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Can we quantify the stability of a teaching?

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ABSTRACT
Our research proposes to show how we can quantify the stability of teaching, by refining a classical model of Activity Theory. Videotaped lessons of a model on energy chain, from two French 5th grade classes with the same teacher, were analysed in order to assess the percentage of stability as to: (i) realised subtasks and duration (ii) communicated themes and (iii)used semiotic resources. Using a self-designed scale, we show that these three-layered practices of the teacher ranged from stable to strongly stable.

KEYWORDS
Stability of teaching practices, Activity Theory, semiotic resources, video analysis

RÉSUMÉ
Notre recherche propose de montrer comment quantifier la stabilité d'un enseignement à partir d'un modèle issue de la théorie de l'activité. L'analyse vidéo d'une leçon portant sur l'introduction d'un modèle de chaîne énergétique, mise en œuvre par le même enseignant dans deux classes françaises (grade 5), a permis de quantifier le pourcentage de stabilité: (i) de l'activité de l'enseignant pour la gestion : des sous-tâches enseignées, et leurs durées, (ii) de ses actions à propos des thèmes communiqués et (iii) des opérations concernant les ressources sémiotiques mobilisés. À partir d'une échelle élaborée par nos soins, nos résultats quantifient la stabilité de ces trois niveaux qui varient de stable à fortement stable.

MOTS-CLÉS
Stabilité des pratiques d'enseignement, théorie de l'activité, ressources sémiotiques, analyse vidéo

INTRODUCTION

The stability of the practices of the teachers has already been underlined by Crahay (1989), who indicated that teachers possibly modify their project during the preparation and not at the

realisation of it. Berliner (2001) pointed out that the expert teachers automate the necessary repetitive operations, but they also make "in-flight" decisions. Hache (2001) searched and found stability in the discourse of the teacher, while Vandebrouck (2002) revealed invariances in the use of the blackboard by the same teacher in different classes. Pariès, Robert and Rogalski (2008) found that the main stabilities are linked with the precise management of the lesson's tasks and with the functions of the teachers' discourse.

Almost six decades ago, Rosenshine (1970) asked the question "A teacher who is effective or ineffective once is equally effective or ineffective a second time?" To answer this question, the constant effectiveness of a teacher (i.e. the positive impact on children's learning) should be linked with a stable characteristic, which may be the stability of the practices. Before the scientific community comes to a conclusion about this hypothesis, a way to measure the stability of the practices has to be developed, which is the main purpose of this paper. Based on the analysis of videotaped data of the same lesson being taught to two classes of 10 years old students (5^{th} grade), we propose a methodology to accomplish that. In order to do so, we refined a model of the Activity Theory, which combined with concepts linked to Social Semiotics worked as the theoretical framework.

THEORETICAL FRAMEWORK

Activity Theory

The organisational elements of the theory are: (1) the task, i.e. what the subject has to do, or "the aim to be reached under certain conditions" (Leontiev, 1978) and (2) the activity, i.e. what the subject really does.

Researches such as Rogalski (2008) make the distinction between the 'prescribed task' (i.e. the task according to the point of view of the person that prescribes it) and the 'effective task' (i.e. the subject's representation of what they have to do in the task). Since the prescribed task is redefined by the subject due to the representation, they have for it, we defined as realised task what the subject realised in relation to that task as such.

The classical model of Leontiev (1978) presents activity in a hierarchical system, in which activity is composed of actions, and these actions of operations. The actions of the teacher have a cognitive dimension, through the clarification of a proposed cognitive path, and a mediatory dimension, the actions of the teacher through communication (Pariès, Robert & Rogalski, 2008). By combining them, we could say that the teacher acts in order to communicate a cognitive path to the students, which is embodied in the themes communicated in the discourse.

As discussed by Jewitt, Kress, Ogborn & Tsatsarelis (2000), the analysis of communication that does not take into account the full repertoire of the active semiotic resources is incapable of perceiving all the expressed meanings, and since, the operations are the means of the actions (see Leontiev, 1978), the semiotic resources constitute the operations of the communicative actions.

Social Semiotics

The social semiotics deals with "the act of meaning making" (Thibault, 2004, p. 68) underlying that the communication is made up of the production and the interpretation of semiotic resources. Semiotic resources considered to be both actions and objects (Van Leeuwen, 2005), which are produced physiologically (with the vocal system, using muscles such as facial expressions and gestures) or technologically (ink and paper, software and hardware etc).

The meaning of any semiotic resource is inherently partial (Airey & Linder, 2009), since different semiotic resources emphasize different aspects of a concept, and it is not always specific, as there is a set of different meanings that any given semiotic resource can realise. According to Kress (2010), each semiotic resource has a meaning potential, different pieces of which, are activated in different contexts. As each individual resource, as well as their integration, can convey meaning in specific ways, the function of the semiotic resources should be deduced from the interplay of all the resources being used (Givry & Roth, 2006). Evaluating one of the above entities separately, the significance which results from their mutual interdependence, as a holistic meaning unit, is stripped down (Pozzer-Ardenghi & Roth, 2007).

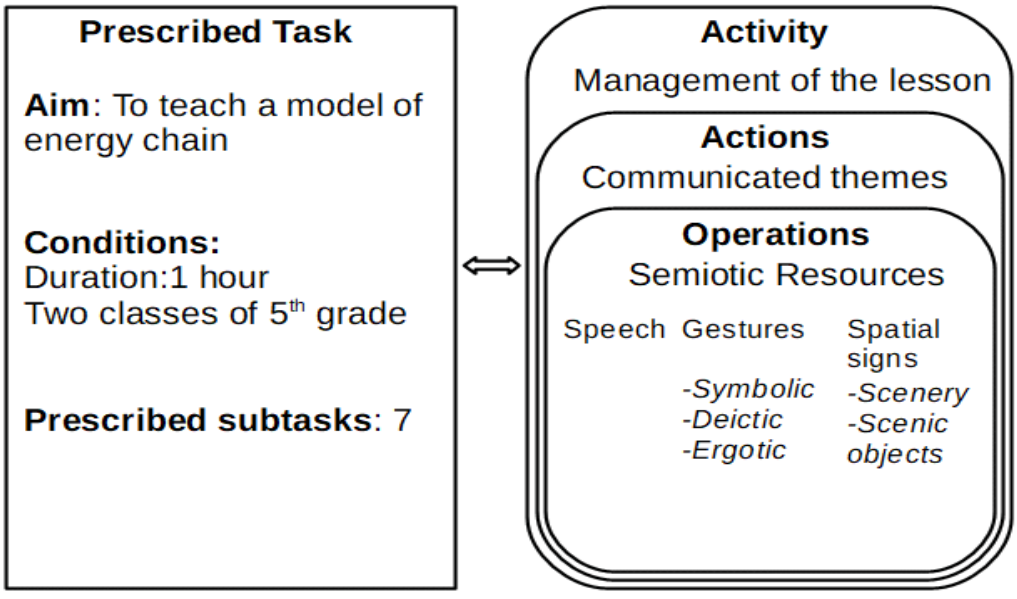
As Givry and Pantidos (2015) explain, a typical semiotic approach in science teaching can focus on (a) acoustic signs (linguistic and paralinguistic) (b) kinesic signs (gestural sings, proxemics and mimic signs) and spatial signs (scenery and scenery objects). The gestural signs include gestures, (i.e. semiotic movement of hands and arms), and specifically forms which are called gesticulation: symbolic (descriptive), deictic (pointing) and ergotic (manipulation of objects) gestures. Writing and designing can be considered as (ergotic) gestures (Flusser, 2014), the material result of manipulating an object that leaves a trace.

METHODOLOGICAL FRAMEWORK

Refined model

The following figure summarises the relevant elements used to study the teacher's activity. The purpose of the teaching is the gradual introduction of the energy chain model, which will take place through seven subtasks within a one-hour lesson to two classes of 5th grade.

FIGURE 1



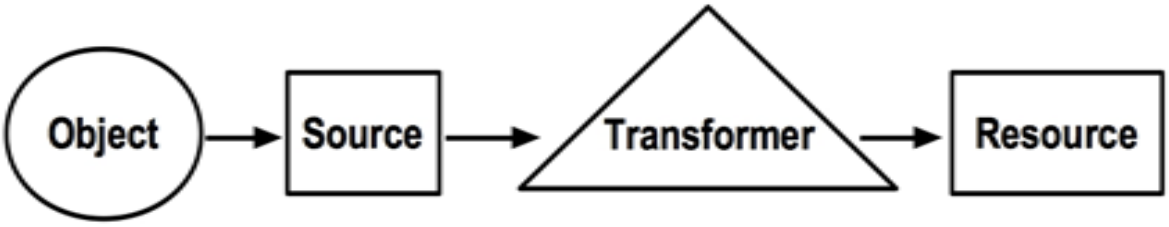
The refined model

Teaching content

The elements of the energy chain are the: (1) Object: which can emit light, heat or be in motion. (2) Source of energy: a product which is used directly to produce energy. (3) Transformer: a factory or a living being that transforms a natural resource into a source of energy (4) Primary source (called Resource): a raw product collected in nature.

The associated geometric forms: a circle for the object, a rectangle for the source and resource of energy and a triangle for the transformer (Figure 2).

FIGURE 2



Energy chain model

The arrow was not used to represent the transfer of energy, but to illustrate "where does the energy come from", by going back to the chain, leading to the resource of energy.

The overview of the study

Our sample consists of a teacher, one class of 26 students (15 boys and 11 girls) and a second one of 22 students (13 boys and 9 girls). The teacher held a morning session from 9:00 to 10:00 with the first class and from 10:30 to 11:30 with the second. A video device (semi-fixed camera) was placed at the back of the classroom to monitor the teacher's movements and record his activity.

The overview of the analytic procedure

This section introduces the six-step process that was followed.

Step 1. Clarification of the subtasks carried out

After getting acquainted with the data body, we separated the lesson into modules. Based on the description of the prescribed subtasks, we clarified what we called realised subtasks and their duration.

Step 2. Creating the text

For each lesson, a transcript of the teacher's discourse was made - the oral speech was written down, while any other active resource was noted in brackets. The coding for the various semiotic resources presented in Table 1.

Step 3. Searching for themes (or thematic categories) and clarifying them

The idea of identifying patterns within the data (Braun & Clarke, 2006) was ideal as a starting point and helped us shape the main themes. We identified the "essence" of what a theme is about and which aspect of the data each theme describes. We considered a new theme when the teacher communicated another component of the same aspect or moved to a different aspect.

TABLE 1
Coding of Semiotic Resources

Semiotic resources	Coding
Speech	s
Deictic Gestures	d.g
Symbolic Gestures	s.g
Ergotic Gestures	e.g
Scenic Objects	s.o
Scenery -Projection	sc.pr
Scenery-Paper elements on the black board	sc.el
Scenery-Black Board	scen
Writing	eg.w
Drawing	eg.dr

TABLE 2
Configuration of themes

Aspect	Component	Example
Element of the model	1. object 2.source3.transformer 4.resource 5. link	object
Symbolisation of elements	1. circle 2. rectangle 3. triangle 4. arrow to the right	circle
Element's position at the model	first, second, third, fourth, between	beginning of the chain
Element's association with material entities	-	car
Elements' relationship	-	need for gasoline
Element's function	-	movement
Everyday life example	-	-

Step 4. Review the themes/thematic categories
Both researchers re-read the text and re-categorized the data. Comparing the work of the researchers, the rate of agreement (Bakeman & Gottman, 1997) was over 80% the first time and over 90% the second time.

Step 5. Creating a combined table of analysis
A table consisting of the themes that were communicated and the used semiotic resources, for each of them, was created. The coding for the comparison of the use of semiotic resources was:

Step 6. Stability rate
In order to quantify stability in each analysed case, we adjusted the percentage agreement that is normally used to find interrater reliability (Bakeman & Gottman, 1997). In our case, the rate of stability (S) is the percentage of the number of common elements divided by the sum of the number of common and uncommon elements, ie:

$$S = \frac{Common\ Elements}{Common\ +\ Uncommon\ Elements}$$

Finally, by adapting the idea of the six-point Likert scale, we have created the following table to help us describe the Stability rate (S).

TABLE 3

The category of comparison and its coding

Category	Coding
When the same theme (1) communicated with the use of the same semiotic resource(s) (1)	1
When the same theme (1) communicated with the use of different semiotic resource(s) (0)	1.0
Different theme	0

TABLE 4

Characterisation of the stability rate

Stability Rate	Characterisation
0% ≤ S< 17%	Strongly Instable
17% ≤ S < 33%	Instable
33%≤ S < 50%	Slightly Instable
50% ≤ S < 67%	Slightly Stable
67% ≤ S < 83%	Stable
83% ≤ S ≤100%	Strongly Stable

RESULTS

Teacher Activity

The realised subtasks are strongly stable (100%)

The table 5 shows that the progress of both lessons was the same, with the same subtasks to succeed one another. In that way, we can see that the teacher managed the same 9 subtasks following exactly the same order in both lessons.

Furthermore, the pedagogical form of work was exactly the same for each subtask: the pupils work on their place and were questioned either individually, by name or not, or collectively. The teacher introduces the elements of the energy chain by discussing the related themes with the children. The students work in groups of four the exercises referring to the design of the energy chain model before moving to the introduction of a new element of the chain.

The teacher taught exactly the same subtasks (in the same order) with the same pedagogical form of work.

Since the teacher realised nine subtasks but there were seven subtasks imposed to him (see Figure 1) we could say that there is a gap between what he had to do and what he really did. To quantify this gap, there is 78% (78% = 7/7+2) stability or 22% instability between the

prescribed and the realised subtasks.

TABLE 5

Subtasks managed the by teacher

Prescribed subtasks	**Realised subtasks during lesson n°1**	**Realised subtasks during lesson n°2**
1. Triggering Phase	1. Triggering Phase	1.Triggering Phase
2. Introduction of the Energy Chain with two elements(object-source)	2. Introduction of the Energy Chain with two elements(object-source)	2.Introduction of the Energy Chain with two elements(object-source)
3. Pupils' Exercise 1: Realisation of the energy chain of two elements in various cases	3.Pupils' Exercise 1: Realisation of the energy chain of two elements in various cases	3.Pupils' Exercise 1: Realisation of the energy chain of two elements in various cases
-	4.Examples of Activity 1	4.Examples of Activity 1
4. Introduction of the Energy Chain with three elements(object-source-transformer)	5.Introduction of the Energy Chain with three elements(object-source-transformer)	5.Introduction of the Energy Chain with three elements(object-source-transformer)
5. Pupils' Exercise 2: Realisation of the energy chain of three elements in various cases	6.Pupils' Exercise 2: Realisation of the energy chain of three elements in various cases	6.Pupils' Exercise 2: Realisation of the energy chain of three elements in various cases
-	7.Examples of Activity 2	7.Examples of Activity 2
6. Introduction of the Energy Chain with four elements(object-source-transformer-resource)	8.Introduction of the Energy Chain with four elements(object-source-transformer-resource)	8.Introduction of the Energy Chain with four elements(object-source-transformer-resource)
7. Pupils' Exercise 3: Realisation of the energy chain of four elements in various cases	9.Pupils' Exercise 3: Realisation of the energy chain of four elements in various cases	9.Pupils' Exercise 3: Realisation of the energy chain of four elements in various cases
Total of common and uncommon tasks		9 and 0
Percentage of stability between the realised subtasks		***100 %*** *= 9/(9+0)*

The duration of the subtasks is stable (78%)

The first lesson lasted 52 minutes and 30 seconds while the second one 55 minutes and 40 seconds. The percentage of stability for the overall duration of the lessons is strongly stable (94%). Most pertinently the percentage of stability of the duration by counting the common and uncommon duration per subtask is stable (78%).

More particularly, we can see that the duration of: (a) four subtasks (n° 1, 2, 5, and 9) are strongly stable (83% ≤ S <100%), (b) two subtasks (n° 6 and 8) are stable (67% ≤ S <83%) and (c) three subtasks (n° 3, 4 and 7) are slightly stable (50% ≤ S <67%).

Communicated themes

The number of themes that the teacher communicated is strongly stable (84%)

Most categories of themes were found in both lessons. The table 6 includes the number of the common and uncommon categories of themes.

TABLE 6
Duration of the realised subtasks

Realised subtasks	**Duration in lesson 1**	**Duration in lesson 2**	***Common duration***	***Uncommon duration***	**Percentage per subtask**
Subtask n°1	2’	1’40’’	1’40’’	0'20"	**83%**
Subtask n°2	10’20’’	9’	9’	1'20"	**87%**
Subtask n°3	3'40"	5'50"	3'40"	2'10"	**63%**
Subtask n°4	1’10’’	2’20’’	1’10’’	1’10’’	**50%**
Subtask n°5	14’40’’	17’10’’	14’40’’	2'30"	**85%**
Subtask n°6	3'50"	5'10"	3'50"	1'40"	**70%**
Subtask n°7	5’50’’	3’30’’	3’30’’	2'20"	**60%**
Subtask n°8	3’20’’	4’10’’	3’20’’	0'50"	**80%**
Subtask n°9	6'40"	7'50"	6'40"	1'10"	**85%**
Total Duration (minutes-seconds and seconds)	*52'30" (3150")*	*55'40" (3340")*	*47'30" (2850")*	*13'30" (810")*	
Percentage of stability of the duration	**94 %** = 3150/(3150+190)		**78 % =** 2850/(2850+810)		

TABLE 7
Stability of the thematic categories

Themes	***Common***	***Uncommon***	**Total of themes**
Number of themes communicated by teacher	*21*	*4*	25
Percentage of stability of themes	**84**% = 21 / (21+4)		

The common categories of themes were twenty-one, while the uncommon were four. This means that the number of the thematic categories communicated by teacher is strongly stable between both lessons (84%).

The thematic communications per subtask are slightly stable (61%)
As it can easily be understood the 21 common thematic categories were communicated various times in the progress of each lesson, sometimes in the exact same subtask sometimes not. Specifically, there were 60 times where the same themes were communicated in the same subtask and 30 times that they were not, which leads, according to our ranking, to a slight stability (61 %) between the two lessons regarding the thematic communications per subtask.

From the one hand there are two subtasks strongly stable, one stable and one with slight stability, from the other hand there are two subtasks which can be characterised as unstable.

TABLE 8
Common and uncommon thematic communications per subtask

Realised subtask	**Lesson 1**	**Lesson 2**	***Common***	***Uncommon***	**Percentage of stability**
Subtask n°1	2	2	*2*	*0*	**100%**
Subtask n°2	23	27	*23*	*4*	**85%**
Subtask n°3	2	11	*2*	*9*	**18%**
Subtask n°4	22	28	*22*	*6*	**79%**
Subtask n°5	6	10	*6*	*4*	**60%**
Subtask n°6	5	21	*5*	*16*	**24%**
Total thematic communications			60	39	
Percentage of Stability			**61%**=60/(60+39)		

Semiotic Resources

The use of semiotic resources is stable (72%) when communicating the common themes

Comparing the semiotic resources between the two lessons for the aforementioned 60 thematic communications, we created the following table (Table 9).

TABLE 9
Comparison of used semiotic resources

Realised subtask	**Common semiotic resources (1.1)**	**Uncommon semiotic resources (1.0)**	***Percentage of stability per task***
Subtask n°1	1	1	**50% (**=1/2)
Subtask n°2	12	11	**52% (**=12/23)
Subtask n°3	2	0	**100% (**=2/2)
Subtask n°4	17	5	**77% (**=17/22)
Subtask n°5	6	0	**100% (**=6/6)
Subtask n°6	5	0	**100% (**=5/5)
Total	43	17	
Percentage of Stability	**72%** = 43 /(43+17)		

In the two out of six tasks, the use of semiotic resources was slightly stable, with the teacher using the same semiotic resources in half of the cases. In one task the teacher used the same semiotic resources in 77% of the cases. The rest of the tasks are considered strongly stable, since the thematic communications were executed with the same way.

DISCUSSION

At the same time, while conducting a different study, in which we studied how differentiations between the material that two groups of students worked on influenced their understanding of the energy chain model, we had to be certain that all the other factors were controlled, and therefore

the teacher's practices. The teacher had been given the same prescribed task/subtasks, but is that sufficient in an experimental research? In order to answer this question, we tried to quantify the stability of the practices, with this three-level analysis of video data being our suggestion.

Bearing in mind that the stability measure we adopted has a certain range (>50% -100%), it is the next step for every subsequent research to check the effect of the (in)stability on students' learning, since a 80% stability means a 20% of instability at the same time.

Taking this discussion one step further, if the stability of practises of the teachers will be found to be a characteristic of their activity and concurrently a linkage with students' performance, we could consider an ineffective teacher to be ineffective for all their professional life. The research on stability of teachers' activity over the years is proposed, in order to have a more holistic view over this topic and to further understand the factors which influence it.

From a didactics point of view, the way the lesson was analysed could work vice versa as a way to organise a teaching, starting with the subtasks and their duration, proceeding to the necessary themes for communication, to finish by selecting the most appropriate semiotic resources for every occasion.

Since this is a case study, this kind of analysis was performed only in one teacher, so in order to validate this method, it should be tested on a bigger sample and various courses.

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