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COLLABORATION BETWEEN TEACHERS AND RESEARCHERS: A THEORETICAL FRAMEWORK BASED ON META-DIDACTICAL TRANSPOSITION

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The meta-didactical transposition framework is an important reference for studying existing relationships in collaborative research between teachers and researchers. Born in a training context, it is important to extend it to describe and analyze these same relationships in the context of research. It is by finely analyzing the objects on which the protagonists focus that we can identify significant elements of interaction description leading to a better understanding and improvement both from a theoretical and methodological point of view of collaborative research.

Introduction

The framework of meta-didactical transposition, born in Turin in a teacher training context (Aldon & al., 2013, Arzarello & al., 2014), has been taken up, expanded and enriched to adapt to the analysis of interactions in so-called collaborative research, involving actors from different institutions, researchers, teachers, computer scientists, etc. The purpose of this paper is to show how the theorizing of relationships between actors can help to better understand and act on the improvement of collaborative research. The fundamental hypotheses that support this work are developed in order both to justify the scientificity and the usefulness of collaborative research in general and particularly in mathematics education. This construction is being tested in a case study coming from the work done with teachers in the European FaSMEd project¹. The work presented in this paper is based on the work done in the EducTice team of the French Institute of Education (IFÉ – ENS de Lyon), in particular in the FoRCE project (Formation et Recherche Collaborative en Éducation), a Franco-Canadian project involving IFÉ, the Lyon's Local Education Authority and the Faculty of Pedagogy of the Université de Sherbrooke (Monod-Ansaldi & al., 2019, Nizet & al., 2019).

An attempt to theorize the relationships between researchers and teachers

Fundamental hypotheses

As anthropologist, Marcel Mauss (1923) pointed out, education is a total fact, "a fact that sets in motion the entire society and its institutions" (p. 102). It is therefore a complex phenomenon, which, as the philosopher Edgar Morin points out, can only be understood through complex thinking (Morin, 1990):

¹ Formative Assessment for Science and Mathematics Education, The research leading to these results has received funding from the European Community's Seventh Framework Programme fp7/2007-2013 under grant agreement No[612337].

It can be said that what is complex is on the one hand empirical, uncertain, unable to be certain of everything, to formulate a law, to design an absolute order. On the other hand, it is also a matter of logic, that is, the inability to avoid contradictions. (chap. 27/57)²

Educational research thus has the need to take this complexity into account and integrate it into its research paradigms:

We are in an uncertain battle and we do not yet know who will win. But it can already be said, however, that if simplifying thinking is based on the domination of two types of logical operations: separation and reduction, both of which are brutalizing and mutilating, then the principles of complex thinking will necessarily be principles of distinction, conjunction and implication. (Id. chap. 33/57)³

Asking questions about the type of research and the position of actors in research raises at least three types of questions, of an epistemological, methodological and ethical nature. Epistemological questions relate to the positions of the research regarding the actors and the aims of this research. They make it possible, in a way, to position research in the tensions between antagonistic poles: academic research to produce new knowledge or research to train actors. And from another point of view, research related to the construction of teaching materials or research to understand a practice. What are the researcher-practitioner relationships? Is it a question of considering the teacher in the research as a parameter, i. e., as an element of the system to be studied, or as a variable, i. e., as an element of the system to be characterized, or finally as an object of research? (Roditi, 2015). What are the targeted productions and what are the conditions for their scientificity?

From a methodological point of view, the organization of collaborative work is not self-evident and must be thought of in relation to the theoretical frameworks at the same time as the goals that the actors set for themselves. The construction of tools to provide collaborative working conditions is essential.

Finally, ethical issues are essential in any work with actors from different institutions. Everyone has different issues in the common work that need to be considered and addressed in the research. Issues relating to institutional recognition and the capitalization of work are at the heart of the "contract" that must be concluded between the actors of collaborative research. This contract seems to me to have two very distinct facets: the first concerns the setting in stone of the conditions and objectives expected by the research actors: what is expected of each party and how it will be possible to achieve these objectives, but also the expected results and the methods for disseminating these results (training, text, actual achievements, etc.). The second facet concerns the object of the research, which can only be defined *a priori* through questions or hypotheses about an object whose boundaries have not yet been precisely constructed. The contract is then similar to the didactic contract of the Theory of Didactic Situations (Brousseau, 1990), i.e. it cannot be fully explained. The contract is negotiated through a devolution of research, just as learning is the result of a devolution of the didactic situation negotiated between teachers and students. Ethical issues are at

² Translated by us from: "On peut dire que ce qui est complexe relève d'une part du monde empirique, de l'incertitude, de l'incapacité d'être certain de tout, de formuler une loi, de concevoir un ordre absolu. Il relève d'autre part de quelque chose de logique, c'est-à-dire de l'incapacité d'éviter des contradictions."

³ Translated by us from: "Nous sommes dans une bataille incertaine et nous ne savons pas encore qui l'emportera. Mais l'on peut dire, d'ores et déjà, que si la pensée simplifiante se fonde sur la domination de deux types d'opération logiques : disjonction et réduction, qui sont l'une et l'autre brutalisantes et mutilantes, alors les principes de la pensée complexe seront nécessairement des principes de distinction, de conjonction et d'implication."

the root of the conceptualization of collaborative research and cannot be neglected under penalty of breach of contract and therefore failure.

These reflections naturally lead to hypotheses on which we base our research and which tend to consider all actors as partners in research. It is therefore a question of working *with* teachers rather than *on* teachers, considering the tensions already encountered.

What answer can be given by research to formalize collaborative research between researchers and teachers?

The Meta-Didactical Transposition

The meta-didactical transposition is based on Chevallard's anthropological approach of didactics (1989, 1992). It describes a dynamic of relationships between teachers, researchers, trainers and any actor involved in collaborative research. In the research team "EducTice" where I was working, we were seduced by this approach (Sanchez & Monod-Ansaldi, 2015, Aldon et al., 2013, Aldon & Panero, 2017, Monod-Ansaldi et al., 2019) and we tried to extend this theoretical model to describe and analyze collaborative research. This model describes a dynamic of relations between researchers and teachers based on five pillars:

1. Double dialectic: didactical dialectic between the three vertices of the didactical triangle knowledge, teaching and learning and meta-didactical dialectic between didactical dialectic and pragmatical or theoretical justification of this dialectic.
2. Meta-didactical praxeologies: according to Chevallard (1989), any human activity can be described as a praxeology modeled by a quadruplet $(T, \tau, \theta, \Theta)$: in front of a task t , one (or several) technique $(s) \tau$ allows the task to be solved in the same way that all tasks of the same type T can be solved. This technique, which depends very closely on the institution in which the type of task is proposed, is justified in the institution by a discourse $(\theta, \text{technology: discourse on techniques})$ and a theory Θ . The double dialectic then leads us to consider two types of praxeologies: a didactical praxeology in which the type of task is built with reference to the knowledge to be taught, the technique being recognized in an institution and the technological and theoretical justifications depending both on institutional habits and learned knowledge; and a meta-didactical praxeology in which the type of task is didactical praxeology: for example in the European project FaSMEd which dealt with formative assessment in science and mathematics, the praxeology of a lesson on fractions, where writing a fraction is based on a technique justified by calculation rules and more theoretically by algebra, is the basis for a formative assessment lesson, itself justified by empiricism and theories of formative assessment.
3. Institutional aspects: for each of the actors, the praxeologies are directed by the fact that the actors belong to an institution; in the case of a type of task, the technique used and the justifications for this technique depend functionally on the actors' institution.

4. Internalization: this phenomenon describes the exchanges between actors from different institutions and is at the heart of the collaborative work that could not exist if the actors did not take advantage of the interactions to modify their knowledge system. Internalization is linked to the knowledge at stake, whether practical or theoretical. Internalization can be considered as a modification of a praxeology at a didactical or meta-didactical level.
5. Brokering: for dialogue to take place in a fruitful way, actions are needed to make the ideas at stake explicit (brokering) in order to facilitate dialogue by clarifying each other's positions. The broker is essential in the phenomenon of internalization to make the link between the points of view expressed and to reformulate in the language of each of the institutions involved the concepts and knowledge at stake.

Figure 1 shows an initial schematization of meta-didactical transposition that describes the dynamics that can be created in collaborative research: through joint work, with the help of brokering actions, teachers and researchers build a shared praxeology by internalizing *a priori* external components to one or the other community (Fig. 1). At the meta-didactical level, i.e. at the level of the discussion of didactical practices, teachers and researchers have developed praxeologies in their own institutions: they have techniques as well as justifications for these techniques. The transposition phenomenon must thus lead to a shared praxeology at the same time as the external components are internalized in the practices.

This schematization shows the dynamics that can be created, but it also raises questions: how can this dynamic be set in motion? How and why is it maintained? What is the meaning of the term "shared" when describing a shared praxeology?

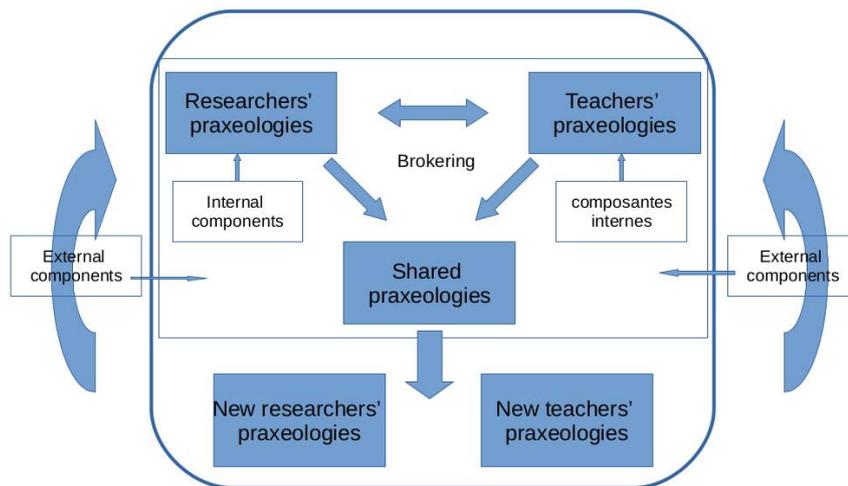


Fig. 1 : Schematization of the Meta-didactical Transposition (from Aldon & al. 2013)

Boundary objects

To go a little further in the concept is to precisely define this work object. By maintaining the conceptualization of meta-didactical transposition, it is possible to provide some answers to these questions by formalizing the nature of the work object (or object of interactions) that can be seen as a boundary object in the sense given by Star and Griesemer (1989) (Robutti & al., 2019). This idea

of a boundary object, resulting from an anthropological approach, is particularly interesting for describing interactions between communities and developing the concept of shared praxeology:

Boundary objects are objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. (Star & Griesemer, 1989, p.393)

In addition to this interpretative flexibility, the structure of the boundary object is also of great importance and the "information needs" trigger the actions that can be carried out on the boundary object at stake. The metaphor of the object as an object in the object-oriented programming paradigm can help to better understand this structure and the scale issue highlighted by Star (2010):

The two other aspects of boundary objects, much more rarely cited or used, are (1) the material/organizational structure of different types of boundary objects and (2) the question of scale/granularity. Boundary objects are a sort of arrangement that allow different groups to work together without consensus. However, the forms this may take are not arbitrary. They are essentially organic infrastructures that have arisen due to what Jim Griesemer and I called "information needs" in 1989 (Star 2010, p. 602)

But what is particularly interesting in this quotation is the fact that the boundary object exists if and only if the actors act on it. It is through interactions that this frontier can be widened, enlightened by the collective activity resulting from all the individual actions of the protagonists. Following Carlile (2004), we distinguish three types of activity on the components of a border object:

[...] we scale the relative complexity of the circumstances at a boundary using Shannon and Weaver's (1949) three levels of communication complexity: syntactic, semantic, and pragmatic. (p. 557)

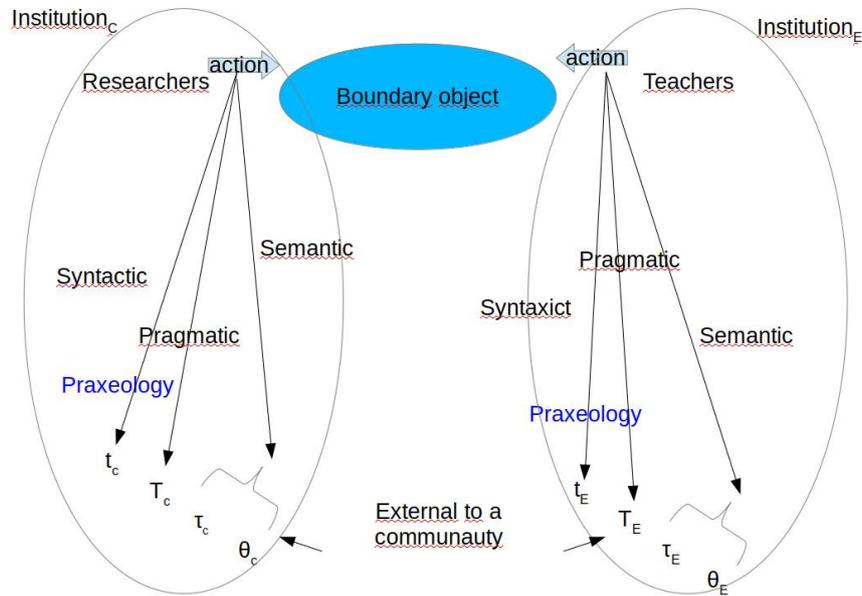
At a syntactic level, the "transfer" action proposes a clarification of the knowledge of the object; it corresponds to a situation where a common vocabulary is established or is *a priori* constituted. These actions keep the frontier in the initial state but allow all actors to explore together by agreeing on the terms used, by highlighting different components of the object but without disrupting the relationships between the objects.

At a semantic level, the "translation" action moves the boundaries of the frontier or affects the relationships between the components of the boundary object. The search for common sense concerns the relations between the components, the constituents of the boundary object as well as a common construction of the meaning of one of its components. The translation activity leads the protagonists to build a sufficient compromise to agree on the subject of study within the specific framework of their discussion.

Finally, at a pragmatic level, "transformation" actions lead to a sharing of knowledge with a view to its use in the rest of the work; we affirm the pragmatic nature of the intervention because there is an awareness of a modification of a technique with regard to a type of task. This "negotiation" (Monod-Ansaldi & al. 2019) can be accepted as an evolution of the work perspectives with the object in a dimension of training and professional development that we can relate to the phenomenon of internalization of meta-didactical transposition.

Transfer and translation activities highlight the mutual understanding of the manipulated components by acting both at a syntactic level of mutual understanding of the manipulated components and at a semantic level of the meaning that can be given and shared to these

components. Transformation actions modify the relationships to objects by including them in all the tools that can be used for action at a didactical level. To make the link with Meta-Didactic Transposition, transfer leads to a shared understanding of the type of tasks, translation leads to a modification of technologies (in the Chevallard sense) and theories when the transformation leads to a modification of techniques related to the types of tasks related to the components of the boundary object at stake allowing a practical investment of the studied component (Fig. 2).



**Fig.2 Boundary objects and MDT.
Illustration**

The announced methodology of the project was built on the paradigm of Design Based Research (Swan 2014). In this project, the general discussion on formative assessment at the meta-didactical level, using in particular the results of the research, promotes the construction of classroom activities and their implementation in the classrooms. At the same time, these classroom implementations provide feedback that, through observations and analyses, evolves the model and participates in the professional development of actors, teachers and researchers. During the experimental phases of FaSMEd (task design, *a priori* analyses, *a posteriori* reflections, etc.), researchers share research results while teachers mainly offer their professional knowledge and pragmatic justifications of their practices. Thus, during the meta-didactical transposition process, the researchers' praxeologies come up against those of the teachers, and it may happen that components of praxeologies that were external to a certain community gradually become internal, within a praxeology "shared" by the two communities. The concepts of "formative assessment" and "use of technology", for example, are the subject of internalization phenomena that have been highlighted and studied in the conduct of FaSMEd. The awareness of the phenomena of internalization appear clearly in the discussions between researchers and teachers; the dialogues clearly show the two didactical and meta-didactical levels, in particular in lines 8-10 and 13-15 where the comparison of class observation with analyses of the constructed situation calls into question the didactic positioning of teachers in a violent way (line 15):

8 H1 And then after that, that's how we expect from... they're in check because maybe what we wanted to do is not what... it's not that in fact...

9 H2 yes yes yes... yes and then it's...

10 H1 ...and, and it's interesting to have it... this exchange there and I think it's great yeah it's great yeah it's great interesting there's that... really if we can continue at the school level it's good eh: really because there's a wealth and an exchange like that and it's... not people like that as you see it in hindsight...

[...]

15 H1 because sometimes we are actually in our thing aah ! fuck and shit (blow on the table) what the fuck they don't understand and in fact it's because yes in fact it's us we didn't propose, put the problem of, of, of, of, and it's really true it's....

But there is also an internalization of the reality of the class that must fit into the model (lines 16-23) and which illustrates this double movement of internalization necessary for a real sharing of praxeologies.

A second meeting illustrates the actions on the boundary object. In the dialogue, the boundary object, as a container, is indeed the formative assessment, which is however never mentioned. On the other hand, interactions focus on Quiz, open questions and technology. First, the question of the relationship between Quiz and technology objects arises and is quickly reduced to discussing the type of question that can be asked, thus integrating the "open question" object as a component of the boundary object. Later on, the protagonists distinguish the role of the use of technology: media-method relationships exist and it is these relationships that need to be studied (line 10-11) from both the student and teacher's point of view; the dialogue then leads to a point of widening the object's boundary by linking "evaluation modalities" to the differentiation strategies specific to formative assessment.

In terms of action on boundary objects, the transfer appears to agree on the relationship that may exist between the assessment and the means of assessment; thus, lines 9 and 10, the distinction to be made between means and end is highlighted:

9 C2: yes, it's not due to technology

10 CP1: no, it's something else

This is followed by a translation action:

11 E1 : this is the evaluation method

In the "Quiz" component of the boundary object, the questioning mode is questioned and linked to the assessment methods, which is then repeated to specify the relationships that may exist between the way of questioning.

Conclusion

Using the example of design-based research from the European FaSMEd project, I presented theoretical and methodological frameworks for analyzing the interactions between teachers and researchers in collaborative research. The essential elements of the Meta-Didactical Transposition are not all developed but remain as a watermark of this text. In particular, the importance of the institutional dimension of transposition, which is not well developed here, remains a fundamental framework for studies. It is clear that analyses of praxeologies but also of the components of a boundary object only make sense in a given institution and that the dialogue between the actors takes into account the institutional positions of each (Fig. 2). Similarly, the dialogues that have been

more finely analysed are only proposed here as illustrations of the theory and should be more broadly detailed. Finally, actions on the components of a boundary object can only lead to internalization to the extent that they are constructed in a sequence, not necessarily linear, of transfer, translation and transformation. The drivers of these actions therefore necessarily involve brokering acts that can be highlighted in the analysis of interactions.

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