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Mathematics textbooks and teaching activity

Maryvonne Priolet¹ and Eric Mounier²

¹University of Reims Champagne Ardenne, France, Maryvonne.priolet@univ-reims.fr

²University of Paris-Est Créteil, eric.mounier@u-pec.fr

This article focuses on the relations between the activity of the teachers and the contents of textbooks and the teacher's manuals. Through the observation of lessons, we analyse and discuss how the teachers follow the recommendations written by the authors of teacher's manuals. We describe the adjustments made by these teachers, comparing them to the recommendations written by the authors of teacher's manuals. The observations lead us to point out some didactic obstacles and to mention the major role of an epistemological and didactic teacher training.

Keywords: Mathematics textbooks, primary school, didactic, resources.

Introduction

The present study constitutes a part of a larger research project investigating the place of mathematical textbooks in the French publishing market and the role teachers assign them in the daily practice (Mounier & Priolet, 2015). In France, teachers may decide for themselves and in each of their classes whether they want to resort to textbooks or not, and which resources they wish to use, on the condition of respecting the national curricula. The resources and their uses have been already the object of plentiful scientific literature (Pepin, Gueudet, & Trouche, 2013; Fan, Zhu, & Miao, 2013; Matic & Gracin, 2015; Lenoir et al., 2001). This paper examines how two teachers interact with mathematics textbooks in teaching the same topic; it focuses on the use of number lines. The choice of this theme seems to us relevant, with regard to the works of Hamdan and Gunderson (2017, p. 587) that show how “the number line plays a causal role in children’s fraction magnitude understanding, and is more beneficial than the widely used area model”.

Theoretical framework and research question

The teaching activity

The teacher has “to prepare the course”, “to handle the class” and “to teach the class” (Amigues, 2003, p. 11). His activity results from a compromise between his objectives, his own purposes, his constraints, and the resources of his work environment (Goigoux, 2007, p. 47). So, it exceeds the context of the classroom. Then, the teaching activity has to be considered outside and inside the classroom, but, in this article, we mainly reserve the expression “teaching activity” for the activity of teaching in the presence of pupils.

Resources, textbook and teacher’s manual

Within the framework of his teaching activity, the teacher interacts with a set of resources. To define the concept of resource, Adler (2010, p. 25) refers to two meanings of a word: a “reserve” from which the teacher can draw, and the action “to be nourishing again”. We define the resource as “product of the human activity, developed to join a finalized activity” (Rabardel, 1995, quoted in Gueudet & Trouche, 2010, p. 58). As produced by an author, the textbook and the teacher’s manual are resources for the teacher. The resource “Textbook” is intended for the pupils in the class and it is in connection with the curricula. The “teacher’s manual” is the documentation annexed to the textbook, intended

for the teacher and who allows “to understand better the transactions of the teachers with the curricular resources in mathematics” (Remillard, 2010, p. 201).

Teacher-resources relation

The teachers are differently positioned with regard to the use of the resources according to “modes of commitment” (Remillard, 2010, p. 214) being able to be shaped by particular expectations, convictions, habits or past experiences. This positioning may have an important effect when the use of the resource leads to the adoption of a didactic device structuring the session. The didactic devices in a primary class come down to three devices (Rey, 2001, pp. 31–35). In the first one named “explanation-application”, some part of knowledge, for example the definition of a mathematical object, is presented to the pupil. Practical exercises follow the presentation of this knowledge. In the second named “observation-explanation-application”, in the first instance the pupil is asked to observe an object, for example a geometrical figure then to generalise from this observation. Practical exercises are then proposed. In the third named “problem-explanation-application”, in the first instance the pupil starts with the active manipulation of material or conceptual resources is brought in to the apply to problem-solving. This phase is followed by the shaping of the knowledge and then by the series of exercises. Some teachers sometimes make some adjustments. If the teacher’s degree of expertise and the level of training are not sufficient, these adjustments can lead to “problems of coherence between objects of teachings, processes and activities” (Arditi, 2011, p. 361). Besides, from a generative document, expert teachers can proceed to relevant adjustments whereas, for lack of self-important training, the novice teachers are sometimes going to bring modifications going against the intentions of the authors of textbooks, the specialists of didactics (Margolinas & Wozniak, 2009; Priolet, 2014).

Research questions

Considering the above research, we question the relations between the activity of the teachers and the contents of mathematics textbooks and of teacher’s manual. Do teacher-users of a medium operate different types of adjustments during the activity of teaching in the presence of their pupils, and do they follow the model led by the teacher’s manual?

Methodology

In order to answer our research questions, we provide a qualitative approach based on observation of practices used by teachers or semi-structured interviews with them.

Participants

This case-study involves two female teachers, Teacher B and Teacher A. Both of them teach at the 4th level of elementary school (9–10 year-old pupils), in two schools located in two small towns in the centre of France. Teacher B has been teaching for 15 years and Teacher A for 10 years. None of them has studied higher education in mathematics. They both teach all school subjects.

Both teachers belong to a sample of 10 teachers of the 4th level of elementary school who declared using mathematics textbooks and being volunteers to participate in our research. We had chosen this level regarding the introduction of fractions and decimal numbers. The ten teachers had agreed to be observed, by one of the two researchers, in their class, during a lesson of mathematics concerning the numbers, then to be interviewed during a semi-directive interview. For this case-study, we chose

Teacher B and Teacher A among these 10 teachers for two reasons. Firstly, Teacher B and Teacher A have the same textbook¹ in their class. Secondly, when we observed them teaching in their classroom, both presented a lesson on the theme of fractions and decimal numbers.

Method

In the classroom of Teacher B, the observation lasted 57 minutes and the interview 36 minutes. In the classroom of Teacher A, the observation lasted 33 minutes and the interview 44 minutes. We did not film the learning sessions, but some photographs have been taken, related to the use of the textbook or other artefacts. An observation table has been assigned in two parts :

- The observation of the classroom with identification of the different moments of the learning session (total duration, duration of each phase), duration of the phases of use of the textbook by the pupils, identify the moments while the teacher uses her teacher's textbook.
- The database about pupil and teacher documentation.

Following this observation of sessions, a second data collection was made through semi-structured interviews. An interview guide was set up on these subjects: preparation of the observed session, place taken by the manual during the session, manual's choice, general use of the teaching and pupil's guide and during the session, and finally, teacher training. The interviews often relied on the photographs that we had taken during the session concerning the use of the manual by the teacher or by the pupils. They can be linked in a methodological way with the self-confrontation method (Theureau, 2010).

For the "fractions and decimal numbers" topic, the classroom manual has eight sessions numbered from five to twelve in its summary. The selected lessons for the analysis are lessons 8 (Teacher B) and 9 (Teacher A), because both of these lessons refer to the use of number line.

Both interviews were transcribed. All the data collected through observation and interviews have been analysed (Bardin, 2007) in order to extract those concerning the presence and frequency of use of the textbook and the resources used by the teacher for the conception of his teaching. The times of effective use of the textbook by the pupil have been converted in percentages of the total duration of the lesson.

Results

For each teaching activity, we present below a lesson in which we can spot the relation that each teacher has with the textbook and with the teacher's manual in her teaching activity.

Teacher B

Teacher B herself chose the textbook given to each of the pupils of her classroom. She reports using it frequently in class, mainly for the exercises. The Teacher's manual is present in the classroom. Teacher B reports that she doesn't use it because she has been disappointed by its general contents. She organizes the distribution of the lessons of the year herself.

¹ Whereas in our study (Mounier & Priolet, 2015), there are at least 23 different textbooks in France for this level of teaching.

Today, she proposes the following situation: she shows on the board a big number line she has prepared herself (Figure 1).

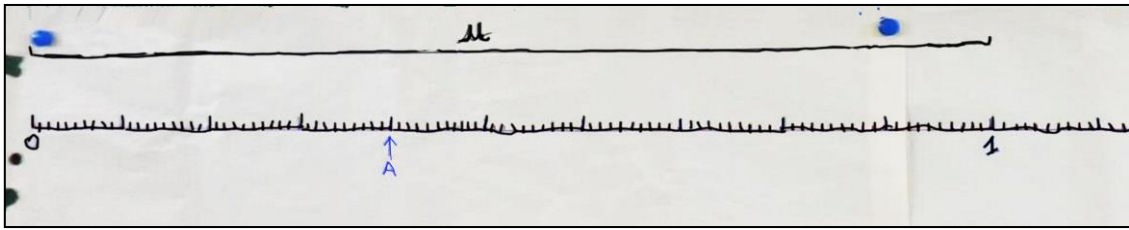


Figure 1: number line showed on the board (Teacher B)

In the first part of the lesson, she explains to the pupils how she made this number line: “the unit is here (u), so here between 0 and 1 there are 10 parts”. She tells them that point A is equivalent to four-tenths of one. Then she asks pupils to write on their board the fractional numbers to which the points placed on the number line are associated. In the second part of the lesson, pupils open their textbook to do the 4th exercise (Figure 2).

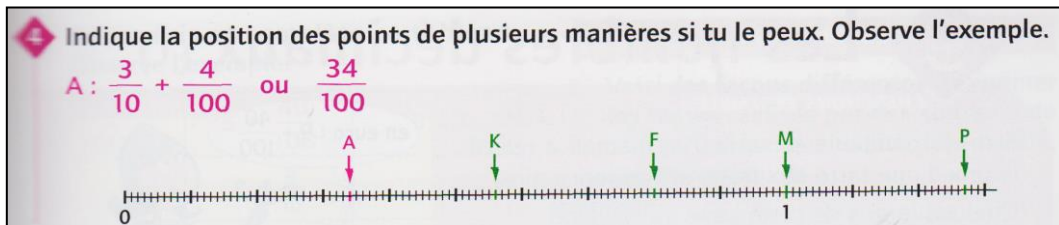


Figure 2: Exercise number 4, page 43 of the pupil's textbook

For this lesson related to session 8 of the manual (*À portée de maths CM1*) page 42–43 and named “decimal fractions”, the teacher’s manual first planned a research path with an individual preparatory report (Figure 3) to the activity “Let’s look together” in the pupil’s manual (Figure 3).

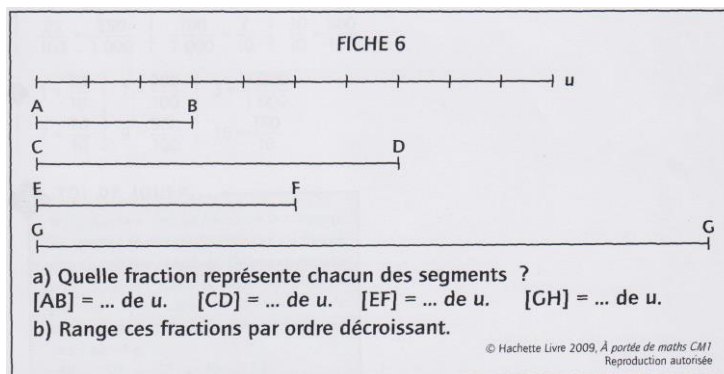


Figure 3: teacher's manual page 37

Teacher A

In Teacher A’s classroom, each pupil has got a textbook. This textbook has been chosen by one of the colleagues predecessors of Teacher A in that school. She declares to have adopted this textbook which was already present in the class before she came. Teacher’s manual is present in the classroom. Teacher A reports: “Mathematics is absolutely not my field. I refer a lot to the teacher’s manual but

after this I try to appropriate it". She says that she follows the annual distribution of the lessons in the manual. She also uses the manual's exercises.

For this lesson related to session 9 of the manual (*À portée de maths CMI*) page 44–45 named "Decimal fractions", the teacher's manual first planned a research path with the number line drawn at the board (Figure 4) to prepare the activity "Let's look together" in the pupil's manual (Figure 4).

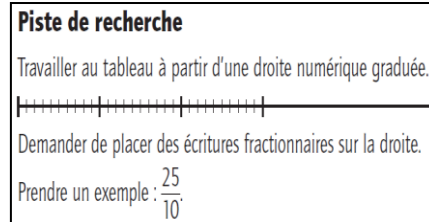


Figure 4: Teacher's manual p. 39 (Beginning of the research path)

Teacher A reports referring to the teacher's manual to build the "Let's look together". While the teacher's manual suggests as support for each exercise a number line increased without digital marks, this teacher writes a number line increased in tenth marks-units from 0 to 3, on the blackboard.

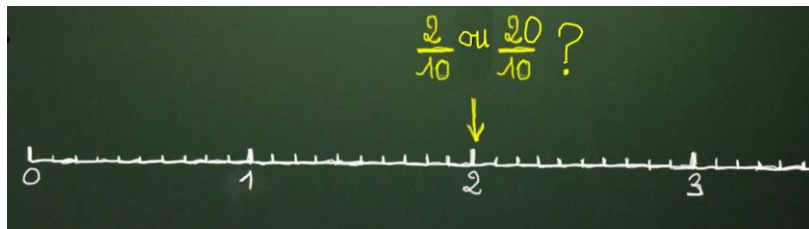


Figure 5: Photography of the board during the lesson (Teacher A)

Then she asks the pupils to indicate which fraction corresponds to such a graduation (yellow arrow).

On the board, she writes two answers $\frac{20}{10}$ and $\frac{2}{10}$ (Figure 5) proposed by two pupils. She asks them to explain their process. Then Teacher A asks all the pupils to open their textbook to individual work on exercise number 2. In this second part of the lesson, and especially with this exercise number 2, the pupils have to use a number line (Figure 6).

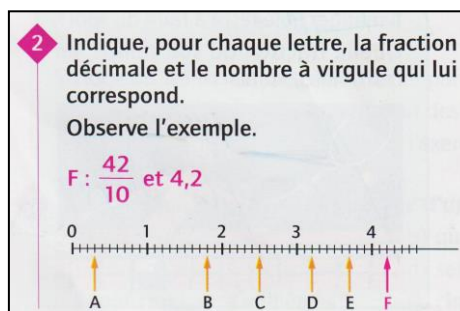


Figure 6: Exercise n°2 page 44 of the pupil's textbook

During the interviews, Teacher A and Teacher B report that they want to do the best to help their pupils to understand the fractions and the decimal numbers. So, Teacher A decided to write a number line increased in tenth marks-units on the blackboard instead of the number line increased without

digital marks which was suggested by the teacher's manual. Teacher B decided to explain to her children what each graduation means on the number line.

Analysis and discussion

We use Rey's model (2001) to analyse the didactic set up plan in each of these two classes. We compare it with the model underpinned by the instructions provided by the teacher's manual's research path.

Although the authors declare in the preface (page 3, pupil's textbook) that the "teacher is a professional that chooses and assumes his pedagogy" and in the preamble (page 3, teacher's guide) that "the guide is conceived in order to give the teacher the freedom of his own ways", the instructions which are supplied in the scenario of the teacher's manual about the research path of both consider lessons, seem to lead an approach of the "observation, explanation, application" type.

Our observations show that Teacher B operates the didactic device "explanation-application", whereas Teacher A tends to use the "observation-explanation-application" device. Teacher A modifies the starting situation support by converting the teacher's manual (number line increased without digital marks on a number line increased in tenth marks-units from 0 to 3).

This modification of the support does not favour the devolution (Brousseau, 1998) of this problem to the pupils. It has transformed, by reducing it, the difficulty of the task planned by the authors' textbook: to question on the density of decimal numbers which constitutes an epistemological obstacle to the pupils' understanding.

Although the authors of the textbook declared that teachers keep their pedagogic freedom, in both of the observed situations, both teachers do not commit the pupils in an approach of type "problem-explanation-application".

Conclusion

In order to analyse the relations between the teaching activity and the contents of mathematics textbooks and of teacher's manual, we have referred to the didactic model of Rey (2001). Our purpose was to detect the adjustments operated by two 4th level of elementary school teachers who use the same mathematics textbook. We observe that both do not follow all the recommendations of the authors of the teacher's manual. For example, the teachers redefine the task planned by the authors of the textbook, then changing the planned didactic device, from a model of "observation-explanation-application" led by the teacher's manual, into a model of "explanation-application" (Rey, 2001). This change may reduce, in a way, the pupils of the understanding of the density of the order of decimal numbers. Thus, our analysis reveals a problem of coherence, already pointed by Arditì (2011) between the adjustments operated by the teacher-user and the authors-designers of the textbook. This echoes the question of the validation of the collected knowledge (Bruillard, 2010), in particular in the context of the development of the recourse to the digital resources.

In conclusion, we notice that the logic of the teacher and the logic of the textbook cannot be the same. We observe that this gap can interfere with the aimed knowledge, from which we conclude in the necessity for the teacher to exercise an epistemological and didactic vigilance on pupils' understanding. It seems to us essential, following the example of Charles-Pézarid (2010), to include this issue in the training of the teachers.

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