Teacher's practices after Experimental Activities: questioning and feedback to students' answers

Rita Khanfour-Armalé, Jean-François Le Maréchal

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roriangel14@yahoo.com & lemarech@ens-lyon.fr
UMR ICAR – COAST, University Lyon, CNRS, INRP

Context of the research

For many years, our research group has explored, with a constructivist point of view, the possibility to organize teaching sequences where the teacher / students relations are based on students' experimental activities more than on lectures (Buty et al., 2004). Although this approach of teaching has proved that students do involve the knowledge to be taught, we found out many teachers' reluctances to keep teaching this way. Our hypothesis is that the class organization has to change from a satisfying teacher situation to a satisfying student situation. During the first situation, teachers are in charge of formulating and structuring the new knowledge during a lecture, and then students are in charge of using this knowledge. This transmissive approach of teaching has been largely criticized on learning and motivating point of view, but the fact is that teachers, students and parents feel comfortable with it. During the second situation, the new knowledge is first to be constructed by students during experimental activities. Then, teachers are somehow disoriented. Among the reasons of this disorientation, we have found, during interviews and group discussions (i) the large heterogeneity of the relation between students and the new knowledge after experimental activities, (ii) the fact that students have involved and start learning a new knowledge that is neither properly formulated nor structured, and (iii) the fact that there are little visible paper traces of the knowledge as the students' laboratory notebooks do not seem appropriate for further teaching/learning.

The aim of our research has been to understand, within the second situation, what the class organization can be after the profitable experimental activities. In most cases, the texts of activities that we found in the research literature and in the school textbooks are structured around questions that are submitted to learners. Although the class following the activity can be organized in different manners, and it will be discussed below, we have noticed that teachers often organize a discussion around the questions of the activity. The analysis of such a discussion is the aim of the present research.

Theoretical background

We consider a class discussion as a dialog between two interlocutors: the teacher and the class, considered as one interlocutor. Discussions between two interlocutors can be analyzed in terms of ternary exchanges or triadic dialogue (I.R.E.) (Lemke, 1990; Mehan, 1979; Sinclair and Coulthard, 1975) where I is an initiation by one interlocutor; R is the reply by the other interlocutor and E an evaluation by the first interlocutor (Orrechioni, 1996; Traverso, 1999). Such a ternary exchange analysis has also been used in science education (Mortimer, 1998; Mortimer and Scott, 2000) and it will be the base of our analysis.

Research questions

We have hypothesized that the ternary exchange would be initiated by the teacher and we will try to understand how the initiation phase, then the evaluation phase, are organized in the case our context. As far as the initiation phase is concerned, we will try to understand the relation between the question and the text of the experimental activity. Then, in the case of the

evaluation phase, we will try to understand how the knowledge is involved by the teacher: its wording, its validation, and its relation to context or models.

Methodology

Our main source of data is class video with the camera focused on the teacher. Discussions were transcribed and the transcription split into ternary exchange.

• Initiation phase was categorized into text questions (when the teacher asks the same question as one that is in the text of the activity) and non text questions. The latter was coded into four categories: (i) context question, when the teacher makes the question from something that was previously observed, done or said; (ii) question with a meta level when the question deals with strategy, reflexion about the question or about the knowledge; (iii) question that simplify a text question; (iv) question that establishes relations (between text questions or different ideas). This categorization should allow a clear understanding of the way the teachers relate their questions to those derived from the text of the experimental activity, being (i) more concrete, (ii) more abstract, (iii) more simple, or (iv) more complex. It is part of our research to validate this categorization.

• Evaluation phase of the ternary exchange was analyzed in categorizing into four other categories in relation to the knowledge: (i) formulation, (ii) knowledge treatment, (iii) contextualization or (iv) generalization. The meaning of these categories is detailed here. **Formulation** corresponds to the case where the teacher keeps the student's idea. The teacher can use the students' answer in repeating it all, or part of it (s/he then sorts the student's words out), or change the students words (reformulation). The teacher can also use a prior student's answer, or a set of answers (recapitulation). **Knowledge treatment** correspond to the case were the teacher deals not only with the student's words but also with student's knowledge. The teacher can judge the answer: correct (validation) or not (correction). He can also use the student's knowledge. A last possibility is to add knowledge to what the student has said. **Contextualization** corresponds to an important teaching activity when a general knowledge, stated with model ideas, is derived in a specific context. **Generalization** is the opposite. Our interest in these two last categories comes from the fact that we study in a class discussion that follow an experimental activity, and we believe that the use of what has been done with the experiment either to be used as a given context, or to be the base for more general statements, may be critical moment of teaching and learning. The analysis of an evaluation may use more than one category, for example the teacher can start repeating the student's answer then he can validate it.

So far, three teachers have been observed with four classes, after three different experimental activities. All the experimental activity took place in the first year of upper secondary school (16 year old students) and all experiments were in chemistry.

Results

The 292 ternary exchanges cover 98,5% of the class discussion. 90 questions of the text activity have been observed and 134 questions were out of the text. Among them, there were 89 questions on context, 22 questions at the meta level, 6 questions for simplification, and 17 for establishing relations.

What happens in the class can therefore be considered as ternary exchanges initiated by the teachers. Most of the non text questions correspond to context questions, most of which aimed at having experimental information from the students' point of view (what have been observed, the colors of the solutions, etc.).

The evaluation of the students' answers corresponds to 223 formulations, 77 treatments of the knowledge, 36 contextualization and 17 generalizations. The formulation corresponds to 175 repetitions, 24 recapitulations, 15 reformulations and 8 selections of students' words. According to the teachers, repetitions allow the whole class to participate to the discussion. Most students' answers were repeated. The large number of recapitulations is in agreement with the many context questions that need to be recapitulated for their answer to make meaning.

The treatment of the knowledge involved by the students in their answers is distributed among the judgments of the knowledge (27), the uses of students' knowledge (23) and the additions of new knowledge (27). Compared to the 41 occurrences of the formulation category (repeating excepted), the higher number of occurrences of the treatment of the knowledge (77) means that teachers spent more efforts on the students' ideas than on the way the ideas were expressed.

Contextualization (36) and generalization (17) prove that teachers spend time on relating the experimental context they are working on to scientific proposition, as far as one car say that general proposition are scientific. We believe that both these numbers may be highly dependant on the field that is at stake during the discussion.

Facets of knowledge mostly occurred during the evaluation phases of the ternary exchange.

Discussion

Our detailed analysis of a class discussion about an experimental activity validates our categories because most of what the teacher says fit to one of those. The occurrences of each category may explain why teacher may fel uncomfortable about such a discussion. From teachers' feeling, information got during interviews, many students (among them the good one) may get bored during such discussions. Teachers declare to spend time for these discussions because they do not want a work been given to 16 years old students and not to come back on it. It seems to be part of a contract that this discussion has to happen. Our analysis can help to understand this negative feeling. Students know 48% of the questions (because they are text questions) and 35% deal with what they have seen and done (which is poor in terms of knowledge). Moreover, the teacher spends a lot of time in repeating students' answers. The treatment of knowledge uses up only a small part of the teaching time.

Group discussions with teachers are now oriented to find other way of using the experimental activities. Among the possibilities, we have pointed two other kinds of organization: one based on a written document different from the text of the activity (textbook, synthetic document, etc.) and one that would integrate the experimental results of the activity to a lecture. More complex organization would be possible, using successively these three possibilities and are currently under investigation.

Conclusion and implications to teaching and research

Our research has been able to provide an understanding of the way teachers come back, with their students, to an experimental activity. Such an understanding may help to improve novice teacher in their practices. Our methodology may also be used to compare the different ways teachers manage the class following experimental activity. We believe that discussion from the text of the activity, which seems to be the most frequent way of dealing with knowledge in class, is probably not the best one. Structuring the knowledge of the experimental activity or working out a document involving the same knowledge might be a better practice, and our theoretical framework may be useful to prove it.

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Summary

Our research aims at understanding what the class organization can be after experimental activities. We have noticed that teachers often organize discussions around the questions of the activity, although they are not always comfortable with this kind of teaching. We consider class discussions as dialogs between two interlocutors: the teacher and the class. Discussions between two interlocutors can be analyzed in terms of ternary exchanges (Initiation, Answer, Evaluation). Our main source of data is class video with the camera focused on teachers. Initiation and Evaluation phases have been categorized. The 292 ternary exchanges cover 98,5% of the class discussion that have been studied. 90 questions of the text activity have been observed and 134 questions were out of the text. Among them, there were 89 questions on context, 22 questions at the meta level, 6 questions for simplification, and 17 for establishing relations. The evaluation of the students' answers corresponds to 223 formulations, 77 treatments of the knowledge, 36 contextualization and 17 generalizations. Knowledge mostly occurred during the evaluation phases. The occurrences of each category may explain why teacher may fell uncomfortable about such a discussion. Other possibilities of organizing the class after experimental activities have been considered.