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WHAT KINDS OF TEACHING IN DIFFERENT TYPES OF CLASSES?

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In our research we examine the forms of teaching found in three structurally different primary classrooms in Geneva ("ordinary" classes, specialized classes, and schools with classes dealing with children with troubles in personality and learning). The aim is to analyze if the ecology of the didactics in those three types of classes obstructs, even prevents, the achievement of certain didactical goals, in our case, the introduction of addition.

Key-words: teaching practices, mathematic organizations (MO) and didactic organizations (DO), conditions and constraints

INTRODUCTION

In this paper, the comparative aspect on which we focus deals with groups of students, which share specific characteristics in primary school. We distinguish “ordinary” classes, specialized classes, and schools with classes dealing with children with personality troubles and learning problems. One of the main aspects of the study is to determine if the teaching is dependent on the type of structure. Indeed, we make the hypothesis that the institutional conditions and constraints particular to each of those three types of classes have an impact in terms of didactical and mathematical organizations. “It is in the classroom that we can best discover those conditions and constraints that make up the specific ecosystem in which the teacher has to handle knowledge” (Chevallard, 1989, p.62). In this research we are interested in the case of the introduction of addition in first year of primary school in Geneva.

BACKGROUND

Our experiment takes place in a primary school in Geneva where there is a policy of structural differentiation, which is defined by Doudin and Lafortune (2006) as the creation of various types of classes within the same school system. Each type is supposed to accommodate a certain profile of pupil defined principally by his school qualification, level and/or problem behaviour in class. In this research, we observed three “ordinary” classes (OC), three specialized classes (SC) and three classes with children with difficulties with personality and learning (TC).

One particularity of the context in French-speaking Switzerland is that there is a single common official set of pedagogical material for mathematics teaching, including text-books and files for students and a book for teachers with didactical commentaries. However, teachers in special education do not have to use those official documents, while it is more or less compulsory in “ordinary” ones. We also know that teachers in special education usually have more liberties than in “ordinary”
education, which will necessarily influence their practice. For example, they are neither obliged to follow the official curriculum nor to evaluate their pupils, through the official tests designed for “ordinary” classes.

METHODOLOGY AND CONSTRUCTION OF A TYPOLOGY OF TASKS

For our research, we have collected scenarios from our 9 classes during a school year. We compared the time of effective teaching of addition during one year, the frequency of use of official documents and we analyzed the types of tasks and register of ostensive involved. These various elements allowed us to bring out the mathematic organizations and didactic organizations in each type of institutions (at the regional\textsuperscript{[1]} level). From those, we were able to define the MO and DO typical for each type of institutions.

To analyze each activity about addition proposed by teachers to their pupils during one year, we needed to construct a typology of tasks. This allowed us to categorized all the activities according to the types of tasks implied.

Our research focuses on teaching practices. This is why we use the ATD – the anthropological theory of the didactic (Chevallard, 1992) – to analyze praxeologies, which are available in one particular type of classes. Therefore, we consider those three types of classes as three different institutions that offer us the possibility of systemic analyses. A “praxeology” is the basic unit into which one can analyze human action at large. In our research we started by a categorization of mathematical praxeologies. This offers tools to analyze institutional practices instead of one single person practice. Any praxeology defines itself by the following quadruplet: [T/τ/θ/Θ].

This grouping defines a system of types of task (T) to carry out with a technique (τ) that must be validated by a technology (θ), which requires a theoretical justification (Θ). The first block [T/τ] defines a know-how which is a matter for the practice (praxis) while the second block [θ/Θ] is from a reasoned speech (logos). To study teacher’s work, the ATD proposes two interdependent components which are mathematical organizations (MO) and didactic organizations (DO). It allows us to examine teachers’ work by means of two questions “what does he teach?” and “how does he teach it?” As mentioned by Chevallard, the analysis of these two components cannot be independently undertaken because of their co-determination.

The tools offered by this theory allow us to bring out the mathematical and didactical organizations set up by the teachers. We thus are interested in the block "praxis", defined by Chevallard, that focuses on the types of tasks and associated techniques. For this purpose we introduce a typology of tasks with two levels of specification that we explain below.

The numerical calculus

At first, we look at the numerical calculus involved in each activity proposed to pupils. In an on-line addition of type $a + b = c$, we distinguish three different possibilities to code the activity: 1) $a$ and $b$ are given and $c$ is to be found; 2) $a$ (resp.
b) and c are given and b (resp. a) are to be found; 3) Only c is given and some or all possibilities for a and b are to be found (additive decomposition). We also differentiate with the symbol (+) and (−) whether the activity involves an addition or a subtraction[2].

Below we present the coding of the various possibilities we distinguished for the analysis of the activities proposed in the classes:

\[
\begin{align*}
1^\circ \text{ Mathematic: (numerical calculus)} \\
T_1 & \quad (+) a + b = .... \quad (-) a - b = .... \\
T_2 & \quad (+) a + .... = c \quad (-) a - .... = c \\
T_3 & \quad (+) .... + .... = c \quad (-) .... - .... = c
\end{align*}
\]

Figure 1: First level of specification: numerical calculus

The registers of ostensive

Then, we added a second level of specification. Indeed, our first categories did not allow us to differentiate the coding of certain activities collected, which were however very different. We used the registers of ostensive introduced by Bosch and Chevallard (1999). Ostensive objects are defined as handleable objects which have a handleable reality by the subject. Non ostensive objects, on the contrary, are neither "seen", nor "perceived", nor "heard". They need ostensive objects to appear. For example, the notion of addition (non ostensive), needs ostensive objects (such as the manipulation of tokens or codes of type \( a + b = c \)) to emerge.

We distinguished six different registers of ostensive, that we present in figure 2 below:

Figure 2: Third level of specification: registers of ostensive
The first register of ostensive corresponds to a task which involves an effective situation involving pupils. This task allows a material validation by manipulation (counting collections of concrete objects representing quantities). In the second register of ostensive, the task represents a fictitious situation where the manipulation is no longer possible, but the result can be reached by counting collections of figurative objects. The register of ostensive 3a represents, through a pictorial representation, a fictitious situation, yet the manipulation is not possible any more. The pupils have to reconstruct mentally the operations to be made, but the image facilitates this organization. The registers of ostensive 3b and 3c correspond to written and oral problems where a fictitious situation is described through writing or oral speech. The pupils have to reconstruct mentally the operations to be made, but there is no image anymore to facilitate the understanding of the described situation. Finally, in the registers of ostensive 4a and 4b, there is no longer any reference situation, this is purely formal, only written or oral numerical operations are conveyed.

This second level of categorization informs us about a hierarchy of possible techniques to solve the types of tasks proposed previously in figure 1. We present, below, the analyses we developed on the basis of this typology of tasks.

**EXPERIMENTATION**

For the nine scenarios of teaching, we established a set of data corresponding to the time of effective teaching about addition during one year (DO), the frequency of use of official documents proposed in Geneva (DO) and an analysis of the types of tasks (MO) and register of ostensive involved during one year of teaching (DO). Those different data bring to light the mathematical and didactic organizations set up about the teaching of addition by the nine teachers.

**Time of effective teaching addition**

We begin with the graph below which indicates for every class the time (in minutes) that was assigned to the teaching of addition during the year.
First of all, we notice a clear disparity within the nine classes. However, the values are more homogeneous in the OCs. This fact can be related to the strong constraint of the program, which constrains teachers in the ordinary classes. In the case of the SCs, one of the teachers dedicated a particularly low time to the teaching of addition. In fact, this teacher has chosen to interrupt her teaching concerning addition in the course of the year. Indeed, she considered this notion too complex for the only pupil of the class for whom the introduction of addition was appropriate. Even if this case is extreme, it shows that the teachers of the SCs are not forced, unlike the teachers in the “ordinary” classes, to follow the official program. Concerning the two other classes, the values indicate a slight overinvestment with respect to “addition” compared to the OC’s average. This seems to be due to the importance of the numerical domain in the specialized context, as several research works have already indicated (Conne, 2003, Cherel & Giroux, 2002). For the three classes of the TC’s institution, we notice two very low values and a very high value (in fact the highest of all 9), in a class, where the teacher has chosen to teach almost only addition in mathematics over the whole year. In the two other classes, the teachers teach all mathematical modules during the year and consequently devote a more restricted time to work on addition.

**Frequency of use of official set of pedagogical material**

The following graphs represent the use of the official pedagogical material by the teachers of the three types of institutions OC, SC and TC:

![Graph 2: Use of the official pedagogical material by the teachers of the three types of institutions OC, SC and TC](image)

In the three OC’s classes, we notice very homogeneous scenarios with a net tendency for teachers to use massively the official pedagogical materials. This fact is not surprising considering the strong constraint that represent those documents. On the contrary, teachers of the three SCs use little, even not at all, the official material. In fact, these teachers do not even employ replacement textbooks, but dig into a reserve.
of activities that they accumulated over the years. Therefore they are more involved in the process of didactical transposition (Chevallard, 1991) through a necessary adaptation of the knowledge to the specificities of their pupils. This work is normally executed by the *noosphere* and thus demands a reflection on the contents of an upper level.

**Analysis of types of tasks**

Let us look in what follows the distribution of the types of tasks T1, T2 and T3 during the year of our observations in each of the nine classes:

![Graph 3: Distribution (in percentages) of the types of tasks T1+, T2+ and T3+ during one year][4]

This graph shows homogeneity within ordinary classes. We note a distribution more or less balanced by the three types of tasks, with however a majority of activities of type T1, then T3 and T2. In the specialized classes, homogeneity is also noticed. However, there is, in the three classes, a substantial overinvestment in type T1 tasks to the detriment of the two other. This result is certainly due, among other factors, to the fact that teachers do not use the official materiel or any other textbook, and implies a "thoughtful" progression of the contents of teaching. On the other hand, for the TC’s institution, no homogeneity is noticed between the three classes. The first one gets closer to the functioning of the "ordinary" classes, the second of the specialized classes and the last one has a functioning rather original. It is the only class, where type T3 tasks are the most represented.

**Analysis of registers of ostensive**

Finally, let us look at the distribution of the registers of ostensive during the year of our observations of the nine classes:
Graph 4: Distribution (in percentages) of the registers of ostensive during one year

Again this graph indicates homogeneity within the OCs that we can attribute to the use of the official pedagogical material by the teachers and to the strong constraint of the program. A certain variety of registers of ostensive is represented in these three classes with, however, a majority of activities involving the register of ostensive 4a. The techniques of calculation, even counting, are thus facilitated, even if this is contrary to the fact that at the end of the primary school such strategies of “enumeration” should be overcome. In the specialized classes a "certain" homogeneity is noticed, because the three teachers chose to introduce a large number of "formalized" activities and the register of ostensive 1 (allowing the counting of collections of concrete objects) is absent. In the TCs, we notice again three different scenarios, representative of a large heterogeneity in these places. The first class has results close to the OCs and the second close to the SCs.

CONCLUSION

Our various analyses quickly presented above show that the different constraints, which weigh on the three types of institutions are not the same and engender the activation of different praxeologies. The teachers of the "ordinary" classes are confronted with strong constraints such as the use of the official pedagogical material and the "strict" follow-up of the proposed program. This results in relatively homogeneous MO and DO in this institution, with a large variety of different types of tasks relative to addition and also a variety of registers of ostensive.

In specialized classes, the constraints are numerous and come along, according to the classes, with more "local" constraints such as the behavior disorders of pupils or school heterogeneousness of the classes. The activated praxeologies are thus more or less homogeneous with, in particular, a massive accent on activities "formalizing" and implying essentially the type of tasks T1. This practice seems to be the result of the fact that teachers do not use reference textbooks. So teachers propose activities "valued" by numerous actors of the school, even the more general society, and overinvest the numerical domain (of which “addition” is part) to the detriment of the
geometrical domain or of measure. Furthermore, the fact that specialized classes are located in the same building as "ordinary" classes occasion a certain connection to the "ordinary norm" and “pressure of reinstatement” of pupils in the "ordinary" network, which influences the choices of MO and DO. In this case, we can notice a preference for the type of tasks T1 and registers of ostensive 4a, with a lot of “formalized” activities. In the interview we had with the teachers, one of the three specialized teachers asserted proposing large number of "formal" activities to his pupils to prepare them for a possible reinstatement in the “ordinary” circuit.

The fact that the TC obtained heterogeneous results can be explained by the large autonomy of the teachers in this institution. They can focus on more “local” constraints to activate their praxeologies, which results in more varied cases.

Our study showed that the differences in teaching in “ordinaries” classes, specialized classes, and schools with classes dealing with children with troubles in personality and learning can be to a certain point explained by the differences in the constraints that weigh on these 3 types of institutions. Our work helped at explaining this fact and sorted out the different effects.

The activated praxeologies thus depend on the conditions and on the institutional constraints, which weigh on the teachers of every type of institutions. It stands out from this research work that the ecology of didactic in the SC’s institution is not optimal and gives rise to scenarios of repetitive and impoverished teaching, which do not coincide with the initial intention to introduce addition. So, the teachers who are due to have a more active role in the process of didactic transposition are not equipped didactically to adapt their practice. On the other hand, the teachers of the TC’s institution have a larger space of freedom that explains why they can focus on the more particular context of their class (local constraints).

NOTES

1. Concerning more particularly the study of the OM, several levels are distinguished in the TAD (punctual, local, regional and global). The regional organization corresponds to a whole sector of the mathematics, as for example the notion of arithmetic operation represented by the sign + or - (Chevallard, 2002).

2. In our whole research, we also took into account if the unknown was a (initial value) or b (Vergnaud, 1981). However, we do not present these results in this article, because they bring few significant elements.

3. Session which we do not discuss in this article.

4. We do not consider the subtractive types of tasks. Indeed, during the first introductory year of addition, no subtractive activity is proposed in the official pedagogical material. However, we noticed that only the classes of the special education (SC and TC) proposed subtractions during the year of our collection of data.
5. For a more detailed analysis of the constraints appropriate for every studied type of institutions, refer to Maréchal (2010).

REFERENCES


