

Chapter 2

Teachers' Work with Resources: Documentational Geneses and Professional Geneses

Ghislaine Gueudet and Luc Trouche

Chapters 2 and 16 constitute two connected components of the presentation of a theoretical approach focusing on phenomena central in this book: the interactions between mathematics teachers and resources, and their consequences for professional growth. We name it *documentational approach of didactics* (Gueudet & Trouche, 2009). We begin (Section 2.1) with a discussion of the elementary concepts of this approach: *documentation work*, *teachers' documentation*, *resource/document dialectics* and *documentational genesis*. We then elaborate (Section 2.2) the methodology we use for studying teachers' documentation and the data we have collected using this methodology over 2 years. In Section 2.3, we detail a case study, extracted from these data. Finally, we present the perspective on teachers' professional growth yielded by this approach (Section 2.4). We pay particular attention to digital resources, the constituting factors of major evolutions.

2.1 The Documentational Approach of Didactics

We begin our discussion of the elementary concepts of the approach we develop by explaining its theoretical roots.

2.1.1 Teachers' Professional Activity and Professional Growth

The approach we present here has a specific orientation to studying mathematics teachers' activity and development. Informed by activity theory, firstly introduced by Vygotski (1978) and developed by Leont'ev (1979), we consider that the teacher's activity is oriented by goals (the object of the activity). Moreover, it

G. Gueudet (✉)
CREAD, Université de Bretagne Occidentale, IUFM Bretagne site de Rennes, 35043 Rennes
Cedex, France
e-mail: ghislaine.gueudet@bretagne.iufm.fr

must be studied as a social activity, which leads us to pay attention to its context: institution and different social groups.

We are interested in the evolution, and factors of evolution, of the teachers' professional activity. The studies about practising mathematics teachers sometimes separate their *practice*, their *knowledge* and their *beliefs* (Perrin-Glorian, DeBlois, & Robert, 2008). We consider here teachers' *professional growth* as a joint evolution of these three aspects. Conceptualising the way the practice articulates with knowledge and beliefs is one of the aims of the theory we expose here. We do not separate knowledge and beliefs, because the boundary between both is often unclear; we use the expression of *professional knowledge* to refer to both and focus particularly on knowledge related to mathematical content.

The reference to activity theory is also directly connected with our interest in *mediation* and *mediating artefacts*. However, we refer to *resources* rather than *artefacts* and discuss the reasons for this choice in the next section.

2.1.2 Resources and Documentation Work

Adler (2000, Chapter 1) proposes a conceptualisation of resources, emphasising the variety and the broadness of the range of *resources* intervening in teachers' professional activity. We retain here a similar conceptualisation and perspective: 'It is possible to think about resource as the verb re-source, to source again or differently' (Adler, 2000, p. 205). With this perspective, a resource can be an *artefact*, i.e. an outcome of human activity, elaborated for a human activity with a precise aim (Rabardel, 1995, Chapter 4). But resources exceed artefacts: For a teacher who draws on them in her activity, the reaction of a student, a wooden stick on the floor can also constitute resources.

The teacher interacts with resources, selects them and works on them (adapting, revising, reorganising, etc.) within processes where *design* and *enacting* are intertwined. The expression *documentation work* encompasses all these interactions. We consider that documentation work is central in teachers' professional activity. It pertains to all the facets of this activity: all the places, all the groups teachers are involved in. We also use the word *documentation*, which means, for us, both this work and its outcomes.

Retaining a wide perspective on resources does not mean ignoring the specificities of different kinds of resources. The work presented here originates in an interest in digital resources and their consequences for the teaching of mathematics. Teachers download lesson plans and exercises texts on websites; they modify, combine several files, elaborate their own texts, share them, etc. Digital resources evidence the documentation work. More generally, *material* resources have a particular status, at least for the researcher, from a methodological point of view. The interaction between teachers and material resources can indeed be visible in some cases: written notes on a book, an answer to an email, modifications in a file, etc. Non-material resources are more difficult to capture; some of them are nevertheless determining, like interactions in class with students. Several chapters in this book emphasise the importance of these interactions: chapters about the use of

resources (Chapter 11 evidences the importance of *non-verbal* interactions) as well as chapters considering the *joint action* of teachers and students (Chapters 3 and 11), the teacher–student interactions in the use of textbooks in particular (Chapter 12). These interactions constitute a specific kind of resource, in particular because they are likely to modify other resources, or the relation between the teacher and a given resource (an exercise text can be modified, because of a student's reaction, for example). They are both resources and a part of the social dimension of the teachers' professional activity.

2.1.3 The Resource/Document Dialectics and the Documentational Geneses

The documentational approach draws on the *instrumental approach*, developed by Rabardel (1995) in cognitive ergonomics and then integrated into mathematics didactics (Guin, Ruthven, & Trouche, 2005). Rabardel distinguishes between an artefact, available for a given user, and an instrument, which is developed by the user, starting from this artefact, in the course of his/her situated action. These development processes, the *instrumental geneses*, are grounded, for a given subject, in the appropriation and the transformation of the artefact, to solve a given problem, through a variety of usage contexts. Through this variety of contexts, utilisation *schemes* of the artefact are constituted. A *scheme* (Vergnaud, 1998) is an invariant organisation of the targeted activity, which is structured by *operational invariants*, developed in various contexts met for the same class of situations. This approach also distinguishes, within the instrumental geneses, two intertwined processes: *instrumentation* (constitution of the schemes of utilisation of the artefacts) and *instrumentalisation* (by which the subject shapes the artefacts).

The instrumental approach has mostly been used to study the consequences of technology-rich environment for the student learning, despite a growing interest for teachers in the educational research about technology in mathematics (Hoyle & Lagrange, 2010). We propose here a theoretical approach extending the scope of the instrumental approach. Moreover, it borrows from other research studies, about *document management* (Pédauque, 2006), which enlightens the evolutions brought by digital resources, and about *curriculum material* (Remillard, 2005, Chapter 6).

The teacher, in her documentation work, for a given class of situations, draws on a set of resources of various nature. Introducing a new vocabulary, we consider that this set of resources bears, for this class of situations, a *document*, within a *documentational genesis* (Fig. 2.1).

The documentational genesis jointly develops a new resource (made up of a set of resources selected, modified and recombined) and a scheme of utilisation of this resource. We can represent this process, in a very simplified way, by the following equation:

$$\text{Document} = \text{Resources} + \text{Scheme of utilisation}$$

The document can be considered as an outcome of the subject's activity. This static equation must nevertheless not obscure the fact that geneses are dynamic;

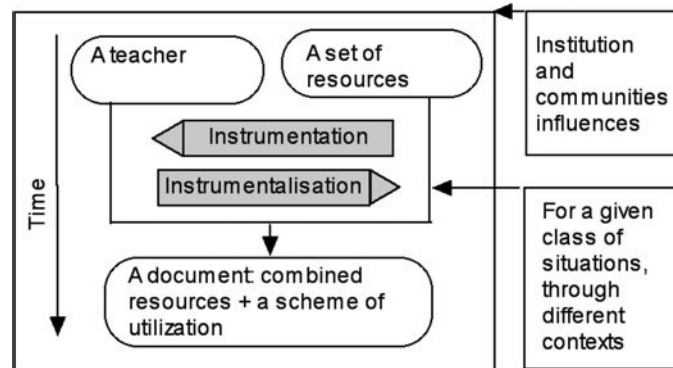


Fig. 2.1 Schematic representation of a documentational genesis

they are ongoing processes: a document comprises resources, which can be associated with others and involved in the development of other documents. A scheme of utilisation is an invariant organisation of the activity to achieve a type of task; however, it can evolve in the course of the documentation work. It can be adapted to take into account new features of the context; several schemes can be associated, etc.

We illustrate our model with a first short example, drawing on a previous study. Sarah has taught mathematics from grade 6 to grade 9, in France, for 10 years. An important objective assigned by the official curriculum is to introduce students to rigorous proofs in the context of geometry. For the class of situations ‘designing and setting up the introduction to proof in geometry’, Sarah selects exercises in the textbook where the figures are coded (equality of lengths and right angles). She uses dynamic geometry software and with it elaborates coded figures. Her students write in their workbook ‘a property of a figure cannot be claimed from mere observation, if there is no coding symbolising this property’. She declares, in an interview, that her long experience in grade 9 classes has led her to pay attention to the difficulties raised by proof in geometry, especially difficulties linked with the use of figures. In this case, we consider that the teacher, in the course of her work and over several years, developed a document, comprising recombined resources: extract of the textbook, dynamic geometry software, etc. This document also entails a scheme of utilisation of these resources, with operational invariants like ‘the proof of a result in geometry must be associated with a coded figure’ and ‘a coded figure helps to identify the relevant properties for the proof’.

We share with other authors in this book [in particular Adler ([Chapter 1](#)), Remillard ([Chapter 6](#)), and Pepin ([Chapter 7](#))] a perspective considering that teachers ‘learn’ when choosing, transforming resources, implementing them, revising them, etc. The documentational approach proposes a specific conceptualisation of this learning, in terms of *genesis*. Documentation being present in all aspects of the teacher’s work, it yields a perspective on teachers’ professional growth as a complex set of documentational geneses. Understanding this growth requires a holistic view on these geneses, by considering all the documents developed by the teacher: her documentation system.

2.1.4 Resource System and Documentation System

Studying teachers' documentational geneses evidences articulations between different documents. Naturally, the class of situations 'designing and setting up the assessment corresponding to the cosine lesson' is connected with 'designing and setting up the introduction of cosine': the objective of the teacher's activity is different, but the mathematical content being the same, the same operational invariants are likely to intervene in the documents developed for each class. However, the mathematical dimension is not the only element accounting for articulation between documents. 'Designing and setting up an assessment' can also be considered as a class of situations, corresponding to a general aim of the teacher's activity, connected with 'managing the class and following the students', another general aim.

Within the framework of the instrumental approach, Rabardel and Bourmaud (2003) consider *systems of instruments*, whose structure depends on the structure of the subject's professional activity. The classes of situations are articulated and organised, because the various aims can be more or less similar or linked. Drawing on this conceptualisation, we consider that the documents of a teacher are articulated in a structured *documentation system*.

The *resource system* of the teacher constitutes the 'resource' part of her documentation system (i.e. without the scheme part of the documents). Ruthven (Chapter 5) also introduces a concept of *resource system*, belonging to the five *key structuring features of classroom practice* he identifies. What 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.

We have presented here the theoretical construct framing our research. The complex object we study also requires a specific methodology, connected with this theory.

2.2 Studying Documentation Work: Reflective Investigation

We elaborated the theory and an associated methodology simultaneously in the development process of the documentational approach. We briefly present here this methodology that we named the *reflective investigation* of the teacher's documentation work.

2.2.1 Methodological Principles

The main principles grounding this methodology are as follows:

- A principle of *long-term follow-up*. Geneses are ongoing processes and schemes develop over long periods of time. This indicates the need for long-term observation, within practical constraints.

- A principle of *in- and out-of-class follow-up*. The classroom is an important place where the teaching elaborated is implemented. As mentioned above, these direct interactions with students are crucial resources for the teacher. They bring adaptations, revisions and improvisations, as Drijvers (Chapter 14) emphasises, distinguishing between an *exploitation mode of a didactical configuration*, planned by the teacher, and the *didactical performance* she realises in class. However, an important part of teachers' work takes place beyond the students' presence – at school, at home, in teacher development programs, etc. We pay attention to all these different locations.
- A principle of *broad collection* of the material resources used and produced in the documentation work, throughout the follow-up.
- A principle of *reflective follow-up* of the documentation work. We closely involve the teacher in the collection of data, with the pragmatic aim of broad collection and in-class and out-of-class follow-up previously discussed. The active involvement of the teacher yields a *reflective* stance (Schön, 1983).

We built a data collection device, presented in the following section, corresponding to these principles.

2.2.2 Data Collection Tools

The data collection we propose is planned to last several years; a teacher is followed at least 3 weeks each year. We detail here the schedule and the tools used. Figure 2.2 presents the overall agenda of the yearly follow-up.

During the first year, the teacher fills in a logbook over at least 3 weeks, describing her activity relative to one of the classes she teaches. The researcher visits the teacher three times at home for interviews and collection of resources. He/she asks (during the first interview) the teacher to draw a schematic representation of the structure of the resources she uses. We call it a *schematic representation of the resource system* (SRRS). An example of an SRRS is displayed in Fig. 2.4.

During the following years, the teacher is still followed in a class of the same level, for the same mathematical content. The overall structure remains the same (Fig. 2.2), but the focus is much more on developments: the teacher is asked to bring the necessary modifications, to explain the changes, compared to the previous year about the questionnaire, the SRRS and during the first interview.

We focus in this book on two teachers whom we followed for 2 years: 2008–2009 and 2009–2010.

2.2.3 Choice of Two Teachers

The two teachers we followed teach in middle school (from grade 6 to 9). They have been selected with very different profiles, according to several dimensions that we assume as crucial for the topic of our study: they differ in terms of ICT

First encounter: - presentation of the methodology, its spirit and its tools.	First visit: - about the resources in general; - about the chapter followed.	Second visit: - about the lesson observed.	Classroom observation	Third visit: - About the lesson observed; - Complements about the chapter and resources.
Tools: - Schedule; - Questionnaire; - Logbook.	Tools: - Interview guidelines; - SRRS	Tools: - Interview guidelines	Tools: - Observation guidelines	Tools: - Interview guidelines; - SRRS; - Collection of resources.
Week 1		Week 2		Week 3
Filling the logbook				
				

Fig. 2.2 Agenda of the follow-up

degree of integration (Assude, 2007), of *participation in collectives* and of *institutional responsibilities* (Gueudet & Trouche, 2009). These teachers were neither at the beginning nor at the end of their career.

Myriam (50 years in 2009) has a strong degree of ICT integration; she regularly takes part in in-service training; she took part in several IREM¹ groups. Pierre (35 years in 2009) has a strong degree of ICT integration; he is responsible for ICT in his school and member of Sésamath² association. This association gathers mathematics teachers; we describe it in more detail in Chapter 16. We mention here only several of the resources designed by the association which are accessible on its website, in particular the Sésamath textbook (which exists in digital and paper versions).

As explained above, we followed each teacher in only one class. Moreover, we chose that class to capture phases of reorganisation of the documentation work. We thus followed Pierre in one grade 6 class with a data-processing speciality which brings an opening towards new forms of work (better equipped students, motivated

¹ IREM, Institute for Research on Mathematics Teaching.

² <http://www.sesamath.net/>

for out-of-class interactions). We followed Myriam in grade 9 on a chapter (functions) corresponding to a change in the official curriculum. In 2008–2009, it was the first time that she taught that topic.

Myriam and Pierre are not chosen as ‘exemplar’ teachers. We do not aim at describing ‘good’ documentation work. Myriam and Pierre share a strong professional involvement; they spend probably more time on their out-of-class work than do the average mathematics teacher in France. This longer time is likely to evidence better the phenomena that we want to capture; however, we consider that these phenomena take place for every teacher.

In this chapter, we detail the case of Myriam; the case of Pierre is studied in [Chapter 16](#).

2.2.4 Analysing the Data Collected

This data collection is followed by a data exploitation device, which comprises various aspects. We carry out a quantitative treatment of the logbook: length of the out-of-class and in-class work, places for this work, number of occurrences of a given activity, length, number of uses of a given resource, length, nature and number of collective work moments, list of implied participants, etc. For the interviews, we note in the same way the occurrences of the types of activity, resources and persons mentioned. The questionnaire provides us with concrete information about the teacher’s career and her current working environment. We also gain access, through the questionnaire, to elements of her professional and personal history, in particular in terms of family environment and collective involvements. We complement these first treatments with the SRRS to evidence elements of structure of the teacher’s activity and of her resources, systematically identifying moreover collective dimensions ([Chapter 16](#)).

We identify, in the logbook and the interviews, all the elements relating to the lesson observed in class. We observe in the lesson’s transcript how the interactions between teacher, students and knowledge lead to adaptations of resources, during or after the lesson. We conduct a systematic comparison of the first-year and second-year data, quantitatively and qualitatively. In the next section, we present a case where we applied this data collection and analysis device.

2.3 A Case Study

In this section we study the case of Myriam and of her teaching about functions in grade 9 to illustrate the concepts presented in [Section 2.1](#).

2.3.1 Synthetic Description of Myriam’s Activity

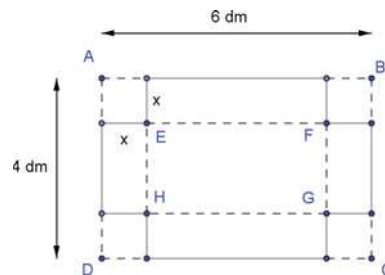
The synthetic description of Myriam’s activity during the follow-up ([Fig. 2.3](#)) corresponds to the year 2009–2010.

Myriam introducing functions in grade 9

Myriam has one grade 9 class, with 20 students. The theme of functions was introduced into the grade 9 curriculum in 2008–2009. The official curriculum is divided between 'core content of knowledge', which every student should learn, and other contents. Functions do not belong to the core content. The students must obtain a diploma, 'diplôme de brevet des collèges', at the end of the year. This diploma comprises a computer certification 'brevet informatique et internet' (shortened as B2i*); Myriam is responsible for ensuring some of the corresponding skills.

Preparing the lesson about functions

For the preparation of her lesson, Myriam uses several websites: Sésamath, and institutional websites. She also uses the classroom textbook and her personal notebook from the previous year. She finds on an institutional website an activity 'the box', where the students are asked to compute (with their calculator and then with a spreadsheet) the volume of a rectangular box for several values of the side x of squares, withdrawn on each corner to build the box.



She retains this activity and takes rough paper to propose to the students to build their own boxes.

Introduction of functions and graphics

She implements the 'box' problem in class and uses it to introduce the vocabulary and notations: function, image, antecedent, $f(1)=8$, $f: 1 \mapsto 8$. The whole activity, with the spreadsheet, and the course synthesis last 3 h (H1–H3). Myriam has observed, in 2008–2009, that many students failed to place a point given by its coordinates in a Cartesian coordinate system. Thus she presents during the fourth hour a mere placement activity, before introducing the notion of the graph of a function, during the fifth hour (H5), and presenting exercises about graphs (H6).

Fig. 2.3 Synthetic description of Myriam's activity, introducing functions in grade 9, 2009–2010.

*<http://www.educnet.education.fr/formation/certifications/b2i>

Work on exercises

After the introduction of the different notions, vocabulary and representations, she presents her students a sheet with five exercises, coming from several sheets downloaded on the Sésamath website (H7). One exercise concerns rectangle areas; all the others are situated within extra-mathematical contexts. The students are organised in homogeneous groups. They have to write their solutions on a slide (this session is filmed and observed). Myriam expects everybody to succeed the two first exercises, which actually happens; she observes only some difficulties in the notation and vocabulary in the students' productions, which are discussed and corrected the following day (H8). Other exercises are presented in H9 with e-exercises video projected and solved by the whole class, and in H10 with the calculator.

Snow, email and spreadsheet

The eleventh hour of the lesson was planned for Wednesday, January 6. But the snow begins to fall, and Myriam is blocked at home. On January 7, she comes to school, but only three students managed to reach it. She starts an exercise with them of the textbook about graphs, which requires the use of a spreadsheet. She is concerned about the following days, because school transport is cancelled. She decides to send the exercise by email to the students and asks them to solve the exercise and to send back the graph, drawn with the spreadsheet. Fifteen students send it, and it is later corrected in class.

In February, Myriam gives a short test on functions. She is not very satisfied with the results: some students still use incorrect notations or are unable to properly read a table of values. She presents them with additional work with the spreadsheet that the students have to send to her by email.

Fig. 2.3 (continued)

In this description for the class of situations 'designing and setting up the introduction of functions', we observe that Myriam uses many material resources of various kinds; digital and non-digital resources are strongly intertwined. We give below examples of geneses which occurred in the course of this activity.

2.3.2 Resources, Documents and Geneses: The Case of Myriam

We have selected, amongst all the geneses we can infer from our data, examples involving knowledge and resources which seem to be of particular importance for Myriam (mentioned on several occasions in the logbook, during the interviews, etc.). We also retained the example of a genesis corresponding to a new class of situations recently introduced in Myriam's system of activity for material reasons.

2.3.2.1 Mathematics as a Tool for Other Topics: Influence of an Operational Invariant

Myriam's professional knowledge and beliefs strongly influence her documentation work: her choice of resources, the way she associates them, etc. For example, Myriam is convinced that mathematics is a tool useful for other scientific topics: biology, physics, etc. An important factor for this belief is that Myriam is married to a physics teacher. The discussions with her husband are resources coming from a specific community, which re-source her practice. In the Sésamath exercises, as in the class textbook, she chooses many exercises related to biology or physics: this is an instrumentalisation process; her knowledge and beliefs guide the choice of resources and drive the teacher's agency. In the exercises she presents, many different letters are used to symbolise functions and variables: not only $f(x)$ but also $h(t)$, $d(v)$, etc. We consider that she has developed an operational invariant like 'the students must be able to manipulate functions with different names, because they will be asked to do so in physics and biology'.

2.3.2.2 Official Texts as Resources

Myriam cares a lot about official recommendations (national, in France). Every Friday, she reads the 'official publication of national education'³ which presents the official curriculum, announces the dates of the exams, etc. She intervenes as an in-service teacher trainer,⁴ discusses with the regional inspectors, etc. She has read a lot of texts about the 'core-content' reform. The organisation she chooses for the exercise sessions we observed, with a homogeneous group, is directly related to this reform. One of the official texts that Myriam often uses describes such an organisation. This text is an important resource for Myriam (coming from the 'official' institution); it frames her choices in an instrumentation process. We separated here, somewhat artificially, the associated processes of instrumentation and instrumentalisation for the sake of clarity; both processes are nevertheless strongly intertwined, as illustrated in the following examples.

2.3.2.3 Students' Productions as Resources

Students' productions constitute essential resources for teachers. Many of Myriam's choices are grounded in observations of difficulties encountered by students in 2008–2009. She changes her introductory activity, as she tells us in the third interview: 'I think that my starting activity this year was easier, more concrete [...] Choosing a good starting activity is very important, it determines the mood for the whole lesson [...] Last year the students rejected the notion of function, they said

³ <http://www.education.gouv.fr/pid285/le-bulletin-officiel.html>

⁴ In France every teacher can propose in-service training, on a given subject, usually for 1 or 2 days. The regional inspectors select some of the propositions to constitute the yearly 'training offer'.

it was useless'. The starting activity of 2008–2009 was situated within the frame of geometry (perimeter of a parallelogram inscribed in a right-angled triangle) and required delicate modelling work to determine a rather simple formula. Moreover, all the students conjectured the formula without calculation using a GeoGebra dynamic figure, which contributed to their reluctance towards a formal proof. It led Myriam to change her introductory activity; we consider that it also produced an evolution of her operational invariants (instrumentation).

2.3.2.4 Distant Work with the Students and Development of a Document

In 2008–2009, Myriam participated for the first time in the assessment of the computer certification (B2i, Fig. 2.3). For this reason, she had to ask the students to send her emails with attached files. She created a special email address (we can consider this process as instrumentation). In 2009–2010, the heavy snowfalls prevented the students from coming to school for almost 1 week. Myriam used a students' mailing list to present homework in an instrumentalisation movement. She is only starting with such requests, so she does not give much attention to being precise about the name of the file to send back or its format. She did not yet develop a stable orchestration (Trouche, 2004; see also Chapter 14) for such situations. The students sent back files with non-significant names; some sent spreadsheet files, while others copied their graphs in a word-processing file – in this case, Myriam cannot see how they built their graphs. We consider that Myriam is developing a document for the class of situations 'designing and setting up distant work about the graphs of functions'. The document has a 'resource' part, associating in particular the classroom textbook, a spreadsheet, email addresses for the teacher and the students, amongst others. Our observation took place at a moment of important evolutions, for this class of situations, linked with new digital means. We hypothesise that Myriam starts to develop operational invariants like 'when asking the students to send spreadsheets productions, it is necessary to precise that the spreadsheet file itself must be sent, and not copied into a word processing document' and 'correcting spreadsheet productions requires access to the formula written in the spreadsheet'. With the data we gathered, we cannot claim that Myriam actually developed these operational invariants; further observations are necessary to confirm this hypothesis. We consider it nevertheless as consistent, being connected with a more general operational invariant: 'correcting the students' mathematical exercises requires access to their procedures', which seems to intervene in many documents developed by Myriam.

Beyond these examples, we are interested in capturing more generally Myriam's (and other teachers') professional growth; for this purpose, we need to consider the documentation system as a whole.

2.4 Documentation Systems and Professional Geneses

We discussed in Section 2.3 several examples of documentational geneses of instrumentation and instrumentalisation processes in the case of Myriam. In this section we first go back to this case, trying to capture the structure of Myriam's documents, their evolutions and factors of evolution. Then we address more generally the issue of documentation systems and professional geneses, focusing especially on the evolutions brought by digital resources.

2.4.1 Myriam's Documentation System and Its Evolutions

Figure 2.4 presents Myriam's representation of her resource system, drawn in 2009–2010.

Myriam represents herself, and specific aspects of her documentation work (in particular her teaching project), in the centre of a space organised in four zones:

- On the left and in the middle, her work at home. This does not mean individual work: for example she is inscribed in mailing lists and receives at home information from these lists. She also works at home with resources given by colleagues.
- Up right, her work at school without students. Meeting with colleagues, entering the students' marks in the special software (Pronote⁵), which builds the school report at the end of each term.
- In the middle of the right side, her work at school in the classroom with her students. Myriam has her own classroom equipped with a computer, a video projector and an overhead projector (which she intends to replace soon with a webcam).
- Down right, in-service training collectives. Myriam is involved in two such groups. One group gathers some mathematics teachers of nearby schools (five teachers); they exchange exercises and discuss changes in the curriculum. They meet once a month. This group is not officially recognised by the institution. Myriam is also a member of an 'official' group, where a regional inspector participates. This group works on problems and investigations in mathematics.

These articulated zones correspond to a structure of Myriam's professional activity. This confirms the relevance of our 'global' positioning: the teacher's resources are structured according to her activity. We emphasise here central features of Myriam's professional activity and related characteristics, and evolutions of her documentation system:

- Myriam develops real agency in the elaboration of her courses linked with the available digital means: she collects exercises from different downloaded files

⁵ <http://www.index-education.com/fr/telecharger-profnote.php>. 'Pronote' means 'professional marks'.

Binder with the courses of previous years	Official curriculum	Entering students' marks (Pronote–Profnote)
	Websites	
Class textbook (Transmath grade 9)	Eduscol	Special meetings for some students
	Official publication of national education	Photocopies for students
	Vade mecum	
	Problems basis	
Other textbooks	ME	Overhead projector
Exam texts	First project	Video projector with the classroom computer
Websites	Reflection time	MatouMatheux
(Institutional – Mathenpoche – MatouMatheux* – Sésamath grade 9)	Discussions with other teachers: physics, biology	Mathenpoche
	Final project	GeoGebra
	Evaluation	Spreadsheet
Documents of training sessions followed or given by colleagues	Computer	Training
	Notebook with planning each day	Local group
	USB key	
	Folders	(St Basil, St Anton)
Report sheet of grade 9 before each holiday (summarising the main notions to know)	Class notebook	Reflection group
	Notebook written as a student	

Fig. 2.4 Schematic representation of the resource system in 2009–2010, Myriam. The original SRRS was handmade and naturally in French. We translated this one and typed it. * Online exercises, <http://matoumatheux.ac-rennes.fr/accueilniveaux/accueilFrance.htm>

to build one exercise sheet; she integrates new software that she does not fully master, etc. Her preparation work at home is represented on more than half of the SRRS. This corresponds perhaps more to the importance of this work in her opinion than to the time actually spent. She filled in the logbook for over 27 days (about the work with her grade 9 class; this includes Saturdays and Sundays). She mentions about 14 h of work in class with the students, 10 h at school for other purposes (several kinds of meetings) and 12 h at home. She can certainly be considered as an expert teacher. We consider that this characteristic acts as a lens, evidencing phenomena that happen for all teachers.

- She is very concerned about official instructions. She follows them and even anticipates further institutional requirements. Her involvement in the assessment of the 'B2i' leads her to send work by email and to develop professional knowledge linked with these email exchanges with the students.

- Myriam is involved in many collectives, which strongly influence her documentation (we detail such processes in [Chapter 16](#)). As discussed above, the collective she forms with her students (Section 2.3) and her interactions with students are central resources. She also discusses with colleagues at school and within the in-service training groups. These groups provide her with new ideas of exercises and develop her interest in problems and in investigation situations. This is probably one of the reasons accounting for her choice of introductory activity ('the box', Fig. 2.3). We have also mentioned the discussions with her husband. Myriam evokes in fact many discussions with her family, which intervene in her documentation work: not only her husband, who teaches physics, but also her sister, who teaches maths, and her daughter, who is now in grade 11. In H10 (see Fig. 2.3), she devotes a whole hour to the work around the calculator, much more than what was done in 2008–2009, because she realised the importance of the calculator at high school by observing the work of her daughter.
- She considers that mathematics needs to provide tools for other scientific topics, physics and biology in particular. This feature is linked with the issue of collectives: her husband is a physics teacher, and at school her discussions are especially with the physics and biology colleagues. It strongly influences her choice of exercises and problems, which are often connected to these scientific topics.

The whole of Fig. 2.4 could be interpreted as a description of Myriam's documentation work: on the left, the resources she draws on; in the centre, her own 'creations'; on the right, the implementation which supplies new resources – back to the left (kept in the 'binder with the lessons of previous years'). The presence, in the centre, of 'ME' written in capital letters emphasises that this work and, according to our perspective, the associated geneses deeply influence the teacher.

2.4.2 Professional Geneses and Integration of Technology

In this section, we address more generally the question of documentational geneses for teachers and the consequences of the use of digital resources, drawing on observations realised with several teachers (including Myriam and Pierre).

2.4.2.1 A Specific Perspective on Professional Growth

The documentational approach offers a specific perspective on teachers' professional growth. The documentation systems articulate professional knowledge and the teacher's resource system.

Therefore, considering teacher's documentation systems leads in particular to identify structuring elements in their professional knowledge. These elements include what Ruthven ([Chapter 5](#)) names the *curriculum script* (model of goals and actions guiding the teaching of a particular topic). We consider nevertheless

that this script is mostly adapted to enlighten the decisions that the teacher takes in class; the documentational approach aims at presenting a more holistic view of the teachers' activity. It can naturally be used to study technology integration phenomena and more generally to understand the professional evolutions resulting from the generalised availability of digital resources.

2.4.2.2 Using Digital Resources: Consequences

We notice here different types of such evolutions:

- The balance evolves between what is limited to the group formed by the professor and her students, and what is more largely accessible. In particular, Myriam and Pierre use the Pronote software, which was retained by the administration in each of their schools. It confers a public dimension to the marking, making the marks immediately accessible to the other teachers from the same class and to the administrative staff.
- The spatial organisation in class includes new forms of display. The two teachers observed use a video projector; Pierre, moreover, has an interactive whiteboard that he combines with his traditional whiteboard ([Chapter 16](#)). Myriam also uses an overhead projector to exploit two forms of display as well. This leads to raise the question of new forms of *ostension* (the teacher showing the content to be learned, Salin, 1999) associated with these new displays, which would require a complementary study.
- Using digital files allows an immediate modification of these files as soon as the teacher observes a problem during the implementation in class. The impact of the interactions with the pupils thus seems increasingly important for the teacher's resources.
- The email allows fast and flexible exchanges of files between the teachers and permits out-of-class exchanges between students and teachers.

2.5 Conclusion

The stake of a documentational approach of didactics is not limited to the analysis, in terms of professional genesis, of the consequences for teachers of their interactions with resources (Cohen, Raudenbush, & Ball, 2003). It constitutes a change of perspective and an invitation to see documentation work as central in the teachers' activity and documentational geneses as the components of a complex professional genesis. The expression *documentational approach of didactics* aims at emphasising that the objective is to not only propose a didactical analysis of the teacher's documents but also consider the documents as central within the didactic phenomena, and in particular within teachers ongoing professional development.

This perspective has already been discussed in Gueudet and Trouche (2009), where we introduced the resource/document dialectics and the concept of documentational genesis. The specific methodology that we have implemented here enabled

us to investigate further, taking advantage of the long-term evolution, over several years.

Complementary studies are needed; the theoretical aspects of the approach have to be refined, in particular by confronting the documentational approach and other theories used for the study of teachers' growth, of professional activity and of mediations in/for this activity. The consequences of this approach for the design and use of resources, in particular with an objective of professional development ([Chapters 7 and 17](#)), require a specific attention. It is also an aspect of our work in progress, in particular about innovative teacher training programs grounded in collaborative documentation work (Gueudet, Soury-Lavergne, & Trouche, [2009](#)).

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Appendix

Myriam, Additional Data

Activity type (and math. theme, if relevant)	Precise place	Time	Other persons involved	Resources used	Materials produced	Archiving (what? where?)	Comments
Lesson about functions	Classroom	10.00–10.55 (A.M.)	The class (grade 9)	Method sheet Online exercises (MatouMatheux)	Students sheet about reading images and antecedents	Ring binder grade 9	
Discussion with the bursar	Dining hall	12.45	The bursar	Videoprojector			She informs me that my webcam has been delivered
Report of the day's lesson	Home	5.00–5.15 (P.M.)				Personal notebook	

Source: Extract of a filled logbook (Myriam, January 4, 2010)

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