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THE EFFECT OF AN ICT ON THE COHERENCE OF THE TEACHER DISCOURSE: CASE STUDY OF AN ELECTRICITY SEQUENCE AT GRADE 12

Suzane El Hage
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ABSTRACT

This paper presents an analysis of the teacher's discursive coherence in a "natural" physics sequence at grade 12 in France. In this sequence about electricity, the students and the teacher use an ICT-tool, belonging to the category of "data-logging systems and Microcomputer-Based Laboratory", following the typology by Pinto and colleagues (2010).

The theoretical framework is based on four elements: 1- an element borrowed from work about the discourse analysis in science classroom, particularly the notion of episode (Mortimer et al, 2007); 2- the categories of articulations proposed by Badreddine & Buty (2011); 3- the semiotic registers (Duval, 1995) and 4- the modelling processes (Tiberghien, 1994).

The collected data consist in the video recording of all the sessions of the sequences, as well the practical sessions as the lectures and debriefing in whole class.

The methodology consists in two parts: first, dividing the video tapes into microscopic episodes using Transana, software for video- and audio-annotation; second, inventorying in a table the links between episodes realised through each category of articulation. In general we use the method of zooming out (Lemke, 2001) for studying the coherence in the discourse at different moments in the sequence.

In this contribution, we will present two cases: the first one when the teacher establishes relationships between an earlier stage of the sequence, and the second one when the teacher makes connections with an episode later in the sequence. We shall particularly highlight how the ICT device intervenes in these connections.

KEYWORDS

ICT, electricity, coherence, discursive analysis.

INTRODUCTION

It can be reasonably hypothesized that teaching coherence is an important factor of learning; a frequent classroom observation is that expert teachers spontaneously establish many cohesive links between the various parts of their discourse. The use of ICT tools, which is rather common nowadays in science instruction, raises a specific problem regarding the coherence of the classroom discourse. Very often, the intervention of ICT tools is limited to one or two sessions in a whole teaching sequence, and the kind of activity or result produced by this intervention is rather disconnected from the usual course of the instruction, from the other activities. This tendency is strengthened by the fact that ICT tools are seldom used in evaluations; this encourages both teachers and students to consider this kind of activity as secondary, compared for example to classical exercising sessions, which prepare classical tests.

This is the reason why this case study turns on how an expert teacher establishes links between the different moments of his teaching sequence about electricity at grade 12. The context gives several reasons for a potentially high degree of coherence in this sequence. The domain (electricity) and the state of classroom technology (the availability of rather cheap and easy-to-use acquisition and modelling devices) make it possible to obtain a high students' engagement in handling computer-based measurement systems; the existence of an experimental test in the national final exam (the *baccalauréat*), where such ICT tools can be used, constitutes a stake for using these tools during the instruction, and for learning to use them autonomously. In the same time, electricity is also a domain where exercises are frequently given in the national exam; it makes it necessary for the teacher to ensure strong links between the computer-based experiments and the concepts and relations allowing the solution of the exercises.

CONTEXT

The observed teacher has around ten years of experience. The school is one of the best ones in an important French city; in the division where the data were collected, students have generally a good sociocultural level. As always in French scientific instruction at this stage, courses belong to two categories: *lectures* in whole class, and *practical sessions* with the half of the class. In this class, practical sessions happen on Monday (for both groups) and lectures happen on Tuesday and Friday, each week.

The teaching sequence in electricity is divided into three chapters, in accordance with the official curriculum: R-C dipole; R-L dipole; R-L-C dipole. Each chapter is divided into several *activities*, mainly elaborated by the teacher himself; in this sense it is a “natural” teaching sequence. Most of the time, during practical activities, students use computer-based acquisition and modelling devices; in fact it is always the case, except in the first practical session. During lectures, the teacher often uses the same ICT tools, projecting the screen of the computer on the white board with a video projector, and adding simultaneously drawings, schemas or equations on the board.

The two ICT tools that are used are on the one hand *Mesures Electriques* (ME; voltage or current acquisition) and on the other hand *Regressi* (data treatment and modelling). They can be classified as data-logging systems and Microcomputer-Based Laboratory following the typology of Pinto and colleagues (2010).

THEORETICAL FRAMEWORK

The analysis of the discourse and its coherence consists essentially in describing the different types of relational marks between the different segments in a text. The use of ICT can affect any links in the discourse, both for their frequency and their characteristics. We need theoretical categories for identifying those links, and for characterising their nature. Identifying the links means first isolating some moments in the flow of discourse that can be linked, and secondly naming the kind of relationship established between two moments.

For defining moments in an objective enough manner, we use the notion of episode as developed by Mortimer and colleagues (2007, page 61): “a discursive unit which constitutes a coherent set of actions and meanings produced by the participants in interaction, which has a clear beginning and end, and can be easily distinguished from the previous and subsequent episodes”. The set of episodes constitute a complete mapping of a session or a sequence, objectifying the rhythm of discourse in the classroom.

For characterising the links between episodes identified at different moment of a sequence, we use the categories of articulation defined by Badreddine & Buty (2011, page 783), pointing from a given episode to previous or posterior ones: three directed to the past (resume, call, remind) and three turned to the future (postpone, announce, advance).

For characterising the nature of the links that is, the eventual transformation they imply in the knowledge content, we use a set of descriptors for science teaching-learning situations (Buty & al., submitted): the epistemological aspects of the situation, particularly the modelling processes (referring to Tiberghien, 1994); the form of representations (referring to Duval, 1995); the management of verbal interactions (referring to Mortimer & Scott, 2003); the management of students' engagement (referring to Engle & Conant, 2002). In this communication, the two first descriptors only will be used (in particular due to the fact that we are analysing teacher's discourse, almost always during authoritative moments).

RESEARCH QUESTIONS

Our aim is to understand how the use of ICT tools for data acquisition and modelling in physics teaching can strengthen the coherence of the instruction, from various points of views, namely the knowledge content and modelling processes, and the link between semiotic registers, through the management of social interactions in the class. In the linked episodes we analyse, we shall especially focus on the existence, or absence, of corresponding knowledge elements.

COLLECTING AND ANALYSING DATA

As far as this communication is concerned, the collected data were essentially constituted by the video-recording of the classroom activity, through a camera at the back of the room, aiming at the teacher. Besides of that, the useful documents for the present analysis were the instruction sheets for the concerned activities.

The treatment of the data is far more sophisticated. In a first step, the whole sequence is divided into episodes, as said before. In a second phase, each episode can be attributed a set of keywords; among these keywords, the categories of articulation described in the theoretical framework are used. In a third step, a table is fulfilled, indicating for each episode affected by such a keyword, to which other episode(s) the articulation establishes a link. In a fourth and last step, after choosing a couple of episodes linked by articulation categories, we consider both episodes in their context (that is mainly their theme or sub- theme, see Tiberghien & Buty, 2007) to describe more accurately the meaning of this articulation.

ANALYSIS

We analyse here two opposite cases of links between two episodes of the sequence. In the first case, the teacher establishes a relation with a previous situation, what Badreddine (2009) names a *call*. In the second case, after another call, the teacher indicates that a subsequent situation will involve such and such piece of knowledge; for Badreddine (2009), this is an *announcement*. All these episodes occur at the beginning of the sequence, when the topic at stake is the R-C circuit.

From the present to the past

In the second session of the sequence, which is a practical session, the teacher performs alone an experiment consisting in the charge of a capacitor with a current generator, that is, the intensity being constant (the circuit is the same than on figure 2). In a first step (episodes 21-29), this experiment is realised with traditional equipment, that is, a chronometer, a voltmeter and an A-meter, all of them visible by students. Students, working by pairs, have to notice the voltage function of time, and draw the graphical representation of this function, which is a line. Students must calculate the value of the capacity from their measurements. We must notice that not all students succeed in this part of the practical activity.

After this first experiment, the teacher introduces (episode 30) the computer-based measurement system (Mesure Electrique software) and shows it gives the same result than the traditional experiment, but

with much more points and faster (figure 1). He somewhat legitimates the use of a computer-based system.

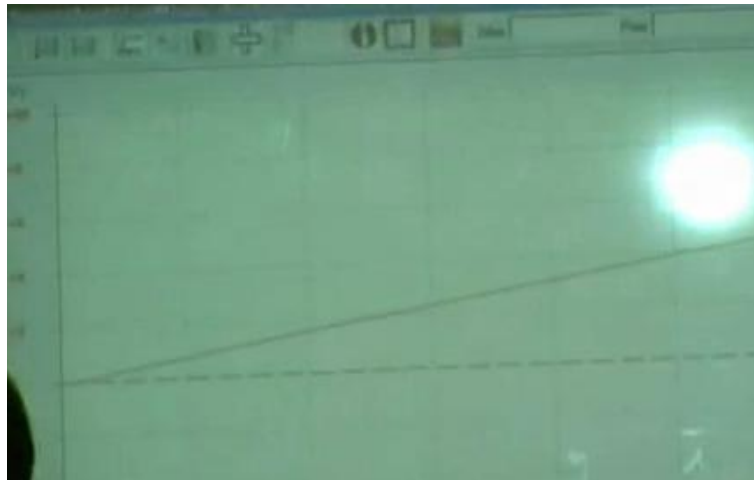


Figure 1. Voltage on the capacitor, versus time.

In the third session of the sequence, which is a whole-class lecture, the teacher makes a first call to the practical session (episode 8), and projects the computerised data acquisition of the line (voltage versus time), which students have seen in the practical session. The students calculate the value of the capacity from the measurements produced by the teacher; at this occasion the teacher makes a link between the world of objects and the world of models, because he reads the value of the capacity on the component, including the uncertainty, and everybody can ascertain that the nominal value and the value found through application of the theory are compatible.

In the same session, a few minutes later (episode 38), the teacher projects a circuit schema and a representation of the plates of a capacitor (figure 2); in this episode we find a second call to the practical session. On this projection we see a superposition and an articulation between two modelling scales, a microscopic model (the elementary charges which accumulate on the plates, symbolised by individual boxes for the electrons or 'plus' signs) and a macroscopic one (the quantity q , linked to other macroscopic quantities such as $i = dq/dt$ and U_{AB}). In this representation and its intervention in the classroom discourse, three semiotic registers (Duval, 1995) are used: a schematic one, a symbolic one (the equation $i = dq/dt$ and other notations), and natural language (for example, it is noticeable that the words 'macroscopic' and 'microscopic' are made explicit by the teacher). Some conversions are made by the teacher: for instance, he translates the equation $i = dq/dt$ by "i is the flow of charge".

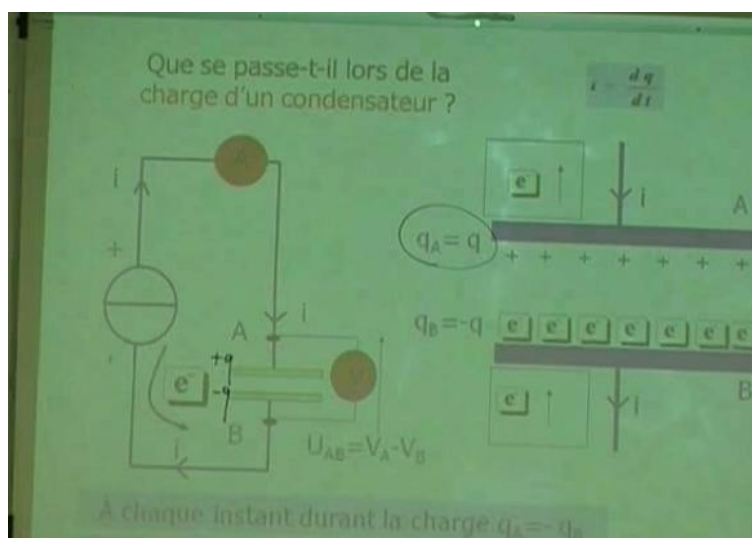


Figure 2. Projection of a slide during the lecture in session 3. One can remark that the teacher has manually added some indications (the circle around $q_A=q$, the charges $+q$ and $-q$ on the schema, left).

From the present to the future

During the second session of the sequence, which was a practical session like it has already been said, some students have made two different acquisitions for two different values of the capacity in a circuit R-C powered by a voltage-generator (episode 100), and observed that the shapes of the two curves were different, particularly that the time necessary to reach the limit was longer if C or R was bigger.

During the following lecture (already discussed in the previous paragraph), the teacher *calls* back this observation and *announces* that this point will be discussed again later (in the next practical session). He also makes an-extra sequence call, because he tells that it is basically the same phenomena than in radioactivity and in kinetics, and that the aim of the discussion will be the same: finding the temporal evolution of the charge of the capacitor.

Three days later (in the following lecture, session 4 of the sequence), the teacher performs again the experiment with two different values of C, in front of the whole class (episode 35, figure 3). Then, he projects three new curves, which he had previously recorded, coming from the same experiment, but with the same value of C and three different values of R (he *announces* there is a link with τ , $\square\square\square\square\square\square\square\square$). These two experiments allow him performing a dimensional analysis, and showing that the product RC has the dimension of a time.

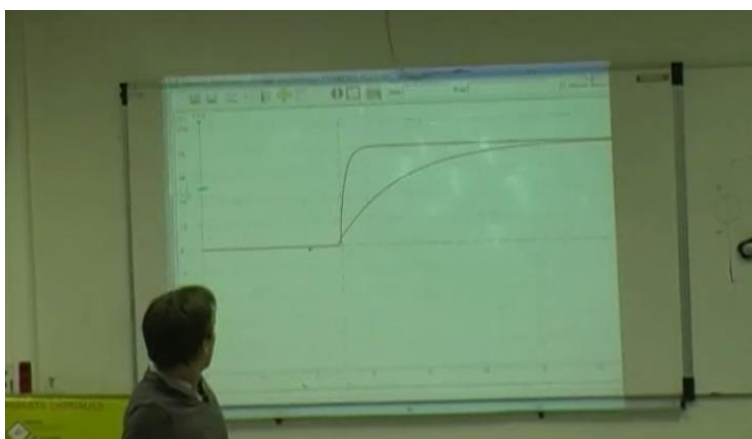


Figure 3. Projection of the results of an acquisition just realised in front of the whole class.

On the next session (5, which is the second practical one) the teacher performs an acquisition followed by a modelling through Regressi. Thus he validates that the time constant, τ , is RC both in the world of theories and models (by this modelling process through the software) and in the world of objects and events (by calculating the product R times C, quantities read on the components, episode 51).

DISCUSSION AND CONCLUSION

In both cases that were discussed, we find some important characteristics of computer-based tools in science instruction.

The fact that the teacher has the possibility to perform the same experiments during the lecture that have been performed during the practical activities strengthens the coherence between these two moments of the sequence, and allows the teacher being sure that all the students have drawn the same conclusions of the practical activities. This portability of modern acquisition systems also gives the possibility to teachers to facilitate the links between the experiments (the world of objects and events) and the theory, which is generally exposed and worked out in the whole-class lectures.

Of course, the fact that the tool exists does not mean that the teacher is able to use it. Like Pinto and colleagues claim (2010), the teacher's role is critical. In the analysis of this case, we must not forget that the observed teacher is an experienced one, who has a deep reflection about modelling processes and the use of combined semiotic registers, due to his proximity with a science education research team. Or, to say it another way, and again in line with Pinto and colleagues remarks (2010), the choice of such software and the decisions on how to use it show a conception of learning in science, for this teacher, based on the establishment of meaningful relationships between the world of objects and events and the world of models and theories, on the one hand, and between symbolic and iconic registers, on the other hand.

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