

## **Analysis of the structure of a resource system, articulation between dynamic aspect and static aspect: case of a mathematical teacher**

Karima Sayah

*University Claude Bernard Lyon 1 France*

An integration of Sésamath association resources (<http://www.sesamath.net/>) took place in the mathematical workshop of an Algerian college by a trainer. We are approaching the teacher's resource system based on concepts already present in the documentary approach. We consider static and dynamic aspects of this resource system. We propose a model of articulation between the system of resources and their schemes, specifically the rules of action and the operating invariants.

**Keywords : Documentary approach, resource system, systemic approach, scheme.**

### **Introduction**

Our research work is at a particular moment of reform of the Algerian education system, marked by a skills approach, and by an introduction of ICT at all levels. Our questioning is rooted in the difficulties created by the implementation of this reform, both from the point of view of the competency-based approach and from the point of view of the integration of ICT, especially for the teaching of mathematics.

We are interested in Sésamath association resources, their adaptation and their translation in an Arabophone environment. We will analyze their impact on the resource system of the teacher of mathematics and on his professional development.

We consider in this seminar more particularly the schematic representation of the resource system of Nadine, trainee teacher of mathematics in Arabic, for the levels, sixth and fifth year in the college. This schematic representation of her resource system is both the object of analysis of the "selection, adaptation and translation" scheme and the "implementation of a Sésamath resource" scheme. For the analysis of its resource system, our method is inspired by systemic analysis and deals with two aspects: a static analysis which consists in defining the constitutive elements of the system, their relations, and under the functional or dynamic aspect marked by action rules and events that govern these constituents.

### **Theoretical frame**

In this section, we present the theoretical frameworks mobilized, we present first, the documentary approach of didactics, articulated with the notion of schema Vergnaud (2011). We continue with the knowledge model of Shulman (1986) where we infer pedagogical knowledge to operative invariants.

### ***Documentary approach to didactics***

Gueudet & Trouche (2008) pay particular attention to the teaching activity and the documentation of mathematics teachers, especially from the point of view of their collective documentary work and their professional development. They consider that

the work of the teacher feeds on the resources available in the collective to build what is necessary to do his job. They also consider that the teacher, in his documentary work, has a set of resources of various kinds that will give birth, for a given class of situations, during a documentary genesis, to a document. The documentary work of the teacher is considered the engine of a documentary genesis, which develops a new resource (composed of a set of selected, modified, recombined resources). Any documentary genesis, for a teacher, is a carrier of professional development in the sense that the teacher acquires new knowledge, new skills and new practices (Gueudet & Trouche, 2008). The documentary approach sees itself as a relevant theoretical framework for understanding the teacher's work around his resources, and even around his resource system.

### ***Resource-document versus resource system-documentary system***

The documentary approach distinguishes the resource from the document. By resource we designate all the elements of the set (materials, digital, notebooks and manuals of Sésamath) these elements are the ingredients, inputs that the teacher needs to create his own document, his output. This conception takes place in a finite cycle that can return to the actions and / or resources the input.

Adler (2000) define the resource as the verb “re-source”; it could be anything which contribute to re-source a teacher’s activity, he appropriates, transforms and adapts them to construct his own documents. Unlike the resource, the document has a teaching objective, a didactic intention, to treat a class of situation adapted to a context (example to integrate activities of dynamic geometry with the aid of a dedicated software). Pédaque (2006) defines a document by its use, intention and information.

During his documentary work, the teacher has a variety of material and / or digital resources, combined in different contexts, which give birth to a document (s) during a documentary genesis. The document resulting from this transformation must meet a didactic intention, the needs of the teacher, rules organizing its use. At this level we can conclude that the document is the fusion of recombined resources and its schema of use. (Gueudet and Trouche 2008). These same authors distinguish two parts in the schema, an observable part and an invisible part. The observable part of the schemes are the regularities in the activities of teachers in the different context, belonging to the same class of situation designated by these authors by the noun "uses". The invisible part essentially represents the teacher's knowledge.

Document = Recombined resources + scheme of use (Gueudet and Trouche 2008, p.59).

In this article, we focus on the work of Vergnaud to expand the notion of scheme. Vergnaud (2011), articulates it with the concept of situation :

It is an invariant organization activity for a given class of situation (Vergnaud 1991, p.36).

Vergnaud (2011) describes this concept "schema" and encompasses it around its constituents: its goal, sub-goals and expectations, rules of action, of information-taking of and controls, operational invariants (concept-in-act and theorem-in-act) and the possibilities of inferences, which he generalizes by the organization of the activity for a given class of situation. In the following section we describe these elements for a better understanding of the concept "schema".

To define a schema therefore amounts to:

"Observe an activity in situation and watch how this activity is generated as and when, according to the previous actions, according to the information and controls, depending on the possible connections of the activity. And this requires finding the concepts-in-acts and theorems-in-actions that are then mobilized «(Vergnaud 2009, p.8)

### ***Knowledge, knowledge model and professional development of mathematics teachers***

Shulman's (1986) model analyzes teachers' knowledge more explicitly, taking into account various institutional, cultural and social aspects. His model highlights the knowledge of the institutional context, the goals and objectives of teaching, the content and the curriculum, general pedagogical knowledge namely the pedagogical approach, the animation of groups, pedagogical knowledge of the subject for our case specific to mathematics Pedagogical Content Knowledge (PCK), student learning and knowledge transfer and finally knowledge about student behavior and learning, knowledge related to psychology, study of the development and behavior of students, the student and his learning. We attempted to present this knowledge structure to reflect the interweaving of the knowledge required for the mathematics teacher. The inclusion of knowledge specific to the mathematical discipline reflects PCK well. Specific knowledge of student behaviors requires the teacher to know the purposes and goals (which students to train in mathematics, and for which societal needs) and general pedagogical knowledge ( learning psychology). We opt for Shulman's (1986) model to analyze the professional knowledge of the mathematics teacher where we consider the concept of PCK as a key tool to approach the operational invariants of the schemas mobilized by the teacher for a class of situation.

### **Methodology**

Gueudet and Trouche (2008) developed a method for the analysis of the teacher's documentary work, based on a continuous monitoring of his activities over a significant period of time but mainly focused on the principle of the reflexivity of data collection. The teacher is considered to be the main actor in this collection and in his reflective return on his own practices. We draw inspiration from this methodology for monitoring and analyzing the documentary work of our experimental sites.

We emphasize that reflexive inquiry focuses on the individual aspect of documentary work, in the context of our work, we are interested in the collective work of teachers. We consider the collective components of this work and we take into account the activity systems of the mathematics teacher in the various communities.

Our methodology is therefore based on a reflexive principle of resource collection used or produced by the teacher during his documentary work, individual or community resources. It is therefore necessary to collect these resources as much as possible during the monitoring period : the ones they used, and those they have developed as they work. We designate:

- as primary resource any institutional resource such as a textbook, an accompanying guide ;
- as resource mother, any starting resource that the teacher mobilizes to prepare a given course (Hammoud, 2012), we retain this definition but we consider that these resources are optional and are not institutional in the Algerian program but from other institutions. We take as an example Sésamath's resources, foreign textbooks, results of didactic research etc.

- as intermediate resource, any resource that dynamically evolves in the system, newly created, modified, recombined, adjusted in an individual and / or collective context. This evolution continues and we consider that the evolution of the intermediate resource over time tends towards stability;
- as stabilized resource, any intermediate resource whose evolution tends towards its stability;
- and lastly, for a standby resource, any resource that is inactive for a period of time, in the sense that it does not undergo any action.

So we track all material resources involved in the life cycle stages of a document, we also track all activities around these resources. Our methodology is therefore based on a connectivity principle linked to institutional or technical or personal constraints.

Analyzing the evolution of the teacher's resource system requires a regularity and continuity of observables in time and place. We follow the teachers for one or two years, during which we observe the effects of the integration of the resources of Sésamath in the long term, we want to choose a collective that has just integrated them and a collective that has integrated them for a long time. We follow the integration of this resource in its original language into a non-institutional class, then translated into an institutional class in Arabic. It involves long-term follow-up in various communities on the documentary work of the teachers, face-to-face monitoring (meeting, training, observation of the work session, etc.).

In this article, we present Nadine's two-year follow-up data, individual and community follow-up. Nadine is a member of the Cop (Sésamath) community for the selection, adaptation and translation of Sésamath resources into institutional classes. We followed her documentary work at home and college in her institutional classes, her interactions with the collective where we focused our attention on the stages of appropriation of Sésamath resources at different times. During this period, we highlight the evolution of its system, or even analyze the appropriation of Sésamath resources over the two years. For the analysis of its resource system, we were inspired by the systemic approach to structure the static part of the system. To understand its dynamics, we infer both data from different interviews, her schematic representations of its resource system (SRRS) at the beginning and end of each year, and video observations to define the elements of the schemas for the different classes of situations. The following section presents some results of our analysis.

## Results

We rely on the collective work observations, interviews and schematic representations of Nadine's resource system, developed at different stages of monitoring.

Our interviews focused on data collection related to our research questions: resource system, collective work, skills approach and finally use of Sésamath resources. To follow the evolution of the occurrence of these themes during the period (year 1 and year 2) of its follow-up, we translated, coded and analyzed the transcripts for a quantitative analysis that we have analyzed using the RQDA software. This analysis was cross-referenced with the qualitative analysis of the different SRRS.

Nadine's resource system is perceived as a world composed of objects (set of material resources such as textbooks, guide, resources of Sésamath,) and of relationship between these objects that represent interactions. A system is a set of elements in dynamic interactions, organized according to a goal. Le Moigne (1977) defines it more explicitly: is something (identifiable); which does something (activity ) and which has

a structure, which evolves in time, in something (environment) and for something (finality). The interviews crossed with the Nadine's SRRS for the design of her intermediate resource ( Sésamath resources), were analyzed to structure her resource system. To do this, Nadine uses institutional primary resources (the guide and the progression), she also resorts to mother resources (such as Sésamath resources,), other stabilized resources (old subjects), but her system has also standby resource such as extracurricular books.

We observed Nadine during her work in the collective to select, adapt and translate the resources of Sésamath, then the implementation of these resources produced in its institutional classes. We are interested in the analysis of the schema "Selection, adaptation, and translation of the resource of Sésamath". This analysis focuses on two levels of abstraction, the conceptual level of resources answering the question (what? And why?), and the organizational level answering the questions (who ? do what ? how ? ). By analogy with the approach of Vergnaud (1991), and for our case the schema "adaptation and translation of a resource of Sésamath" was analyzed on the basis of the schematic representation and the observation of the working sessions with the coordinator and colleagues and interviews. This schema must meet four criteria (Vergnaud, 1991) described below

The goal and its goals, the rules of action that engender Nadine's activity during her interactions with her colleagues, as rules of actions, or of taking information or of controlling, the operational invariants, which represent the concepts in act or the theorems in act identified by these PCKs during our different stages of its follow-up. For example during her interview Nadine added: "I know that my students are more motivated to work on MathenPoche", a theorem in act can be formulated by: "The resources of Sésamath arouse more motivation among students". Another example can be derived from her guided tour of her final schematic representation where Nadine adds: "here I added the resources of Sésamath, activities, as some courses in our textbooks do not treat all the concepts, ... ", We deduce another theorem in act:" the resources of Sésamath are evoked as complementary resources and support to fill the lack in institutional resources ". Finally the inference describe the adaptative part of the scheme which can make adjustments to use this scheme, as example, she judges that her course of the previous year prepared from her institutional resources did not encompass all the situations on the equations (notions, and cases).

## **Conclusion**

We have taken the documentary approach to which we have tried to make our contribution, to enlighten the documentary work of the teacher to follow the evolution of her system of resources and her professional development but especially to understand the dynamics of her resource system. We have proposed a taxonomy of resources according to their function in the resource system: mother, primary, intermediate and stabilized resource, we have assigned the concept of resource in standby, for any other resource present in the system but temporarily inactive. During its follow-up, Nadine's resource system, initially analyzed around primary, intermediate and few stabilized resources, is evolving towards a differentiated resource system by their role. The PCK, identified during its follow-up, enabled us to define theorems in act and to define the rules of operation of its resource system.

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