

## **IN-SERVICE TEACHER EDUCATION AND E-TEXTBOOK DEVELOPMENT: AN INTEGRATED APPROACH**

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*MatDigital is a project conducted by the Brazilian Mathematical Society (SBM), aiming the development of a set of e-textbooks for elementary school (grades 6 to 9, ages 11 to 14). Due to the challenges (mostly related to the acceptance by teachers of a model of instructional materials they are not familiar with) faced during development process, it was clear to the team responsible for the project that it should be integrated with in-service teachers training programs. In this paper, we report results of a pilot study, in which preliminary versions of the e-textbooks were applied in classrooms from 17 public schools in Brazil, involving 50 teachers and reaching 2355 students.*

*Keywords: e-textbook, in-service teachers, MatDigital project, Brazil*

### **THE MATDIGITAL PROJECT**

The Brazilian Mathematical Society (SBM) has been running, since early 2012, the research project *MatDigital*, for the design and production of digital materials (e-textbooks) for the teaching of mathematics in the elementary school (Brazilian grades 6 to 9, corresponding to ages 11 to 14). *MatDigital* is under the *Klein Project for the 21<sup>st</sup> Century*, internationally conducted by International Commission for Mathematical Instruction (ICMI) and International Mathematical Union (IMU). The authors of this paper integrate the editorial board responsible for the project.

On his renowned work *Elementary Mathematics from a Higher Standpoint* (Klein, 1908), the mathematician Felix Klein points out a rupture between school and academic mathematics. According to the author, elementary and secondary school curricula lost any bonds with more recent scientific production in mathematics (at the time the book was written). He associates this rupture with a *double discontinuity* in teachers' education: the mathematics prospective teachers are presented to in undergraduate courses have insipient connection with, on the one hand, the one they had contact with as students, and, on the other hand, the one they will approach in their practice as school teachers. Another important aspect of Klein's view is the important role he assigns to the school in the development of mathematics. For the author, school is responsible for assessing education needs and establishing categories that will determine the production of new knowledge, rather than simply receiving and spreading knowledge produced at the university, (Kilpatrick, 2008; Schubring, 2014).

Despite Klein's ideas were situated in the context of German secondary education in early 20<sup>th</sup> Century, they highlight issues that are still on spotlight in 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.

The *Klein Project* was launched in 2008 by ICMI and IMU as a celebration for the 100<sup>th</sup> anniversary of the first edition of the book *Elementary Mathematics from a Higher Standpoint*, and of the foundation of ICMI (of which Klein was the first president). The goal of Klein Project is to develop instructional materials, in different languages and media, accessible to any person with interest in mathematics, and, more specifically to teachers and other people involved with the teaching of mathematics in elementary and secondary school, and with teachers' education. With inspiration in Klein's ideas, the guiding principle of the Klein Project is to establish links between a comprehensive view of mathematics, the contents and approaches of the discipline in elementary and secondary school, and the curricula of undergraduate teachers' courses (Barton, 2008).

*MatDigital* was initially conceived as a project to develop a set of textbooks integrating digital tools (e-textbooks) for elementary education. The set of e-textbooks would be implemented in html and Android operational system versions. In line with Klein Project's guiding principle, the methodology of the project is structured upon the collaborative work of a design team of 60 members, including elementary school teachers and university lecturers, based on different parts of the country. This team members was organized into subgroups (of 4 or 5 members), coordinated by a central editorial board. Each chapter of the e-textbooks was assigned to a subgroup. All the subgroups as well as the central editorial board are formed by school teachers and university lecturers.

The subgroups were instructed by the editorial board to design the chapters in effective hypermedia structure. That is, rather than reproducing the linear structure of conventional texts on a pdf version, the chapters should incorporate different modalities of media in a such way that they would play an actual role in the approach of the concepts, and not just be garnishments for traditional models of teaching. The tools available in the devices allowed the use of videos, audios, games, interactive activities, and also to interact with external environment (by means of taking pictures, recording sounds, making measurements). These tools offered a wide range of possibilities for creating innovative approaches.

Therefore, it was clear from the beginning of the project that its aims, conception and methodological design posed challenges in different dimensions: (1) how to manage to collaborative work of a large team, including members with quite different (and complementary) backgrounds; (2) how to make the best possible use of the available digital tools, as intended by the project's conception; (3) how to incorporate e-textbooks into classroom, especially in the case of teacher who have little familiarity (and resistance) with digital tools.

Thus, the success of the project was clearly dependent on carefully examining these questions through the lens of scientific research. *MatDigital*, as a development/research, is still ongoing. In this paper, we briefly report partial results of a pilot study that tested preliminary version of the materials in actual classroom situations.

### **CONTEXT: ELEMENTARY EDUCATION IN BRAZIL**

Compulsory education system in Brazil is organised in three sections: fundamental school I (grades 1 to 5, ages 6 to 10), fundamental school II (grades 6 to 9, ages 11 to 14), and middle school (grades 1 to 3, ages 15 to 17).

Textbooks are distributed for free to public schools, and are chosen by each school out of a list of titles previously approved by the Ministry of Education, through the National Textbook and the National Middle School Textbook Programs (PNLD and PNLEM, initials in Portuguese). Textbooks are submitted by authors or editors to PNLD and PNLEM, in full sets for each section of education system (5 books for fundamental I, 4 books for fundamental II, and 3 books for middle school). The assessment is mainly based on evaluations by experts.

Since the latest editions of PNLD Program, it is required that textbook sets submitted to PNLD and PNLEM programs must be accompanied by electronic versions. However, in most of the cases, these electronic versions are only digitalised conventional texts, showing little or none differences from the hardcopy versions. *MatDigital* aims to differ from this model.

### **DEVELOPMENT OF THE PROJECT: CHOICES AND SHIFTS**

An important obstacle for incorporation of e-textbooks into classroom is expected to be resistance from teachers, who, in most of the cases, had little contact with digital tools during pre-service training, and have been working within a culture formed by schools and classrooms that ignore the use of these tools. This resistance is expected to be manifested in two levels (that overlap each other): (1) a *substantive level*, related to lack of familiarity or insecurity towards technical aspects of the tools; (2) a *subjective level*, concerning lack of preparation for the new classroom dynamics triggered by the use of digital tools, which can possibly drive students to a more independent attitude towards their own learning process, and seriously change the authority position established for teachers.

Therefore, the need to integrate the design of digital materials with in-service teachers' education initiatives was clear for the team from the beginning of *MatDigital* project. These initiatives had several goals: (1) to train teachers on the use the digital materials, from both the perspectives of technical knowledge of software, and devices and of the preparation for potential changes in the classroom dynamics brought into play by the emergence of digital instructional tools; (2) to create and consolidate an environment, involving school teachers, teachers educators and policy makers, for long- term joint discussion, integration the reflection on mathematical subject matter, classroom practices and use of instructional materials; (3) to enroll teachers in the development process of the digital materials, as a means to turn passive use to authorship, and to reverse the traditional top-to-bottom paradigm on instruction development; (4) to use the feedback from workshops and testing in actual classroom situations to develop successively improved versions of the digital materials.

Thus, *MatDigital* has evolved to a project with two-fold, integrated and equally important objectives: design of digital textbooks and in-service teachers' education. This perspective is grounded upon a conception of teachers' education as a permanent on-going process of knowledge and meta-knowledge construction, which is not restricted to pre-service and in-service formal courses, but also comprises the reflection to, in and on classroom practice, including, in particular, the design and critical use of instructional materials.

## THE PILOT STUDY

### The participants

During the year of 2012, a pilot study of *MatDigital* Project was conducted in Brazilian public schools. The full list of participant schools is shown on table 1.

Table 1: Schools participating on the pilot study

State	School	Number of teachers	Number of students
Amazonas	AM1	3	75
Minas Gerais	MG1	4	170
Minas Gerais	MG2	2	120
Minas Gerais	MG3	3	175
Minas Gerais	MG4	3	130
Minas Gerais	MG5	2	140
Piauí	PI1	1	40
Rio de Janeiro	RJ1	1	60
Rio de Janeiro	RJ2	1	140
Rio de Janeiro	RJ3	3	190
Rio Grande do Norte	RN1	2	125
Rio Grande do Norte	RN2	1	80
Rio Grande do Sul	RS1	3	210
Rio Grande do Sul	RS2	2	155
Rio Grande do Sul	RS3	11	250
São Paulo	SP1	6	115
São Paulo	SP2	2	180

The pilot study was broadly offered to teachers who were taking a professional masters course conducted by the Brazilian Mathematical Society in a countrywide network (for more information see <http://www.proformat-sbm.org.br/>). In order to participate, school had to be public, and available to apply the materials on the first semester of the grade 6. In response, the 17 school from 7 different Brazilian states enrolled for the pilot study. Thus, in total, the pilot study involved 50 teachers and reached 2355 students from grade 6.

Two chapters were distributed to the participant schools, approximately corresponding to the first three months of grade 6:

- Chapter 1 – Numbers in Daly Life
- Chapter 2 – Geometric Forms: First Drawings

Participant teachers were invited to a three days meeting to discuss the chapters. Their critiques and suggestions were taken into account for the versions of the chapters that were distributed to schools. During the pilot study, communication among the participant teachers, and between them and the project's design team was conduct through an online discussion forum.

### **Data collection and analysis**

Data were collected from several sources: (1) written questionnaires from participant teachers, assessing adequacy and difficulties of each of the chapters; (2) interviews with participant teachers; (3) interviews with participant schools' pedagogical support teams; (4) students' answers to tests and selected tasks; (5) students' performance in exams; (6) written questionnaires from a selected sample of students, concerning their general experience and difficulties with the materials.

All the interviews were tape recorded and fully transcribed. Data concerning teachers, pedagogical team, and students was separately analysed. General impressions, advantages and obstacle pointed out by each group were identified and categorized by frequency. In the following section, we report results of schools from the state of Minas Gerais (MG1 to MG5).

## **RESULTS AND DISCUSSION**

### **Students' learning**

Initial resistance by students was reported from all the participant schools. However, this resistance decreased through the development of the study. Students' responses to questionnaires revealed that: 93% of the students claimed that they liked mathematics more after the experience than before; and 89% of they claimed they liked the pilot study materials more than their usual textbooks. A significant increase on students' performance on exams exams was also reported.

### **Teachers' practices**

All the participant teachers commented that they faced difficulties on adapting to a new classroom dynamics. On the other hand, all of them claimed to be unable to resume previous practices after the pilot materials were used. They claimed that they "could not be the same teachers as they used to be before". Teachers also reported an increase on engagement, performance and a more inquiring attitude from their students. After the materials were used,

they reported that most of the students showed resistance on fit back to usual approaches: “they no longer take things for granted, and want to know *why* everything is like that”.

## FINAL COMMENTS

A detailed analysis of the results is in preparation, to be published on a longer paper. The positive results surprised to authors. Obstacle and teachers from both students and teachers were much less profound and serious than expected. In our interpretation, the engagement of the teachers with the project was more important to these results, than to any particular feature of the material. Therefore, we are aware that these results are very particular, and can hardly be generalized to a context in which teachers just receive the materials and do not participate on discussion about them.

Participant teachers were invited to discuss and criticize the textbook they were using in the classroom with the design team, and to exchange ideas with each other about the approaches and methodological challenges involved. This aspect seems to have created an environment that integrated collective discussion about mathematical content, pedagogical approach, use of textbooks and use of technology. This may have led to a shift on teachers’ role: from mere recipients of instructional materials to an attitude of authorship and a sense of ownership. The participant teachers’ engagement with project may be associated with a profound change in the classroom dynamics and in their own practices.

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