Scientific Mathematics and School Mathematics: Knowledge, Conceptions and Beliefs of Teachers and Mathematicians during the Development of an E-Textbooks

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Context: The Project

- The Brazilian Mathematical Society (SBM) has been running, since 2012, ***MatDigital Project***: design of digital materials (e-textbooks) for elementary school (grades 6 to 9, ages 11 to 14).
- ***MatDigital*** is under the ICMI's Klein Project.

Context: The Project

Klein's Ideas

- The rupture between school and academic mathematics → ***double discontinuity*** in teachers' education.
- The ***role of school***: assessing education needs and establishing categories that will determine the production of new knowledge (rather than simply spreading knowledge produced at the university).

Context: The Project

Klein's Ideas

- Overlaps with current mathematics education research (e.g. Shulman, 1986; Even & Ball, 2009).
- For instance, as teachers often see poor relation between their undergraduate courses and their classroom practice, they tend to acknowledge their prior experience as school students as a major reference to build up their practice, as if these courses had to influence to shape them as teachers.

Project Design

- **Collaborative work** of a design team of 60 members, including elementary school teachers and university lecturers (in line with Klein Project's guiding principle).
- **Subgroups** (of 4 or 5 members), coordinated by a central editorial board.
- All the subgroups as well as the central editorial board are formed by **school teachers and university lecturers**.

Project Design

- Each chapter of the e-textbooks was assigned to a subgroup.
- The subgroups were instructed by the editorial board to design the chapters in **effective hypermedia structure**. That is, the chapters should incorporate a network of different modalities of media would playing an actual role in the approach of the concepts.

Research Aims

- The **interplay between school mathematics and scientific mathematics on teachers' education and practice** has been extensively discussed on research literature.
- The **use of textbooks is an important component of practice**, since it largely influences the aspects of the content that will be given less or more stress and the way they are conveyed at the classroom.
- Therefore, **the investigation on teachers' choices concerning textbooks** can help to understand their conceptions on school mathematics on scientific mathematics and the ways their mathematical knowledge is connected with practice.

Research Aims

- In this paper we report results from an ongoing research on the **sharing and negotiation of knowledge and conceptions, on school mathematics and on scientific mathematics**, among the participants *MatDigital* Project team, through the process of e-textbooks development.

Research Aims

We understand school mathematics and scientific mathematics as formulated by Moreira & David (2003).

- **Scientific mathematics**: all the academic production, with its own rigour standards and warrants for truth, as accepted by the academic community at large.
- **School mathematics:** not only pedagogical strategies, but the whole context of the discipline in elementary education, with its production processes and knowledge validation criteria, as well as the choices of what to teach and what not to teach.

Research Aims

More specifically, we aim to answer the questions:

1. *What are the main **conflicts and consensus** about school mathematics that emerge from the discussions on the contents of the e-textbooks?*
2. *How is the **relationship between school and university teachers**?*
3. *How **different types of knowledge** – the knowledge provided by elementary school practice and the knowledge provided by academic research – **are activated** in the production of the e-textbook?*

Literature Review

- To Schulman, **teachers must take on a protagonist role on the construction of their own knowledge**, by forming a clinical view on pedagogical practices. Taking this perspective into account, the links between knowledge involved in pre-service education and knowledge activated in practice can help to understand the constitution of school mathematics (Moreira & David, 2003, p.59).
- Shulman's and Klein's perspectives are opposite to **conceptions that establish a hierarchy** between scientific mathematics, as the privileged source of knowledge, and constrain school mathematics, as a vulgarization of scientific knowledge (Chervell, 1990).

Methodology: Data Collection

- **Written sources**: notes taken during subgroups meetings; online discussion forums; and weekly reports of the subgroups.
- **Semi-structured individual interview** with a sample of six volunteer participants, selected to balance school teachers and university lecturers, and members who were working in different subgroups.
- Questions: the process of production of the e-textbook; the discussion within the subgroup and between the subgroup and the editorial board; choices of topics and approaches to compose the e-textbook.

Methodology: Data Analysis

From the initial exploration of the interview transcripts, most recurrent topics were identified. Four analysis units emerged from this data exploration:

1. *Why to teach mathematics?*
2. *Relationships between school mathematics and scientific mathematics.*
3. *Knowledge and reflections on practice.*
4. *The e-textbook and the collective construction.*

The discourse of these units was compared with data from written sources.

Results

Why to teach mathematics?

Both elementary school and university teachers used three kinds of justifications:

- applications to students' daily lives;
- development of specific skills (such as logical reasoning, sense of organization and mental strategy);
- preparation to following undergraduate studies.

Results

Relationships between school mathematics and scientific mathematics

- School teachers point out that they need to have a view of mathematics that differs from the view of academic mathematics, and is mostly associated with pedagogy.
- They recognize that their undergraduate courses at the university did not fulfil the preparation needed to classroom.
- Nevertheless, they regard the university as the source where they must seek for improvements to practice.

Results

Knowledge and reflections on the practice

- University lecturers believe their main contribution concerns providing a proper theoretical grounding and assuring mathematical correctness of the concepts.
- School teachers claim that their role regards the adequacy to what they call “elementary school reality”, assuring suitable (not too formal) language and approach.
- Both associate their respective roles with their objectives and experiences as teachers.

Results

The e-textbook and the collective construction

- Importance of developing a textbook that incorporates digital tools, as they can facilitate learning in several situations, such as visualization in geometry.
- Concerns about the weak preparation of teacher to use digital materials in the classroom.
- Importance the collaboration between school and university teachers is imperative, since each one has a specific.

Discussion

- **More consensus than conflict was found**.
- School and university teachers agree: on the importance of teaching mathematics in the elementary school, on well-defined roles of each group, on the importance of developing a textbook with digital tools and on the challenges involved.

Discussion

- In particular, they seem to agree that the **roles of university lecturers concerns mathematical content correctness**, whilst the **role of school teachers concerns pedagogy**.
- The task of criticizing or interfering on mathematical content has not been assigned to school teachers in the discourse of the participants.

Discussion

This indicates:

- a view of the university is the main source of mathematical (correct) knowledge, which must be didactically adapted by school teachers to be taught in school;
- a hierarchy between participants.

This view is reinforced by the fact that school teachers acknowledge the university as the source to improve the knowledge needed for teaching, even though they admit that their undergraduate courses have poorly contributed to their classroom skills.

Discussion

- A possible interpretation for this is that teachers associate the knowledge needed for teaching solely with mathematical knowledge, and attribute their own difficulties on teaching to a lack of mathematical knowledge.
- However, this remains a question for future investigation.