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Documentational trajectory: a tool for analyzing the genesis of a teacher's resource system across her collective work

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Our contribution to TWG 22 is dedicated to discussing teachers' interactions with resources for planning their classroom instruction, particularly in the context of collective work. Each teacher along her professional life uses and creates a lot of resources. For analyzing the history of teacher work with/for resources, we propose the notion of documentational trajectory. This idea is based on and aims to contribute to the development of the documentational approach to didactics. We present the data related to a teacher's work, which allows us building her documentational trajectory. We use it to analyze teacher's professional development. It evidences a strong participation in collective work, in particular a collective named SESAMES, has an essential role. It contributes to the emergence of a particular resource, which is called as metaresource, structuring her documentation work.

Keywords: Documentational approach to didactics, documentational trajectory, metaresource, reflective investigation, professional development.

Introduction

The new possibilities arising from communication and information technologies have had a significant impact on discussions on mathematics education, due to their impact on resources available to teachers and the way of designing them. It led to new conceptualization of teaching resources (Adler, 2000) and evidenced new teachers' relationships with these resources (Remilliard, 2005). In this thread, Gueudet and Trouche (2009) analysed teacher professional development through the lens of resources: they (ibid, 2009) introduced the *documentational approach to didactics* aiming to analyze how teachers select, use, and produce their resources, along with a process named *documentation work*. Later, Gulay and Ruthven (2015) showed how digital resources structure classroom practices, evidencing five main features: *working environment, resource system, activity format, curriculum script, and time economy*. In this article, we rely on and articulate these approaches for analyzing teacher's history with resources. We propose a new concept for modeling this history: the teacher's *documentational trajectory*. We mainly discuss here *which could be the effects of a teacher's collective work on her documentational trajectory?* For doing this, we organize our contributions in four sections. In the first one, we introduce the concepts structuring our analysis. In the following one, we present our methodological choices. In the third one, we develop a case study based on a middle school teacher, Anna. And in the last section, we propose some considerations and perspectives.

Theoretical framework and research issues

We present and articulate in this section the theoretical approaches grounding our analysis: the documentational approach to didactics, the structuring features of teachers' practices, and the notion of thought collective. Then we present our own propositions.

As stated by Gueudet and Trouche (2012, p. 24) "teachers interact with resources, select them and work on them (adapting, revising, reorganizing, *etc.*) *within processes where design and enacting are intertwined*". This process is the central focus of the Documentational Approach to Didactics (Gueudet & Trouche, 2012) grounding our work. In this approach, the term *resource* is used in a broad sense, as everything that can nourish teacher's work. To prepare their teaching, teachers work on resources, and the result of this process is called a *document*, made of resources that have been modified and re-organized, and knowledge, both guiding, and produced by, teacher's work, grounding her professional development. The new resources generated take place in a very structured set of teacher's resources, called teacher's *resource system*. For developing this system, some resources play a critical role: *metaresources*, introduced by Prieur (2016) for designating resources supporting and guiding the creation of other ones and favoring a reflection on teacher's own documentation work.

Teacher's documentation work grounds teacher's classroom practices, structured, according to Gulay and Ruthven (2012) by five *features*: the *working environment*, where lessons class take place (infrastructure, social organization, etc); the *activity format*, which comprises the body of work in the classroom, such as routines and models of interactions between teacher and student along teaching and learning; the *resource system*, which gathers tools and materials for class. The *curriculum script* is to be understood in the cognitive sense of structured organization of activity guiding teacher's work in the classroom: goals, actions, activities, potential difficulties of students, among others. And *time economy*, based on the comparison between the teaching time and the learning time of students. Gulay and Ruthven use this framework for analyzing teacher's integration of new digital resources into classroom practices. We will extend this usage for analyzing teacher's design and usages of resources. Thus, we will retain the notion of *resource system* as proposed by Gueudet and Trouche (2012):

"we consider here as resource system does not fully coincide with Ruthven's definition, because of the broader meaning of resources we retained. The resource system comprises material elements, but also other elements that are more difficult to collect, like conversations between teachers" (p. 27).

We consider that teachers' interactions with colleagues are likely to foster their documentation work and professional development (Gueudet & Trouche, 2012). This is the reason why we give a primary importance to *collectives*. A collective is, for us, a place designed by a teacher where interactions develop with others actors of her teaching. We retain the broad definition of *thought collective* (Fleck, 1934, p. 44) existing when "two or more people are exchanging thoughts" and generating a *thought style* "characterized by standard features in the problems of interest to a thought collective, by the judgment which the thought collective considers evident, and by the methods which it applies as a means of cognition" (p. 99). We distinguish different types of collectives, according to their duration

(stable vs. unstable), their organization (formal vs. informal) and type of participation (voluntary vs. required).

Finally, we present our proposition for modeling teacher' history with resources based on the notions of resource, collective, and *event*. An event is something happening in the professional life of a teacher, and remembered by her as important regarding her documentation work. We define the teacher's documentational trajectory (Rocha, 2016) as the interplay, over the time, between events and resources, this interplay being socially situated, because it happens in schools or collectives, or because the events or the resources themselves are social products. The design of a teacher's documentational trajectory is then a way to analyze *when, where, why, how* and *which* resources are created. We will focus in this article on the documentational trajectory as a tool for analyzing the genesis of a teacher' resource system across her collective work. We describe, in the following section, our methodological choices for such a design.

Methodological design

Our methodology is inspired by the four principles of *reflective investigation* presented by Gueudet and Trouche (2012): "*long-term follow-up*", "*in- and out-of-class follow-up*", "*reflective follow-up*" and "*broad collection of the material resources*". This methodology also gives a major importance to specific drawings made by the teacher (for example the 'schematic representation of her resource system'). Retaining this way of reflective investigation, by the teacher, of her documentation work, we propose some changes: instead of the word "representation", we propose (Rocha, 2016) the word "mapping", integrating the metaphor of a *progressive exploration* of a new territory. And we propose two kinds of mapping: *reflective* (made by the teacher herself) vs. *inferred* (made by the researcher) mapping. We distinguish then Reflective, vs. Inferred, Mapping of teacher Resource System; Reflective, vs. Inferred, Mapping of teacher Documentational Trajectory. For the design and analysis of a documentational trajectory, we also use: interviews, follow-up of lesson preparation, and classroom observation, and a logbook filled by teachers.

Our current research is mainly based on cases study. For choosing teachers, we search teachers that had *Sésamath* textbooks as official textbooks in their class. *Sésamath* (<http://www.sesamath.net/>) is an association of mathematics teachers in France that collaboratively designs online resources (software, textbooks, etc.) at a very large scale, opening for us a window on advanced teachers from resources design and use. We present here the case of Anna, a middle school mathematics teacher, whose school had chosen a textbook designed by *Sésamath*. She has a strong partnership with a colleague from her school, Cindy, and both of them participate in various collectives and use a lot of digital resources beyond the *Sésamath* textbook.

Our work with Anna started in mars 2015, when we followed her 6th grade class for three months. During this period, Anna created and shared with us a Dropbox folder, where she uploads resources that she used in or to prepare her lessons. In addition, we also had videorecorded four moments of interaction involving her. In the first one, she made a reflexive mapping of her documentational trajectory. In the second one, she reviewed her reflexive mapping (focusing on a particular resource and a specific year). In the third one, she prepared a lesson with Cindy about a new curricular subject. In the last one, she spoke about her usages of a particular digital tool, a padlet (<https://padlet.com/>)

used to save and organize resources found online. Also, we used a logbook for complement our collect of data in the moments that we can not follow her documentation work.

We will explore in this paper different mappings of Anna's documentational trajectory: inferred and reflexive mapping. For obtaining the initial reflexive mapping, we have asked her to write down *over* an axis (representing time) the mains events having influenced her uses of resources for teaching, or the way of conceiving them, and to write down, *under* this axis, the resources associated with the event at stake. For helping Anna, we gave her a sample of possible events: the arrival of a new person in her school; the participation in a new collective, an unexpected interaction with a student or colleague; a change of program; a change of teaching level or of textbook; a training course or the discovery of a new resource related to mathematics teaching (book, movie, website, etc.). For obtaining inferred map we made a data crossing among all collected data.

Our method of analysis is in development. For data analyzing exposed in this article, we transcribed our first interview with Anna and we did a digital transposition of her reflexive mapping. After, we identified on the map, among the events she exposed, those related with collective work, following our hypothesis that knowledge is socially situated. Afterwards, we identified the effects of collective work on her documentation work through associated resources at the event. After we looked in Anna speech her role in which collective and collective's nature, this is based on our hypothesis that some features tell us as a collective effect teachers documentation work. For example, a collective where teachers are voluntary and have a long or permanent engagement nourish teachers work differently than a collective where they are required and they had a short time engagement. Then, we searched collectives that have an important status in her documentational work. For this purpose, we looked for the collectives that appeared more frequently and related to related to other events in the map. Afterwards, we analyzed how these collective nourished her documentational work exploring associated resources, and identifying in her words features relating resources and collective work. We will present, in the following section, the main results of this analysis, still in progress.

Analysis

This analyze is divided into two parts: Anna's participation in collectives along her documentational trajectory and the structuring role of a particular collective, SESAMES in it; and, the structuring role of a particular resource, "Mise en train", on Anna's individual and collective documentation work.

Anna's documentation work in collectives along her documentational trajectory and relationships with SESAMES."

We start analysing the first reflexive mapping drawn by Anna (Figure 1). The analysis of the events evidences Anna's strong involvement in collective work (she says: "I cannot work alone"). Eight (E6, E7, E8, E9, E10, E12, E13 and E14) over 14 events are related to collectives. For deepening the analysis, we study the *properties* of collectives, the *roles* of Anna in these collectives, and the *functions* of the resources that are designed.

The collectives have different natures:

- some of them are transient, as a short episode of coworking with Sésamath (E4), or Assist Me (E12, linked to a European project), or M@gistère (E13, linked to the design of a teacher training path);

some of them are ‘permanent’ (meaning that, once Anna enters this collective, she stays in it), as APMEP (E10/E11, the French national mathematics teacher association), or L  A (E9, collective linking Anna’s middle school and the French Institute of Education), or SESAMES¹ (E6, a team associating researchers and teachers for renewing Algebra teaching);

- some of them are required (as E14, meeting with parents), some of them are voluntary (as E7 the close partnership with Cindy).

In these collectives, Anna can have six different roles: *member*, reading and using their resources (E8 and E10); *author*, conceiving articles and resources in a group for outside this group (E6, E8, E10, among others); *teacher trainer*, training middle school teachers (E6, E8, and E10); *teacher researcher*, reflecting about mathematics teaching (E6, E12 and E8); *partner*, exchanging and co-producing resources with colleagues (E6 and E10).

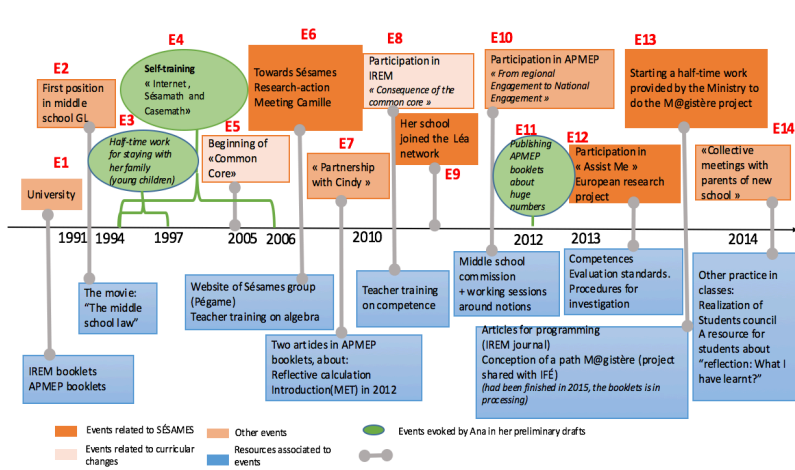


Figure 1. Anna’s reflective mapping (October, 22nd 2016) of her documental trajectory

Each collective contributes in different ways to her documentation work. However, they are so entangled, that it is difficult to attribute a single function to each of them. The interviews of Anna help us to distinguish some structuring features of Anna’s documentation work: elaborating her resources for teaching Algebra; elaborating activities for teaching mathematics notions and interpreting curriculum materials; elaborating resources for developing and evaluating students’ competencies; creating lessons and curricular script for her class; reflecting about using digital resources; creating new resources according to pedagogical changes in the school, supporting her participation in other collectives outside school, writing papers, teachers training.

These functions are not supported by all collectives, but all of them are exploited in S  sames, where Anna and Cindy use to work together. And SESAMES opens for Anna new possibilities for participating in new collectives and establishing new partnerships. Figure 2 evidences how SESAMES resources nourish the resources of other collectives. Develop a critical thinking on their practice. When she was invited to join SESAMES, Anna hesitated “*that was a change, anyway. I accepted, finally, to join ... to join SESAMES. [...] It was a real challenge...*”.

¹ In spite of the likeness of the acronyms, S  sath, a mathematics teacher association designing resources at a large scale, is totally different of SESAMES, a small team gathering researchers and teachers for re-thinking Algebra teaching.

SESAMES² had a big impact in Anna collective work. We can see (Figure 1) that she joined Assist me, M@gistère and Léa as a consequence of her engagement in SESAMES. It gave the opportunity for a new partnership with Camille. It opened a window on competencies at the heart of the French new curriculum, giving matter to the design of a teacher training path in IREM, and an occasion for joining this institute.

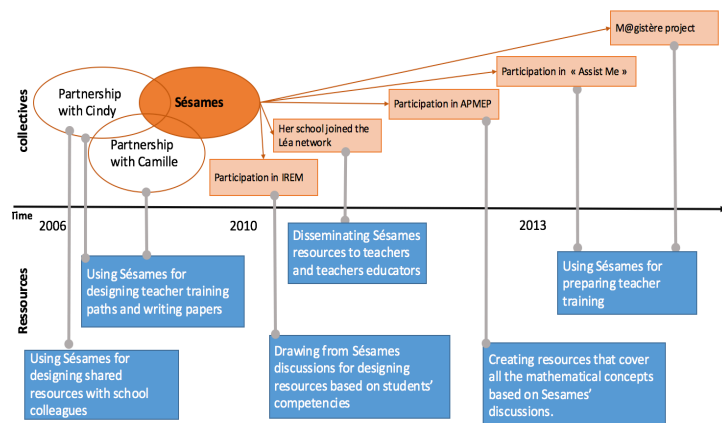


Figure 2. Inferred mapping about the collectives and resource system impact

SESAMES has two sets of *principles* guiding Anna’s documentation work (cf. the SESAMES website, names Pégame: <http://pegame.ens-lyon.fr/>), constituting the thought style of this collective. The first set is composed of three principles for teaching Algebra: justifying computation throughout algebraic rules; proposing proving activities and exploiting formula to introduce the notion of function. The second set is composed of four principles for teaching mathematics: providing students with sufficiently rich and open problems; giving them a chance to seek; giving them a chance to speculate; giving sense to concepts taught.

These principles gave birth to resources emblematic of SESAMES thought style, guiding then the whole process of collaborative resource design in this group. It’s exactly the characteristic of the metaresources we have already introduced in this paper. One of them is *Mise en train*, and we will analyze in the following section its impact on Anna’s documentation work.

The structuring role of a metaresource on Anna’s individual and collective documentation

The *Mise en train* (MET) corresponds to a specific activity format: it aims to organize teacher’s work at the beginning (around 15 minutes) of each class. The expression *Mise en train* has three meanings: the direct one is *warming up* (like for an athlete at the beginning of its training); the second one derives from a literal translation, “*put on a train*”, meaning ‘cutting a mathematics subject in short successive parts (allowing to store them in the successive wagons of a train); the third meaning derives from an acronym (created by Anna): Travail de Recherche ou d’Approfondissement avec prise d’INitiative (Research and Deepening Work with Initiative Taken). Then the global meaning of *Mise en Train* has to be understood as the compilation of these three interpretations. In the following, we have chosen to keep this acronym MET, incorporating this global meaning. This global meaning evidences some features of MET resources design. MET is exactly a metaresource, as it gives a way to produce news resources and stimulates teacher’s reflection on her documentation work and its effect on student’s activity.

² Science Education: Modeling Activities, Assessment, Simulation (SESAMES, Situations d’Enseignement Scientifique : Activités de Modélisation, d’Evaluation, de Simulation).

MET appears as emerging, in SESAMES, from the documentation work of Anna and her colleagues. Anna explains factors leading them to create this metaresource: the lost of time at the beginning of each class (teacher being mobilized by administrative tasks); the good experience with the short sections of reflecting calculation; and her exchange with English teachers dividing student's activity in short articulated moments for a more dynamics activity format.

Once created, MET deeply changed Anna's documentation work (cf. Figure 4). It affects all five structuring features of classroom practice. The working environment change, for example, students entering class lately do not disturb class activity. The activity format also is altered, because the class is divided in two moments: MET vs. main course.



Figure 4. The impact of MET on Anna's documentation work

The *curriculum script* is modified, including new goals and activities. Anna has then three possibilities for developing a lesson: MET then the main course; the main course, then MET; or beginning with MET... and going on with MET, for giving more responsibility to students for the advancement of the knowledge in the classroom. Regarding Anna's *resource system*, new resources are created (new curriculum script, new notebook for students, new lesson plans with MET activities, slides that contains MET activities linked to a given notion, new articles (APMEP, IREM, Pégame website) for disseminating SESAMES resources. Last, but not least, the *time economy* changed, for example, Anna removes the initial "call to students" at the beginning of each lesson.

MET also affects Anna's work in other collectives: in her school, the new curricular script is shared by all teachers, as Cindy and Anna explain the principles of MET, and evidence their interest from their practice; outside of her school, Anna disseminates this metaresource in SESAMES training, IREM group, and training, APMEP group and training.

Finally, this metaresource, initially constructed in SESAMES group to teach Algebra, was enlarged to others mathematics subjects. For us, the metaresource *MET* is a point of convergence between Anna's need and SESAMES interest.

Final considerations and perspectives

Our original question was: *which could be the effects of teacher's collective work on her documental trajectory?* Our initial analysis of Anna's documentation work gives us some clues. Our exploration of Anna's documentation work in collectives allows understanding her resource system better. We saw a diversity of collectives that she participates or participated in, different roles and contribution to her work. Among them, SESAMES appears as an important collective, having a strong impact on Anna's documental trajectory. It contributes to developing new collective work, resources and thought style. In this collective, she contributes to create a metaresource that

structures afterwards her documentation work: this metaresource is exploited in various collectives and structures her way to create resources.

We proposed the concept of documentational trajectory for modelling the teacher's history with resources. In this modeling, the reflective and inferred mapping of documentational trajectory allows us to evidence some critical aspects of this history. It should be noted that these maps constitute a picture at a given moment, and in a given context. This temporal aspect is linked to the fact that her documentation work is still ongoing. The context aspect is also linked to the relationships the researcher can build with the teacher.

The combination of the *Structuring Features of Classroom Practice* and the *Documentary Approach to Didactics* helps us to analyze teachers documentational trajectory, evidencing the structuring role of SESAMES and a metaresource associated to a though collective.

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