# Chapter 9
# Mathematics Teachers' Expertise in Resources Work and Its Development in Collectives: A French and a Chinese Cases

**Chongyang Wang**

**Abstract** Designed as a case study, two mathematics teachers from two contrasting contexts, China and France, were selected and investigated. Looking through both the teachers' resource system and their resources work in collectives, it is hoped to develop a deeper understandings on teacher's expertise in working with resources, and the factors from collectives to develop it.

**Keywords** Mathematics teachers' resources · Documentational approach to didactics · Teacher expertise · Teachers' collective work

## 9.1 Introduction

Teachers always interact with resources in their work, which provides a lens to see their work and professional development in a resource dimension (Gueudet et al. 2012). What is more, the relationship between teachers and resources has changed with the evolution of technology: teachers are no longer only users anymore, but designers for developing resources, such as Open Educational Resources (discussed in Chap. 1) or online e-textbooks (discussed in Chaps. 12 and 15).

In the pilot study (Pepin et al. 2016) of our Ph.D.[1] thesis, concerning three Chinese "expert" mathematics teachers, we explored their expertise combining the

---

C. Wang (✉)
École Normale Supérieure de Lyon, 15 Parvis René Descartes, BP 7000, 69342 Lyon Cedex 07, France
e-mail: chongyang.wang@ens-lyon.fr

C. Wang
East China Normal University, 3663 North Zhongshan Road, 200062 Shanghai, China

analysis of their *resource systems* (i.e. the structured set of resources supporting their teaching) with deep-interviews and observation. In this study, I paid particular attention to teachers' expertise in their work with resources. It is assumed this expertise contains a way of integrating resources: when the teachers are interacting with resources, they are in fact experiencing a process of integrating the resources from outside into their own resource systems. Since cooperation among teachers is considered important for their professional development (Hargreaves 1995; Cui and Zheng 2008), this expertise will be explored from a collective dimension: two cases from two different collective contexts, one in China, and the other one in France, will be chosen and studied.

Contributing to the exploration of the expertise in teacher's working with resources, and how it is developed through teachers' collective work, this research is hoped to develop a refined definition of such expertise and the factors that are due to collective work. The research questions are:

(1) What kinds of expertise are there in teachers' work with resources?
(2) How do teachers develop their expertise working with resources, particularly in collectives?

In the following parts, firstly the theoretical framework and methodological discussion will be presented, subsequently two cases in China and France, and a deep analysis on the French case will be expanded.

## 9.2 Theoretical Framework and Definition of Concepts

This study is based on two frameworks: *Documentational Approach to Didactics* (Gueudet and Trouche 2009, see also in Chap. 1) to analyse the features of teachers' resource work, and elements of the expertise in resource work; and *Activity Theory* (Engeström 2001) for tracing the influences from collective work. This section will start from the definition of resource, then the two theoretical frameworks, and a preliminary definition of expertise in teachers' work with resources will be given based on the literature review.

Regarding the notion of resource, Adler (2000) described the resource as the verb "re-source"; a resource could be anything with the potential to *re-source* a teacher's activity. This study kept the idea of Adler's definition, but in this chapter, the resource refers mainly to elements developed or used by teachers in their work about the curriculum, like textbooks, reference books, no matter digital ones, material ones, and even personal ones, etc.

### 9.2.1 Documentational Approach to Didactics (DAD)

According to Documentational Approach to Didactics (DAD), the interactions between teachers and resources, including restricting, selecting, implementing, modifying, adapting, saving and sharing, were defined as *documentation work*: a document is composed of a resource and schemes of utilization. The documents of a teacher are articulated in a structured documentation system, correspondingly, the resource system constitutes the "resource" part of the documentation system without the scheme part of the documents. A scheme in Vergnaud's study (2009) was defined as the invariant organization of activity for a given class of situations, comprising the goal(s) of the activity, the rules to generate activity, the operational invariants for picking up and selecting the relevant information, and the possibilities of inference. The frameworks of DAD provided a view to see teachers' expertise in resource work by analyzing the elements of scheme in using resources: goal(s), rules of generating activity (how to do), the operational invariants (why to do), and the possibilities of inference.

### 9.2.2 Activity Theory

While taking DAD as a framework to analyze the resource perspective on teacher work, there also comes the question of the nature of teachers' work: teachers belong to institutions (Chevallard 2006), their work is neither isolated nor individual, but part of society, their documentation work is connected to others, and culturally and socially situated (Gueudet et al. 2013). Hence, the *Activity Theory* (Engeström 1987, 2001) is adapted as the second framework. Engeström expanded a mediational triangle as "activity system" from Vygotsky (1978) and Leont'ev (1978), with six elements: subject, mediating artifacts, object, rules, community and division of labor, emphasizing that activity should be situated into a cultural and historical background with five principles: (1) the activity system as a whole as the unit of analysis; (2) multi-voicedness, "multiple points of view, traditions and interests"; (3) historicity, "activity systems take shape and get transformed over lengthy periods of time"; (4) contradictions, "as sources of change and development"; (5) the possibility of expansive transformations (ibid., pp. 136–137). Inspired from Activity Theory, teachers' resource work could be situated into an activity system with the corresponding elements: teacher (subject), resource (mediating artifacts), object, rules, collective (community), and division of labor.

While the activity system is taken as the unit of analyzing teacher's activity, the resource system of the teacher also gets developed (re-organized or enriched) along with the teacher's resource mobilization from her resource system to achieve the goal of the activity. It is believed in this study that the resource which works as the mediating artifact in the activity system comes from the teacher's resource system. This way, teachers' resource system could be understood by observing how the

teacher adapts it in specific activities, while teachers' activities could be analyzed through a lens of her resource system.

As stated before, Activity Theory provided a framework to trace the influences from the collective, (1) the history and culture of the collective where the teachers work in will be considered when analyzing their collective work, (2) the points of view from other colleagues in this collective will also be paid attention to when following the targeted teachers, (3) the contradictions between the targeted teachers and other colleagues (like the conflicts in using resources), as well as the collective or the environment (such as new tasks or challenges) will be studied carefully to see the "source of change and development". The specific tools inspired from DAD and Activity Theory will be introduced at length in the methodology section.

### 9.2.3 Definition of Documentation Expertise

The expertise in teachers' documentation work is defined as *Documentation Expertise (DE)* in this study. According to Berliner (1988), expertise "is *specific to a domain*, and to particular contexts in domains, which is developed over hundreds and thousands of hours". Key elements of expertise are linked with teaching problems solving efficiently and creatively with a wide range of knowledge and experiences (Sternberg and Horvath 1995), or to be more precise, teachers with "adaptive expertise" were proposed as "specialists in retrieving, organizing, utilizing, and reconsidering their professional knowledge and beliefs" (Avalos 2011). Drawing from the definitions of expertise and documentation work, DE is defined preliminarily as the schemes while interacting (retrieving, selecting, organizing, modifying, adapting, creating and sharing off) with resources. DE is considered as a developing state of teacher expertise, offering a resource aspect to explore the way of teacher's professional development (Pepin et al. 2016).

In this study, we assumed that the elements of DE could be summarized from schemes. Comparing with *Pedagogical Design Capacity* (PDC) (Brown 2009; see Remillard's study in Chap. 5), DE emerges with the property of documentation work, which covers the whole process of interacting with resources. It means that DE is more than "teacher design" or "teacher design capacity" (Pepin et al. 2017), which appears not only in the design phase and the implementation phase, but also the phases of reflection, modification, saving or organizing, and sharing off etc.

To summarise, DE could be defined as a series of structured schemes in resources retrieving, selecting, organising, modifying, creating and sharing off, with an aim of achieving some teaching goals or solving some teaching problems.

## 9.3 Methodology

As stated in Sect. 9.2, the methodology and tools inspired by DAD (like the reflective investigation), and Activity Theory (such as the documentation-working mate) will be presented in this section.

### 9.3.1 Reflective Investigation and the Tools Developed

Different from the traditional investigation, reflective investigation involves the teachers as part of the study throughout the whole data collection, with four principles: long-term follow-up; in- and out-of-class follow-up; broad collection of the material resources used and produced throughout the follow-up; and reflective follow-up of the documentation work (Gueudet et al. 2013, p. 27).

To know how the teacher organizes and represents her available resources, and in line with our pilot study (see Pepin et al. 2016), we adapted the tools of "*Reflective Mapping of Resource System (RMRS)*", in which a teacher is asked to draw a map to present her resources in a structured way based on her own reflection, and "*Inferred Mapping of Resource System (IMRS)*", in which the researcher completes some information on the RMRS derived from combining the interview and observation. It should be noticed that the RMRS and IMRS are not final, but will be improved, complemented, and reorganized continuously during the long-term follow up, along with the development of teachers' reflections on their resource systems.

Some other tools were also developed. An online "*Reflective Investigation Box (RI Box)*" was built and shared between the researcher and the targeted teacher, in which the teacher could share her resources used in her activity (such as lesson plans, screenshots of blackboard writing etc.), and respond to the questions (either about resources in RI Box, or any other questions) from the researcher regularly. The software chosen for supporting RI Box depends on teachers' using habits in different contexts, for example, RI Box supported by Dropbox[2] in France (see Chap. 12), and Wechat[3] in China.

Besides field notes of teachers' activity, observation and school visiting from the researcher were also adapted. The combination of field notes and RI Box provides the possibility of a long-term follow-up of the teachers' resource work, for example, during the activity, what resources are integrated, where these resources come from, and how they are integrated.

---

[2]Dropbox is a file hosting service, which offers cloud storage, file synchronization, personal cloud, and client software. See more information on: https://www.dropbox.com.

[3]Wechat is a Chinese social media, with the functions like instant messaging (text and voice), hold-to-talk messaging, broadcast (one-to-many) messaging, video conferencing, group chatting, official accounts and moments etc. See more information on: https://web.wechat.com.

### 9.3.2 Documentation-Working Mate for Understanding Collective Documentation Work

Following the principle of "multi-voicedness" of Activity Theory, a new notion of *documentation-working mate* was proposed here as someone who works closely with the targeted teacher, with mutual influences on their documentation work and DE development. *Mate* in Oxford Dictionary is defined as infers "a fellow member of joint occupant of a specific thing, like table-mate", with an "origin related to meat (the underlying concept being that of eating together)[4]". The reason to choose "mate" and but not "peer" as in "peer education" (Turner and Shepherd 1999) is that "mate" breaks the boundary of age and education/professional background. For a given teacher, her *documentation working mate* could be a colleague with similar working experiences in her school, or someone from a totally different working context as an university or research institute etc. In each case of this study, a *documentation working mate* will be selected according to the targeted teacher: they form the smallest but closest collective, and the documentation working mate will be followed in the same way as the targeted teacher.

### 9.3.3 A Two-Step Case Study Analysis

Designed as a case study focusing on DE from different contexts, two mathematics teachers were selected from two middle schools, one (named Gao) from Shanghai in China, and the other (named Anna) from Lyon in France.[5]

The two teachers' work is situated in different collectives, TRG in China, and AeP in France. TRG is chosen because it is a widely spread collective schoolwork unit for Chinese teachers since 1952, and AeP is selected because it is an association of French schools linked to the French Institute of Education (IFÉ) which started in 2013 but with rapid expansion. The specific introduction of these two collective work contexts will be presented in Sect. 9.4.

The cities where the schools locate, Shanghai and Lyon, are both developed cities, and the middle schools selected were both located in the city center and they all have close cooperation with the research institutions where the author works in, one is an affiliated school of ECNU and the other is a member of AeP. From the level of students' performance and teaching technology equipment, they were both ordinary schools, neither top nor bottom.

The two teachers were selected because of (1) their willingness to participate in the research; (2) administrative support from their schools; (3) active participation

---

[4]See in https://en.oxforddictionaries.com/definition/mate.

[5]As stated at the beginning of this chapter, the French case of Anna was shared with another Ph.D. student (see Rocha in Chap. 11).

in collective work; (4) rich working experiences and good technology operation skills.

This study is situated in a time of change, which demands the teachers working with resources intensively: a new middle school curriculum reform in France had started since September 2016, and one of the big changes is "algorithmic", which appeared in middle school stage for the first time; while in China, although without any education reforms in curriculum, it was the time (March to May each year) for the novice teachers to prepare open classes with the instructions of the experienced teachers.

The analysis of the cases includes two steps: (1) the teachers' individual resource work analysis, such as their RMRS and IMRS, the collectives they participated in and related working experiences (see the documentational trajectory discussed in Chap. 12), and (2) the teachers' collective work analysis through videos and reflective interviews.

The aim of the first step is to obtain an overall landscape of the targeted teachers' resource work, such as what resources they use, in which collectives they work, how their resources are organized etc. In this phase, a variety of information from the teachers is considered: emails, CVs, published papers and articles, blogs etc. School activity observations and interviews are intertwined as main tools: while observing school activities (such as classroom teaching or conferences), field notes taken by the researcher, and complementary interviews with the teachers are also adapted.

In the second step, three phases including lesson preparation, lesson implementation and the reflective interview were filmed. In Sect. 9.6 of this chapter, a collective lesson preparation of the French case will be analyzed particularly. The collective lesson preparation lasts for one hour. Before their collective work, an email with three questions was sent to them: "What are the difficulties of this activity? What resources do you bring and lack of? Why do you prefer to work together?" The first transcription was shared with Anna through Google document, in which we (the author, Katiane Rocha, and Luc Trouche) marked our confusions and questions in the video, particularly the name of the resources that are unclear for us. Then with the second transcription, we discuss with Anna face-to-face, mainly on the source of the resource appeared in their collective lesson preparation.

## 9.4 Contexts of Teachers' Collective Documentation Work: TRG and AeP

Working as the contexts of the two teachers' collective work, TRG and AeP will be presented in this section from their cultural backgrounds and historical developments.

With top performances in international tests, such as PISA, TRG is considered as an important factor for Chinese teachers' professional development (Wang 2013).

While remaining a limited network of schools associated to IFE in France, AeP is now a new typical exploration in teachers' collective work in France. They are both school-level collectives with strong institutional supports, closely linking with research institutions, which make them serve as a hub for connecting some professional collectives (both teaching collectives and researching collectives) as well as the resources circulating in the collective activities.

### 9.4.1 Collective Culture and TRG in China

Working collectively, in China, is considered as essential since Confucius. "Whenever walking in a company of several persons, among them must be someone worth learning from (三人行, 必有我师)". From the view of culture, the school-level working culture in China has been described as *collective* in Yang's study (2013). Research on teacher education in China shows that Chinese teachers are benefiting from some efficient school-based means (Li and Huang 2008): they gain a deep understanding of basic mathematics and adequate pedagogical expertise through the activities of TRG. The word "TRG" firstly appeared in Chinese Ministry of Education regulation in 1952, aiming to "study and improve the way of teaching". In 1957, the property and tasks of TRG were emphasized again and more clearly stated (Wang 2013). Since the 1990s, TRG undertook the work of carrying out post-1990 curriculum reform. From 2001, encouraged to participate in education experiments, TRG slowly gained research components. Now the TRG has become a basic unit for teachers' collective work in each school, a main platform where resources are generated and shared through the regular collective activities.

Generally, a TRG consists of teachers from the same discipline, such as mathematics TRG, or English TRG. And each TRG is composed by several different Lesson Preparation Groups (LPG) based on grade, like a mathematics LPG in Grade 6. In most of the Chinese schools, teachers work full time with their own office or office desk, and generally speaking, teachers from a same LPG are arranged to share the same office (sometimes with other discipline teachers, it depends on the scale and conditions of the school), so that they could communicate with each other conveniently. LPG also works as the basic unit of teaching research activities. Sharing a same office, teachers from the same LPG work collectively very often.

The working modes of TRG could be sorted into "task-based activity" and "operation mode of diagnose-based activity" (Hu and Wang 2014). The former is represented by collective design of resources, such as school-based exercise books, and the latter could be embodied through Chinese open class with several rounds of adjustments during the lesson preparation. Thus, the daily activities in TRG mainly focus on issues about design or implementation of teaching, for but not only for resources.

### 9.4.2   Collective Experiences and AeP in France

AeP is a network of schools linked to IFÉ (French Institute of Education, see http://ife.ens-lyon.fr/lea/lea-english-version), ENS de Lyon. The first network, comprising 12 schools, was set up in 2011; up to 2015, there are 34 schools in this network, aiming to go beyond the boundaries between basic, clinical and technological research. To be a member of AeP, the school needs to be strongly supported by their administrative staff and to meet the interest of research of a research team in IFÉ. Then the school and the research team will co-propose to IFÉ a joint AeP project which builds on questions emerging from the actor's concerns (Chabanne et al. 2015). Once a school, such as middle school A, becomes a member of AeP, its name will be changed into "AeP A" by other members. AeP builds an explicit association between schools and research institutes, to gain resources and better understanding from interactions between teachers and researchers, or teachers themselves. The short history of AeP does not mean that the collective work among teachers in France is recent. Actually, before AeP, IREM (Institute of Research in Mathematics Education), which gathers teachers and researchers, has existed since 1968, and the origin of teachers' collective work can be traced back to 1900, as the French Dictionary of Pedagogy (Buisson 1911) saying, "Teaching is collaborating".

Different from TRG in China, AeP is not a compulsory choice for neither teachers, nor schools, that is why at the beginning part of this session AeP was introduced as a limited network of schools. However, the teachers who join AeP have compulsory cooperation with the researchers in IFE, because each member of AeP needs to sign a contract based on a common research project, which generally lasts for three years, and could be renewed if it is agreed by both sides. In this way, activities of AeP provide the opportunities for teachers' collective work with both their colleagues inside their school and the researchers outside.

## 9.5   A First Analysis of Teachers' Individual Documentation Work

As introduced in Sect. 9.3, in France and China, one math teacher was selected from each side as the main teacher to be followed, thus this case study includes two cases, one in China and one in France. Since the author was born and has studied in China, the duration of the two case studies was different: the follow up of the French case took more time, because the author is familiar with the Chinese context already. So more time was spent on the French case when the author was staying in France (from March 2015 to January 2017).

## 9.5.1   The Chinese Case

Since the thesis is still in process, the Chinese data collection has not finished yet; this is also the reason why the following section will only present the video analysis of the French case. Up to this chapter, I conducted two rounds of data collection in China. The first round included two interviews with Gao and the principle of the middle school. In the second round of data collection, I spent 3 weeks for full-day observation in both Gao's classroom teaching and her school life, including her interactions with other colleagues in office and meetings in TRG. During the observation, I also conducted some informal interviews mainly about her resource usage.

In this school, each Tuesday afternoon was the fixed time for math teachers' collective activities: math TRG activity was held once per month, math LPG activity was held each week. Besides the school activities, teachers in this school were also sometimes arranged to accept training in other schools, in Shanghai or other cities; in return, teachers from other schools could also get trainings in their school.

As a math teacher with 2 classes in grade 7, Gao was also in charge of some class management work of one class. She was the leader of grade group 7 (in charge of administrative management of the whole grade), and the leader of math LPG in grade 7 (mainly for math teaching affairs of this grade). In grade 7, there were 4 classes and 2 mathematics teachers (Gao and Liu) were in charge 2 classes for each. In this school, all teachers from the same grade were arranged to work in a same office, so Gao and Liu shared the same office with all the other teachers who teach grade 7. She needed to give 12 lessons each week (6 lessons in each class), the rest of working time she had to deal with students' homework, attend training or teaching research activities, or prepare lessons etc. Working as the leader of math LPG in grade 7, Gao's responsibility was to unify the teaching progress, or organize discussions when facing some complex problems, and the discussions would be conducted whenever they needed, because "although we have regular teaching research activities each Tuesday, we cannot leave the problems and wait until that day, some of the problems need to be fixed at once, this is also why we keep the teachers in the same grade in a common office, we can communicate in time" (cited from the interview with Gao).

As for the *documentation working mate* of Gao, three teachers were chosen (see Fig. 9.1): Yao, who was a new teacher in grade 6 and supervised by Gao; Liu, a teacher who taught the same grade and shared a common office with Gao; and Zhang, the leader of math TRG in their school.

According to the interview and school observation, the scheme of resources accumulation could be seen in Gao's resources work:

– Goal of the activity: accumulating resources in daily work;
– Rules of generating activity: (1) Marking the students' homework and helping them correct the mistakes one by one, and face to face. For Gao, marking her 70 students' homework, including checking the mistakes and asking the students to

**Fig. 9.1** Gao and her
*documentation-working mates*
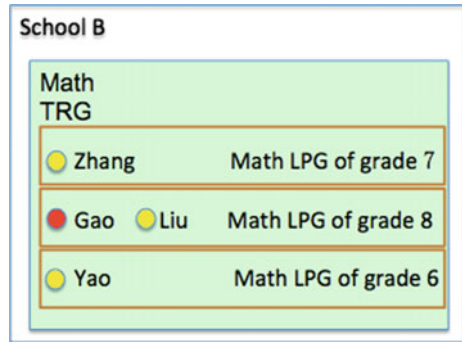


correct them, is a regular job which could cost her two hours each day to deal with their homework, but she insisted on marking the homework of students face to face, and adapts lots of students' feedback into the next lessons. (2) Discussing with other colleagues, both in TRG activities, like open class or teacher trainings, and interactions with researchers; (3) Regularly reading, sorting and writing down the selected exercise items from her self-purchased reference books. Gao has several notebooks for these items, and Gao often sends some of these items to her students as their homework.

– The operational invariants: Gao considers the feedback (like the mistakes made by the students) from the students as the most important resources for her teaching, because "the touchstone for testing whether I have achieved my teaching goal is to see if they have mastered the knowledge, which could be reflected in their homework." Gao also has a clear cognition on her various reference books, some with very detailed explanation on the content are ideal for new lesson preparation; some with basic items and improving items are good for stratified teaching; some are for review lessons. "Learning mathematics needs a lot of exercise, but if the students do not have enough time, we need to offer some selected exercises").

– The possibilities of inference: Gao has built some "organic cycle system" for accumulating resources, which is students-centered. She gathers and selects the available resources, then sends them to the students, and gets their feedbacks as her teaching resources in class, also she exchanges these experiences and items through discussing with other colleagues. This process is beyond accumulation, Gao also experiences the resources integrating, adapting, modification and sharing etc.

## 9.5.2 The French Case

A 3-month's preliminary follow up of Anna's school activities was conducted from April to July 2015, including her classroom teaching activities observation,

in-service teacher training, pre-service teacher mentoring, and school meetings with her colleagues.

Middle school A became a member of AeP since 2013, the first year when AeP was set up. The invitation to join AeP was enabled by a researcher who had close cooperation with Anna in SESAMES (Situations of Science Education: Activities of Modeling and Simulation Evaluation) since 2006. The SESAMES team is composed of researchers and teachers, working for teaching and evaluation resources. The SESAMES Algebra Group that Anna participates in includes 7 math teachers from secondary schools. This group aims to build resources for mathematics teaching, especially for algebra teaching in middle school, providing guidance for teachers.

Graduated in 1989, Anna passed her CAPES (Certificate of Secondary Education Professional Qualification) exam in 1990, after one year's pre-service teacher education, she got her first position in a middle school of urban Paris, a "famous" school for the tricky problem students, till 1995. From 1995 to 2005, she worked in a middle school in Lyon. In 2005 she started to work in the current middle school A. She is a math teacher of three classes. She is also in charge of classroom management in one class in grade 6. In 2013, the same year when her school became a member of AeP, she began to work half time in IFÉ, and became a correspondent of this AeP. She works in SESAMES since 2006, APMEP (Association of mathematics teachers of public education) since 1990, and IREM (Institutes of research of mathematics teaching) since 2010.

As Anna's *documentation-working mate*, Cindy (see Fig. 9.2) is a math teacher who works in the same school as Anna, and she is the other correspondent of this AeP A. She is also a member of the SESAMES team and IREM, in which she works closely with Anna.

Based on the observation and interviews with Anna and Cindy, the following scheme of Anna's resource accumulation and management could be found:

– Goal: accumulating and managing the resources meanwhile;
– Rules for generating activity: (1) Taking various technological tools for storing personal resources, like Dropbox or Google Drive used for storing resources; (2) creating a common Dropbox folder to share the resources with all the other



**Fig. 9.2** Anna and her *documentation-working mate*
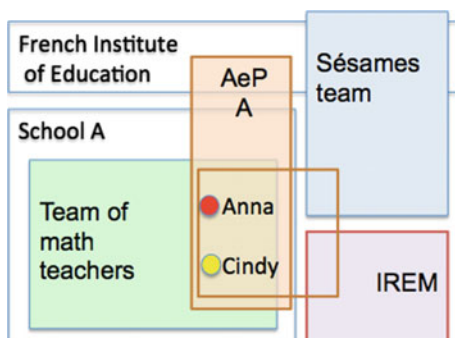
math teachers in her school, and regularly sorting up the structure of the sub-folders; (3) mobilizing the resources from different sources to support their other jobs. For example, when teaching the chapter of "line, segment and half-line", she arranged several activities from IREM website for her students. Then she collected and took pictures of their work, and uploaded to the school webpage for inter-discipline students' masterpieces; and she also adapts these as examples to her teacher-training work, shared and discussed with other teachers.

– The operational invariants: Without fixed office or desks, Anna always took her laptop wherever she went, so she used digital resources more than material ones. For Anna, the reasons why she used to store or share resources with others in such a way are more than "it is my habit", she also had her critical ways in selecting the valuable resources. She emphasized the importance of the analysis and explanations on the content and the order of the exercises to be donated to students: "I need to know the reason why they provide these exercises but not others, and if there is no analysis on the links between textbooks and exercises, I will not use it" (cited from an interview with Anna).

– The possibilities of inference: Anna tried to balance her various roles like teachers, teacher trainers, researchers, users and members in some teacher professional organizations such as APMEP. She tried to organize the resources she accumulated in her working roles in a mutual beneficiation way, which can be evidenced not only in adapting resources from different sources (or collectives) into her different jobs, but also in adapting the same resources into different working roles and get the feedbacks at the same time.

### 9.5.3 A Preliminary Comparison Result on Documentation Work of the Two Cases

Compared with Anna's resources, Gao relied less on Internet resources when retrieving resources, but more on Wechat, with which the teachers could exchange resources and information with their mobile phones. Reasons may come from the poor construction and maintenance of the official websites, as the principle said, "Frankly speaking, we don't pay too much time on the website or platform construction". Anna had better skills in using non face-to-face collective communication methods than Gao, such as frequent emails exchange, while the Chinese teachers interviewed had no unified and widely accepted communication method. An important reason might be that in China, the teachers have their fixed office, desk, and bookshelf; they can communicate face to face conveniently, which is quite different with the French case: Anna shared a big teacher office (without personal working space) with all the other teachers, and she had to use the digital white board (TBI) often in mathematics classroom: all these conditions compel her to use digital resources and Internet more. Seeing from the different preferences of the two teachers, a priliminary classification on resources could be made:  I sorted

the resources into two types, the resources work as the explanations for teachers' better understanding or extending the curriculum resources, and resource work as technological or traditional tools for working on curriculum resources like storing and sharing etc.

Some elements for developing teachers' schemes, or DE could also be found:

– Collective work with colleagues. No matter for Gao or Anna, they emphasized the importance of collective work in their interviews. Gao gained lots of reflective ideas from the collective activities in TRG/LPG, such as the open class, even though most of the time, she plays a role of instructors for others. While for Anna, collectives worked as the sources for getting various resources or feedbacks, for example, the resources she gained from IREM (like some exercises or activities) were often adapted to her classroom teaching, while the work and feedbacks of the students were also the resources for her teacher training in SESAMES.
– The competence to adapt to their environments. Anna showed her expertise by choosing different collectives and resources because the French teachers had the "pedagogy freedom", while Gao showed it by doing differently in given collectives and resources because in China generally the important and high quality resources were mainly distributed from superior units to the subordinate units. For Anna, she had the freedom and choices to decide which collectives to join, while TRG for Gao is the main and compulsory collective to work in.
– Reflections. To some extent, the different working modes of the two teachers can be seen as the results of their reflections: Anna has a clear understanding where to get the resources, how to adapt them and get a feedback meanwhile, which could be considered as a new resources for her next activity. While Gao also paved her own way of producing new resources from the feedbacks of her students and the communications with her colleagues. The reflective expertise is also shown in attending research projects, which is a way to combine practice and reflection.

## 9.6   A Video Analysis of a French Teacher Collective Work

This section will present a video analysis of the French case, because the Chinese videos have not been collected yet up to this chapter. To conducted a deep anaylsis, in this section, the video of a collective lesson preparation will be analyzed through two dimensions: (1) the schemes shown in this collective resource work, and (2) how they gain new elements for their resource systems through their collective interactions.

### 9.6.1  Background of the Collective Lesson Preparation

After three months of school activities follow up of Anna (individual level), from September 2015, another cycle of collective activities (collective level) follow up was conducted, such as meetings in SESAMES or in their school. In May 2016, a video of collective lesson preparation between Anna and Cindy on algorithmic was filmed, because it was the time to prepare the teaching plans for the following academic year, and they had to decide the textbooks for the new curriculum program.

### 9.6.2  An Analysis on Schemes

Some schemes of working with resources could be seen in their action. For example, although we asked them not to prepare anything before this collective lesson preparation, Anna made some preparations: she transferred and gathered the resources possibly useful (from Viaéduc[6] to a Padlet[7]), and she brought all the textbooks (13 kinds) provided by the publishers, and a word document with a copy of the contents on algorithmic in the program, and she put it in their common Dropbox folder. This could be seen as a scheme of Anna on preparing a work and resource management: with an aim of preparing a new lesson, she brought the available resources (textbooks, and the related digital resources), she prepared a word document and put it in common Dropbox folders because it is a habit of collective lesson preparation.

The second scheme turns out to be a conscious re-organization of resources. At the beginning of their formal lesson preparation, Cindy proposed to adapt an educational game "le robot" to teach Inter-discipline Teaching Practice (EPI). When Anna wrote this down in the word document, she shared it in a common folder named "les cours", and Cindy suggested that "…we should sort up this folder". This is an evidence that among the math teachers in middle school A, they had already a lived resource pond ("vivier" in French), in which they share their resources (the word document completed in the end), and they reorganize it regularly with the development of the resource inside.

Thirdly, a critical thinking towards the official resources (program) was shown several times:

– When Cindy was reading "re-visit the notion of variable and functions in a different form" with some doubt, Anna said "yes, the problem…is…they cannot

---

[6]Viaéduc is a French online platform for teachers' collaborative work, see in https://www.viaeduc. fr.

[7]Padlet is an online platform for both personal and collective resources collection and creative, in the case of Anna, she use Padlet mainly for personal resources collection, see https://padlet.com.

re-visit it, because in grade 7 they haven't learned it…In grade 8 and grade 9, but…no, I want to say, re-visit…they need to already…they haven't learned algebra… for example…they haven't used the algebra variable…They cannot re-visit it". From their dialogue, Cindy proposed her doubt on the text of program, and Anna reflected it on her teaching experience and knowledge of the students' progress, and she concluded that the statement in the program is "impossible".

– About the suggestion of using "Scratch" in the program, Anna disagreed two times: the first time happened at the beginning, when Claire mentioned that the inspectors suggested to use Scratch with the students, Anna said "for me, I do not want to teach Scratch, so algorithmic, for me, it is more a thinking, it is not knowing how to use a software like Scratch; that is to say, a software, we can give it to the students as something non important, they can…" Cindy reacted with "Hum" and "Yes". The second time happened when Cindy comments that the axial position of Scratch, Anna said: "it does not matter if they emphasize Scratch and suggest to teach a lesson on it. Me, I do not want to teach a lesson on it…it is not interesting…".

### 9.6.3 An Analysis of the Collective Mutual Beneficiation

According to the principle of Activity Theory, we should pay attention to the contradictions of the activity. The interactions between Anna and Cindy thus were analyzed in three types: conflicts, agreements and complements, questions and answers.

– The conflicts could be seen when they hold different ideas, but between Anna and Cindy, there are not obvious or strong conflicts in their dialogues. Taking their first ideas about Scratch as an example: At the beginning, Cindy seems to agree with teaching Scratch according to the suggestions in the program, when she heard the word "but…" from Anna, she tried to remind her that the inspectors also suggested to use Scratch. When Anna explained that algorithmic should be a kind of thinking rather than using a software usage, Cindy seems to change her ideas, she reacted with "Hum" and "Yes". Later she commented that almost all activities suggested in the program are centered in using Scratch, then Anna re-stated her idea that she does not want to teach Scratch. However, in the end, they decided to arrange a computer lesson for the students to let them explore Scratch. This could be seen as a process in exchanging their ideas, and influences on each other.

– There are more agreements and complementation in this collective work, and there appeared more tacit agreements when Anna and Cindy were discussing the textbooks, they read textbooks on their own, they had their division for these 13 textbooks, and they shared the valuable parts, and exchanged the doubtful points.

– In this collective work, the questions and answers happened when one teacher did not know something, and the other explained it. Between Anna and Cindy, Anna often works as an answer-provider. For example, when reading the textbook of Sésamath, Cindy asked Anna: "How do you understand 'some languages are not used in a declared way'?", Anna proposed an example of Python, the equal ("=") is not the equal that we know normally, "it is specific, but it has a different meaning". Also, when Cindy proposed the "idea of dance" in the document of creative computing, she also explained the source and author of the document.

From an overview of this collective work, there are also some evidences or complementation on how they use their resources mentioned in their resource systems. Taking the Dropbox as an example, they all proposed that they had a common folder for sharing lesson plans, but in this video analysis, it was found that the common folder was not only some place for storing resources, they often re-organized the structure of this folder, which made this common folder a "lived pool" for resources.

## 9.7  Discusion and Conclusion

To explore the definition and the elements of DE, as well as how it is developed in collectives, we defined it at the beginning as the abilities and knowledge in resources integration (retrieving, selecting, organizing, modifying, adapting, creating and sharing off), in order to achieve the teaching goals, or to solve some teaching problems efficiently.

After a preliminary study of the two cases, and a deep study of a collective lesson preparation of the French case, a refined definition of DE was proposed below:

DE is the schemes in resources retrieving, selecting, modifying, adapting, storing and re-organizing, sharing off, in order to solve teaching problems efficiently. For a teacher, DE is developing to integrate her available resources to her understanding of the goals of the activity. In this way, DE is more like the common set of schemes that are suitable for given situations. It could be understood as an adaptive expertise to integrate resources into efficient problem solving in given situations. The "efficient" infers that within the ability scape of the teacher, DE could help her get some efficient and practical solutions, so DE has more an individual nature, because it is based on the understanding of the individuals, and it helps to get the solutions for problems in specific situations with the resources of the individuals. The schemes, or the elements of DE could be:

– The schemes of retrieving resources, which are also based on the schemes of resources management or storage. It could be an ability to make the use of the available resources. For example, due to the different resources environments in

China and France, Gao seldom turns to the Internet for retrieving resources, but she prefers to purchase regularly some specific reference books that she considers good in the bookstore. While for Anna, DE could be traced back to her online working habit, in both the organization and preparation: with various high qualified website resources, she has Google drive to share documents and agendas with her colleagues in the SESAMES team, Dropbox with her colleagues in her school. Meanwhile she stored her personal resources in Dropbox and Evernote, in which the documents are classified by the name of different collectives and projects. She also has some online platform like Pixees and Viaéduc to collect and store her favorite resources so that when she needs some resources she could find them easily.

– The schemes of selecting resources, which rely on the understanding of activity goals, related concepts, and their teaching practices. For Anna, she is clear so that the first lesson preparation of algorithmic should be an introduction with some activities. She has her own understanding of algorithmic, which is different from the explanations in the official program, and this is the basis for her critical thinking on the official resources and the suggestions from the inspectors. The critical thinking in selecting resources also relies on the confidence and proficient knowledge about their teaching practice, for example, when Anna and Cindy were reading the goals of algorithmic in a textbook, they doubted that the goals written ("encourage the students to understand the variables…") impossible, because "it is a notion in information", so "it is better to change the name". What's more, the feedback from the students, which is valued by Gao, could also become an important factor to decide the resources to be used in the following class.

– The schemes of modifying and adapting resources need the teacher's understanding of the situation requirements, and technology skills. Such trends appear more obvious on Anna, she has no personal office space, and so she has to take her laptop all day, which compels her to use digital and online resources more than Gao. According to an interview, as a mathematics teacher in middle school, Anna does not need to learn very complex software, and her first big challenge was the whiteboard when her school equipped it in each classroom, and she had to learn how to use it, which cost her almost one year. She explained happily that her students learned much quicker and often assisted her. This is also an open mind or a kind of curious towards new things, and new changes.

– The schemes of resources sharing, which is not a spirit of contributing others, but an efficient way of mutual benefiting. Taking Anna and Cindy as an example, Cindy used to say directly that when she had some problems in searching information and resources, she will turn to Anna and she always got her answer. And also from the observation of their school meetings or co-training in service teachers, Cindy seems to be strong to propose her ideas, comments, and suggestions in a clear and reasonable way. The sharing off of resources is not only an action of throwing the resources into the common area, but a carefully maintained, regular refreshed and re-organized, just like the common folder named "le cours" shared among Anna, Cindy and other

mathematics colleagues. Working culture or atmosphere, and personal characters could influence these. For example, in the interview with Gao, she also shared her resources, such as books and teaching instruments, with others in her LPG, and teachers in her school exchange resources like messages through Wechat group chatting, but there is seldom processed personal resources such as lesson plans or courseware.

As for the second question of how DE is developed in collectives, evidences could be seen in the interactions between Anna and Cindy:

– Conflicts in understanding or ideas are the entry points to see the influences on each other. For example, the ideas of using Scratch experienced a series of change: at the beginning, Cindy preferred to follow suggestions from program to teach Scratch, then with the arguments of Anna, Cindy changed her attitude and considered the textbooks who suggested to teach Scratch are boring, but in the end, after they finished reading all the textbooks, they both decided to teach Scratch again.
– Agreements and complements could reinforce their common ideas or enrich the current solutions. It seems like to search the hyperlinks with two search energies, which could find the complement information efficiently.
– Questions and answers is a quite direct way to benefit from each other, especially for something unknown to the other. For example, the idea of "danser" proposed by Cindy, it is the first time heard by Anna, but she learned this after it is explained.

Due to the limited space, this chapter cannot present all the three phases (preparation, implementation, reflection) of the whole document generation process. As stated in the methodology part, this case study is a long-term study, paying attention to the whole process of documentation work, and being situated in special moments with contradictions, so after the collective lesson preparation in France, in January 2017, a video of lesson implementation and a video of reflective interview were filmed. Also at the end of June 2017, the second round of lesson preparation on the same topic, algorithmic, was conducted and filmed. On the Chinese side, a series of videos on the Chinese teachers' intense collective lesson preparation, lesson implementation, and reflection discussions were also filmed in April 2017. The analysis will be presented in other papers. Through the two contexts with very different working cultures, institutional systems, and working habits, a final definition of DE, as well as the elements to develop DE in each context are hoped to be found through a synthetic analysis, and suggestions are also expected to be given for benefiting each country.

# References

Adler, J. (2000). Conceptualizing resources as a theme for teacher education. *Journal of Mathematics Teacher Education, 3*(3), 205–224.

Avalos, B. (2011). Teacher professional development in teaching and teacher education over ten years. *Teaching and Teacher Education, 27*(1), 10–20.

Berliner, D. C. (1988). Describing the behaviors and documenting the accomplishments of expert teachers. *Bulletin of Science, Technology & Society, 24*(3), 200–212.

Brown, M. W. (2009). The teacher–tool relationship: Theorizing the design and use of curriculum materials. In J. T. Remillard, B. A. Herbel-Eisenmann, & G. M. Lloyd (Eds.), *Mathematics teachers at work: Connecting curriculum materials and classroom instruction* (pp. 17–36). New York: Routledge.

Buisson, F. (Ed.). (1911). *Nouveau Dictionnaire de Pédagogie et d'instruction primaire*. Paris: Hachette. http://www.inrp.fr/edition-electronique/lodel/dictionnaire-ferdinand-buisson/. Accessed September 15, 2015.

Chabanne, J., Monod-Ansaldi, R., & Loisy, C. (2015). Faire le lien entre la pratique et la recherche pour transformer l'école? Le dispositif AeP de l'IFÉ comme laboratoire de l'innovation en recherche-intervention-formation. Analyse d'un cas particulier d'un AeP impliquant une ESPE. *Printemps des ESPE* 2015.

Chevallard, Y. (2006). Steps towards a new epistemology in mathematics education. In M. Bosch (Ed.), *Proceedings of the Fourth European Conference on Research on Mathematics Education* (pp. 21–30). FUNDEMI IQS—Universitat Ramon Llull. http://ermeweb.free.fr/CERME4. Accessed June 3, 2016.

Cui, Y., & Zheng, D. (2008). On teacher cooperation pointing to professional development. *Education Research, 6,* 78–83. (in Chinese)

Engeström, Y. (1987). *Learning by expanding. An activity-theoretical approach to developmental research*. Helsinki: Orienta-Konsultit.

Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work, 14*(1), 133–156.

Gueudet, G., Pepin, B., & Trouche, L. (Eds.). (2012). *From text to 'lived' resources: Mathematics curriculum materials and teacher development*. New York: Springer.

Gueudet, G., Pepin, B., & Trouche, L. (2013). Collective work with resources: An essential dimension for teacher documentation. *ZDM Mathematics Education, 45*(7), 1003–1016.

Gueudet, G., & Trouche, L. (2009). Towards new documentation systems for mathematics teachers? *Educational Studies in Mathematics, 71*(3), 199–218.

Hargreaves, A. (1995). Beyond collaboration: Critical teacher development in the postmodern age. In J. Smyth (Ed.), *Critical discourse on teacher development* (pp. 149–173). London: Cassell.

Hu, H., & Wang, J. (2014). *Teacher professional development*. Shanghai: East China Normal University Press. (in Chinese)

Leont'ev, A. N. (1978). *Activity, consciousness, and personality*. Englewood Cliffs, NJ: Prentice-Hall.

Li, Y., & Huang, R. (2008). Chinese elementary mathematics teachers' knowledge in mathematics and pedagogy for teaching: The case of fraction division. *ZDM Mathematics Education, 40*(5), 845–859.

Pepin, B., Gueudet, G., & Trouche, L. (2017, online). *Refining teacher design capacity*: Mathematics teachers' interactions with digital curriculum resources. *ZDM Mathematics Education, 49*(5), 799–812.

Pepin, B., Xu, B., Trouche, L., & Wang, C. (2016). Chinese expert teachers' resource systems: A window into their work and expertise. *Educational Studies in Mathematics, 94*(3), 257–274.

Sternberg, R. J., & Horvath, J. A. (1995). A prototype view of expert teaching. *Educational Researcher, 24*(6), 9–17.

Turner, G., & Shepherd, J. (1999). A method in search of a theory: Peer education and health promotion. *Health Education Research, 14*(2), 235–247.

Vergnaud, G. (2009). The theory of conceptual fields. *Human Development, 52*(2), 83–94.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wang, J. (Ed.). (2013). *Mathematics education in China: Tradition and reality*. Nanjing: Jiangsu Education Publishing House. (in Chinese)

Yang, X. (2013). *Conception and characteristics of expert mathematics teachers in China*. Wiesbaden: Springer Spektrum.

## Author Biography

**Chongyang Wang** is a Ph.D. student co-supervised by Binyan Xu (East China Normal University) and Luc Trouche (ENS de Lyon), in the frame of a teaching and research project (JORISS) involving these two universities. Her Ph.D. is funded by the Chinese Scholarship Council (CSC). Her current research focuses on teaching resources and teacher professional development. Born in Hebei Province, China, she graduated in Mathematics Education in East China Normal University with Master of Science in Education in 2014, and Technology Education in Jiangnan University with Bachelor of Science in 2012.