keeping it close to the Bacharelado. These statements confirm that there are disputes, not with respect to different conceptions of mathematics teacher education, but to keep the political territories intact. As evidence for this, we also include the purposes to prepare new undergraduate or graduate students and to hire new lecturers to their own fields.

On *Question 2*, the divergence of opinions among the participants was remarkable. Thus, concerns towards the participation of mathematicians in the first year of the undergraduate programme, the need to engage mathematicians more interested in teacher education, the polysemy and fragility of the term "collaboration", and the highlight of the need to differentiate prospective teachers and prospective mathematicians are brought about in a debate that implicitly underlines the acknowledgement of disputes between mathematicians and mathematics educators.

Our interpretation of the debate around the two questions suggests that these participants, clearly affiliated with mathematics education, acknowledge the professionalization and the orientation to school practice as constitutive aspects for the education of mathematics teachers, as per, for example, Tardif (2013) and Nóvoa (2009). In this context, disputes initially seem to be over the consideration of what constitutes mathematical knowledge for teaching (Ball et al, 2008) in pre-service mathematics teacher education, as Brazilian research literature advocates (e.g. Moreira, 2012). However, the debate among the participants indicates that these disputes are situated in more strategic goals: the preservation of political terrains, where students in the mathematics department, here prospective teachers, are background characters who suffer the side effects of someone else's quarrels. As others have noted (Lopes, 2013; Gabriel, 2013), the complexity of the disputes we discuss briefly in this paper is evidenced by a displacement of a more local terrain (undergraduate mathematics teachers programmes) to a broader one (preservation of fields and professional agency). The divergence of responses concerning possible collaborations also reinforce this complexity, since the binarism and tensions between mathematics and mathematics education (Nardi, 2008, p.257-292) was not always prominent in the participants' utterances. Such inferences

were only possible because of the particular data analysis design we adopted. These utterances, which appeared initially in each individual interview, were intertwined, revealing convergences and contradictions at the same time as they produce dialogues on ideas that might not be present in a collective interview. These ideas are shaped under the authors' own standpoint, which, as we stressed earlier, is not neutral.

In the broader doctoral project, we are now collecting and analyzing data from discussion groups of former and current students of UFRJ's mathematics teachers education programme. The perspectives put forward in the overall study will therefore be enriched and complemented by our triad of analyses of institution (through analysis of official documents), lecturer and student data.

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