MEDIATION OF STUDENT LEARNING: DIMENSIONS AND EVIDENCES IN SCIENCE TEACHING

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Abstract

Our study intends to focus the teacher mediation of student learning in sciences' classrooms in new theoretical and empirical perspectives. The science teacher action, in a research perspective, has been considered as sum of several aspects. Our research problem is how to consider, in a scientific way, the mediation of student learning in science classroom by facing the teaching activity as a whole. We present a theoretical framework to analyse the teacher mediation. We also developed an innovative methodological instrument to obtain data relevant to analyse the teacher mediation. Our instrument is a multimodal account of what happens inside the classroom or what particular context conditions some teacher decisions. We provide preliminary results from two particular science teachers to evidence the usefulness of this framework, in particular the dimensions of analyse and the richness of the instrument to collect data from multiple sources.
Key words*: teacher mediation, student learning, classroom, science education, account.*

Introduction

This study is a part of a more general project[1] that has two main goals: to elaborate a theoretical framework about mediation; to produce tested tools for guiding teachers, as elaborated examples of successful teaching for understanding (Wallace & Louden, 2003).

The science teacher action has been considered by research as a sum of several aspects (Lopes et al., 2008). Besides, there is a lack of studies in natural classroom environment (Lopes et al., 2008), in spite of a few works published (e.g. Pintó & Couso, 2007). Our concern is to consider the mediation as a whole in natural classroom environment. We present a theoretical framework to analyse the teacher mediation. We have developed a methodological instrument to obtain relevant data: a multimodal account to analyse the teacher mediation. We have also developed an analytical method to work with the data.

The data reported here comes from the classes of two secondary school teachers (students aged

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12-15 years). We will focus one perspective of teacher mediation that we consider and use the first two levels of analysis. This will allow us to illustrate our methodological approach and to present some preliminary results.

Theoretical approach

The research about teacher mediation of student learning in sciences classroom (for short we will refer to this as simply teacher mediation) is related with other well-established knowledge like interaction (Mazur, 1997; Hoadley & Linn, 2000), question-based learning (Pedrosa, Francislê, Teixeira Dias, & Watts, 2005), classroom talk and its several discourse forms (Leach & Scott, 2003; Mortimer & Scott, 2003; Scott, Mortimer & Aguiar, 2006), information flow (Lemke, 1990), questions (Pedrosa et al., 2005); argumentation (Erduran & Aleixandre-Jimenez, 2008); news conceptions of interactions within the classroom (Shepardson & Britsch, 2006); classroom climate (Valero, 2002); student work autonomy (Pea, 2004; Reiser, 2004), among others. However, the teacher mediation is a subject not well known because it is complex in nature and, also, because there are few research studies centred in the classroom (Lopes et al., 2008). Besides, there is no comprehensive theoretical framework about the teacher mediation in Sciences classes. There is some work done by Engle and Conant (2002) that points towards some basic principles. In spite of its specificity (the study focus is biology and argumentation) their work provides some ground for the elaboration of an evaluation tool to monitor, in a global way, the quality of teacher mediation in the classroom. Also there is research in teaching practices (Tiberghien & Buty, 2007) that can help us with insights to analyse the teacher mediation as teacher practice in classroom.

Nevertheless, we need further empirical evidence about teacher mediation in Physical Sciences classes to support a comprehensive theoretical framework.

We define tentatively the teacher mediation as the teacher action and language (verbal and not verbal) as a systematic answer to the students' learning demand in their specific development pathways to the intended curriculum learning outcomes (namely in terms of students' knowledge, competences and attitudes).

It is a well known result that the students have specific learning development pathways to achieve the desired learning outcomes (e.g Lopes, Costa, Weil-Barais, & Dumas-Carré, 1999). So, through mediation, the teacher should try to know what are the students' prior knowledge, competences and worldview, and systematically check the students' learning demand in their learning process.

The teacher systematic effort to know what his students know and check the students' learning demand in their learning process are the two core components of the teacher mediation. The teacher can not do this for each and every student for two main reasons: i) in a class, it is impossible to pay attention simultaneously and permanently to each student as an individual; ii) it is a well known result that the learning, in spite the need for an individual effort, is a social enterprise (Felder, Woods, Stice, & Rugarcia, 2000; Mazur, 1997; Felder & Brent, 2007)). In consequence of this, the teaching practice shows that the teachers develop several ways to deal with the students as a class.

To improve teacher mediation we should consider the intended learning outcomes. For example if she wants high level learning outcomes, the teacher should provide support for learners in complex tasks, "that enable students to deal with more complex content and skill demands than they could otherwise handle" (Reiser, 2004). Besides, teacher mediation is a complex phenomenon because the class is a system in which the teacher is a member (even if with authority and more qualified) and the teacher must take into account, at the same time, the cognitive, affective, relational and social-political dimensions of what happens in the classroom (Valero, 2002; Dumas-Carré & Weil-Barais , 1998).

Our definition of teacher mediation has six components: i) action, ii) language, iii) students' learning demand, iv) students' development pathways v) learning outcomes and vi) curriculum intentions. Because of their complexity it is not possible to encapsulate all aspects that determine how certain teacher mediation takes place in a real science classroom with real teachers and students. So to consider the teacher mediation we propose to face it as a whole that can be studied in several perspectives.

The knowledge accumulated in science education research and the experience of the authors of this paper in several science teaching levels, allow us, tentatively, to consider ten perspectives that we may use to describe relevant evidences about teacher mediation. With these different perspectives

of mediation we can conceive a comprehensive theoretical framework and propose relevant tools for teachers to improve their teacher mediation. Below we explain briefly each perspective:

- The work really demanded from students: A task is the work demanded from students, that they must perform to reach, within a certain time, an answer to a question or other kind of request. A task with educational interest must give to students an acceptable control over their activity. Our focus is the work really demanded form students and not the task as previously planned by the teacher.
- Classroom talk**:** How classroom talk is considered. Leach and Scott (2003) propose two dimensions to analyse the classroom talk (authoritative/dialogic and interactive/non-interactive). We should look for aspects like: i) communicative approach; ii) patterns of interaction (Scott, Mortimer & Aguiar, 2006).
- Support and authority given to students: How the student's work occurs in classroom. The student work depends on the type of support given by the teacher and the authority awarded to students (Engle & Conant, 2002). We consider aspects like: type of teacher support; class organization; patterns of student work; authority given to students.
- Scientific and technological contexts: This concerns how the contexts and physical situations are taken into account, namely if problem solving is based in real-life contexts and if tasks are authentic (Hill & Smith, 2005). We consider aspects like: the types of situations that are used to work concepts, laws and principles; how the situations are modelled and exploited.
- Epistemic practices: This concerns the student work in certain type of practices to construct scientific knowledge having as reference the scientific practices in the context of scientific production. This characterization uses epistemological foundations that arise from the analysis of scientific production in enlarged context (Kelly & Crawford, 1997; Kelly & Chen, 1999; Kelly, Brown, & Crawford, 2000; Reveles, Cordova, & Kelly, 2004).
- Information: How the information is presented, used and processed.
- Productive disciplinary engagement (Engle & Conant, 2002). Look for engagement, disciplinary subjects, and learning outcomes achieved
- Assessment and feedback: Whatever the kind of task performed (assignments, classroom questions, self-evaluation tests, etc), it is very important that students get proper and timely feedback on their learning outcomes. This feedback works both ways: teachers get relevant information about their students' learning evolution and students get useful (and timely) information about their own personal achievements. Another important aspect of teacher mediation is the quality of assessment. The assessment of learning outcomes, performed on a regular basis, must provide relevant results concerning the learning outcomes on both the competences developed and the concepts learnt.
- Learning induced: In terms of how students' learning can be extended outside the classroom.
- Teacher awareness and real-time decision-making in the classroom.

Research methods and instruments

Analytical approach

Our analytical approach has the following four levels: i) Dimensions of teacher mediation, that correspond to the perspectives presented in section "theoretical approach". Each teacher mediation dimension allows us to look to the teacher mediation as a whole, but searching for a specific type of evidences. ii) Emergent categories, identified by using open coding in a preliminary analysis of the data. The dimensions of teacher mediation only guide the analysis. In this phase of analysis we find some categories that emerge from the data. iii) Qualitative data analysis using the mediation dimensions and the emergent categories. Using some qualitative analysis software we can extend the preliminary analysis to a larger amount of data, in order to refine the emergent categories. iv) Quantitative data analysis.

In this paper, we will deal only with one perspective to face the teacher mediation and use the first

two levels of analysis referred above. In particular we use only the analytical dimension "The work really demanded from students" analysing it in levels i) and ii).

We will now present our rational for searching evidences in the data concerning the dimension "The work really demanded from students". We believe that each task may be analysed regarding the following aspects: i) type of requests and their sequence; ii) type of answer asked; iii) way of presentation; iv) resources available; v) how a physics situation is presented. In fact, depending on some class circumstances the work really demanded to students may be quite different from the task previously conceived or used by teacher. A task has educational interest, as the research about learning shows, because activity is important for learning and it is through it that the students can direct their attention to what they must learn and do (Bot, Gossiaux, Rauch, & Tabiou, 2005; Laws, 1997). Every task with educational interest must give to students an acceptable control over their activity. A task as the real work demanded to students has four general educational goals relevant for science education. The first and most obvious is providing a real student activity in the classroom. Second goal: only through a set of carefully chosen tasks it is possible to induce the development of the intended students' competences. A competence is developed through action that mobilizes knowledge (Kirschner, Van Vilsteren, Hummel, & Wigman, 1997). Third goal: through the students' activity, demanded by a task, the teacher can access what and how students know about an issue. This is a condition for the teacher to do an adequate mediation. Fourth goal: the tasks can be a reference for students to develop an autonomous work. With the tasks proposed, if they are relevant, the students may know what they must study. In spite of those tasks' general educational goals, there are obviously specific goals for each particular task.

"Account": An instrument for collecting data

As we explain above, our definition of teacher mediation has six components (see also table 1). For each component we collect several kinds of data. As we can see in table 1, the accounts are a transversal data source to report the relationship between a teacher's action and language and students' learning demand and development pathways.

An account (an instrument based on Mason, 2002) is a story, with a narrative thread, complete and self-contained, genuine and descriptive, with the minimum of interpretation possible. It is, however, a true history and this can be asserted by a third party through the analysis of the documents in which the account is based. These documents are: the audio recording of the lesson (indispensable as a register because of the limitations of teacher's memory, as well as to document the time); documents produced by the students (such as their notebooks) and documents about the tasks given by the teacher. An account has also multimodal elements, for instance, schemes and sketches made on the blackboard, the spatial organization of the classroom, the students' reactions, reproduction of dialogues excerpts, indication of silences, etc. These elements should appear when they are significant to the story. As the focus of the account is the teacher mediation, the focus of it reports is what the teacher and the students do with a proposed task. So, the account lets you know, even if you are not in the classroom, what happens and how it happens.

Table 1. Data sources for each mediation components.

Mediation components	Data source
Action	Accounts + Documents (students' notebook, tasks' sheet …)
Language	Audiotapes + accounts
Students' learning demand	Audiotapes + accounts + dynamic list of questions + students' auto-evaluation of their competences for accomplish similar tasks.
Students' development pathways	Accounts + dynamic list of questions + students' auto-evaluation of their competences for accomplish similar tasks + students' portfolio
Curriculum intentions	Curricular official documents + teacher documents
Learning outcomes	Concept and competencies Tests

An account has the following structure:

First part: a general description of the lesson and its contextual elements.

Second part: specific episodes (mentioning start and end times). Each episode begins with the presentation of a task, problem or challenge and ends with the completion of the task or, in some cases, the teacher may terminate the task before it is completed.

In summary, an account of teacher mediation is a multimodal narrative of what happens in the science classroom from the perspective of the teacher. The accounts used in our analysis have the main characteristics presented in table 2.

Table 2. Main characteristics of some episodes of the four accounts used in this research.

Episodes identification	Extension / time elapsed	Disciplinary Subject	Specific scenario
Teacher A Account 1 1st episode	285 text lines 33min: 46 s	Chemistry 8th grade: Acid–base reactions	Teacher uses the context of acid rain. The episode begins with the presentation of an image with dead fish floating in a lake. Students are asked to observe the picture. Teacher starts questioning students about causes of the phenomenon. After the initial discussion, based upon the observation of the picture, teacher distributes five questions in identical strips of paper, to the different groups. After students wrote the answers to the questions they present them to their classroom mates.
Teacher A Account 2 1st episode	354 text lines 33min: 41s	Chemistry 8th grade Acid-base reactions	This episode begins with the review of some concepts and results of previews tasks (previous lesson). There was a discussion about the natural acidity of rain caused by the presence of carbon dioxide in the atmosphere. Then teacher distributes to the different groups strips of paper with a picture of the water cycle and sources of pollution. The students have to identify the sources of pollution that cause the increase of acidity in the rain. Then students have to write the chemical word equations that translate the reactions that lead to the formation of the acid solutions in the atmosphere. Teacher supports the work in the different groups.
Teacher B Account 1 1st episode	119 lines 10min	Energy	The episode starts with the teacher asking the students to focus their attention in energy.
2nd episode	310 lines 24min;	System, energy source and receptor and energy transfer.	In this episode, the teacher defines the following concepts: system, energy source and receptor and energy transfer.
Teacher B Account 2 1st episode	71 lines 14min	System, energy source and receptor and energy transfer	The teacher started this episode by telling the students that they are going to talk about renewable and non-renewable sources of energy.
2nd episode	376 lines 31 min	Renewable non-renewable energy sources	The teacher questioned the students about this theme and presented the subject matter, with a Powerpoint presentation with elucidating examples. The teacher also informs students about the advantages of using renewable energy sources and the disadvantages of using non-renewable energy sources.

Method of analysis

The preliminary analysis of the data, to find the emergent categories, was made based on four accounts by two teachers (two lessons from each teacher). The accounts were validated by the analysis of other researchers, taking into consideration the audio recordings and the other available data for each lesson

The analysis was done in four steps, taking into account that we want categories to emerge instead of doing an analysis based in pre-existing categories:

First. In these accounts, we selected all the parts that were about the work really demanded

from the students.

Second. We analysed each one of these parts of the accounts, to search evidences considering the following aspects (as explained in the previous section: analytical approach):

- Type of request/sequence of actions and requests by the teacher: we searched for and made explicit all questions/requests made by the teacher to students, in a sequential way, for each episode.
- Type of answer asked: taking into consideration the requests made by the teacher (and made explicit in point 1), we selected from the account the answers given by the students.
- Way of presentation: we analysed in the account the articulation between aspects 1 and 2, and we verified exactly the way the work requested by the teacher was presented to students.
- Resources available: based on the account, and taking into consideration the previous steps, we verified if the available resources allowed (or not) the students to achieve the requested answer.
- How a physical situation is presented: We identified the physics situations relative to the proposed tasks, which are in the account, and analysed how the physics situations were presented.
- With this analysis we produced a sequential list of evidences of the data in a form similar to the one presented in table 4.

Third. We analysed the evidences produced in the second step in order to see what categories emerge in the teacher mediation dimension "The work really demanded from the students".

Forth. We verified if the emergent categories were operative for all the episodes.

These four steps were always carried out independently by two researchers and then verified by the research team.

Preliminary results

Emergent categories

Following the method of analysis described previously, we find in the four accounts that the work really demanded in class depends on the type of task really requested and on the conditions that change the demanded work. In table 3 we show what categories emerge from the referred two aspects (that we call sub-dimensions in table 3). The categories identified are strongly dependent on the teaching practices reported in the four accounts. For example, we know that one condition that may change the requested work is an explicit and pertinent propose or student demand. In our data, however, we did not find these conditions.

Table 3. Categories emerged from data.

Dimension	Sub-Dimension	Category emerged
The work really demanded from the students	Type of task really requested	Set of actions to respond to a question (T-Ac→Q)
		Use of information to respond to a question (T-I→Q)
		Observation (T-O)
		Answers to successive questions from the teacher (T-Q→A)
		Follow the reasoning and the information from the teacher (T-At)
	Conditions that change the requested work	Task is totally revealed at the beginning (C-TR)
		Task reformulated in agreement with the answers/behaviour of the students: •Behaviour (C-R-B); •Answers (disciplinary engagement) (C-R-DE)
		Transforming the task: Nature of the requested work (C-T-NW); •Induces in mistake (C-T-I); •A different question from the initial (C-T-DQ)
		Resources do allow students to accomplish the requested task (C-Re)
		The answer obtained by some students is worked by the whole class. (C-A-C)
		Explicit the type of the product (For example: An oral answer, individual answer, written answer, etc.) (C-EP)

How the categories emerged from data

Table 4 shows how we make the analysis to obtain the emergent categories elucidating in particular the second and third phases of the method of analysis presented in section 4.2. In the first column we present a description of the data from the accounts, pointing out the action and requests by the teacher, the answers asked, way of presentation and resources. In the second column we show the acronyms of the emergent categories.

Table 4. Example of how we extract the emergent categories (the acronyms are described in table 3).

Evidences of the data from the accounts	Categorization
Type of request / sequence of actions and requests by the teacher: The teacher asked the students to observe an image with dead fish floating in a lake. The teacher says that what is in the picture is a phenomenon that the students have studied in science and she asked if they know what it is. 1 - "But this pollution has a specific name...that causes acidity... from the waters?!" 2 - "is the acid rain formed? Anybody knows?" 3 -"More… Anybody knows more things about the subject?" The teacher distributes the questions in strips of paper, to the different groups. 4 - "So, you already have listened so much about the subject ... Are you already in condition to answer these questions …" "You copy them to the notebook that you have... copy to the notebook" 5 - As you were so excited to talk about the subject… you know perfectly the answer to what is there. Collective correction: 6 -"So, Bruno is going to say what is the effect of acid rain in a living organism, based on the opinion of his group. We are all going to listen to the groups and if there are different things to add... will be add them in the end" 7 - Can someone give a reason for them [the plants] to become infertile? [This comes from an answer given by a student]	T O T- I→Q C-TR C-R-DE C-A-C
Way of presentation: There is a real task. But the task is presented at different moments. So, it is presented gradually along the lesson. There are open questions that are not of immediate answer but the teacher accepts that the students given immediate answers. For instance:: T- "How is the acid rain formed?" Anybody knows?" S- "Through carbon dioxide" S- "The gas emitted by automobiles and industries going into the atmosphere and in contact with the water, acidifies it and then it precipitates." T-"More… Anybody more knows more things about the subject?" When the teacher is requested by the groups, she tries do not gives the answers.	C-T-NW
Resources available: Image on paper; written questionnaire.	C-Re
Type of obtained answer: The students started to give the answer immediately after observing the image, without waiting for their turn. The student's answers: Answer to the first demand - S1- "Pollution." S2- "Aquatic." S3- "Acid rain; acidification; pollution of rivers; acidification of aquifers. Answer to request 5 - S5- "The gas emitted by automobiles and industries going into the atmosphere and in contact with the water, acidifies it and then it precipitates." Answer to request 6 - S6- "The acid rain, by polluting the soils, makes them infertile, hindering the development of plants."	C-EP
How a physics situation is presented: Image with dead fish floating in a lake. Observation of the phenomenon.	

It is important to find the categories about "the work really demanded from the students" to characterize the teacher mediation in this perspective. Even more important is to recognize that the type and sequence of categories identified in a teacher account allows us to put in evidence the dy-

namic created in the classroom by the type of task really requested and the conditions that change the requested work to the students.

For example, in the episode described in table 4 we can recognize a certain dynamic that depends not just from the task itself, but from the work really demanded and the conditions that can change it. As we can see, during the presentation of the task the teacher does not make clear what is expected from students and only later do they have the exact notion of what they need to do to accomplish the task. Thus, the requested work is changed by the fact that it is not clear from the beginning what kind of product is expected in the end of the task. There is a real task that students must accomplish, however this will be presented bit by bit to students at different times during this episode (Task is not totally revealed at the beginning (C-TR)). So, in these circumstances the students have not the control of what they must do because the task is not totally revealed at the beginning. The task of observation (T-O) of the picture with the dead fish floating in a lake is presented to the students without specifying the objectives or the purpose for which they should do it. During the discussion about the phenomenon that had caused the death of the fishes in lake, students presented several oral responses and, by the moment teacher delivers them the strips of paper with the questions, the answers had been fully disclosed in the initial dialogue. Thus, the work required from students has changed since the task was not totally revealed at the beginning (C-TR). Also in this episode, when the teacher asks about the process of formation of the acid rain, the students begin to present immediate responses. By accepting the immediate answers of students to the initial question, the initial character of the task will change completely the nature of task (the nature of the requested work (C-T-NW) change from open question to closed question). Since the students are only required to provide oral and immediate answers, at this point students know what is expected for them (C-EP). However, an important aspect revealed in the episode was the fact that the answers obtained by some students are worked by the whole class (C-A-C) when they are trying to explain how the acid rain is formed in the atmosphere. At the end of the task presented on the strips of paper, depending on what students were writing in their notebooks as they went along and presented their group responses to the class, they would be amended and supplemented by all. Thus, the work request to students changes according to their involvement during the presentation of the answers by the different groups (C-R-DE). In this episode, the resources provided to students allow them to perform the work requested (C-Re).

Discussion

The data and results presented here come from the context of secondary school. Of course, teacher mediation can not be completely faced, theoretically and/or empirically, taking into account only one perspective of teacher mediation. Finally, we use only four accounts in two levels of analysis. In spite of these constraints, we have a new approach to consider the teacher mediation. Our approach has two essential components. One is the account of what happens in science classrooms that allows us to preserve the teacher mediation as a phenomenon that happens in the science classroom from the perspective of the teacher. The other is the theoretical framework that allows us to analyse and propose tools.

As we see in the results, the type of work really demand in the science classroom can be sensibly different from the initial teacher intentions. In particular, the conditions that change the requested work may be crucial. For example, if the teacher wants her students to have some control over the work that they do, it is essential that task is totally revealed at the beginning. Another example is the students' natural tendency to answer immediately to any question, which can be avoided if the teacher allows time for reflection to obtain a deeper answer to an open question. What our results show is that from an account (a teacher perspective of teacher mediation in classroom) it is possible to find several conditions that influence the really work demanded from students. The awareness, by the teachers, of these conditions in their own practice can be a powerful way for teachers to improve teacher mediation and, more generally, to base their professional development.

The perspective used showed to be heuristically useful in analysing teacher mediation. Several categories and subcategories emerged. We consider that we have obtained rich data and results. We also consider that our theoretical and methodological framework allowed us to obtain them in a

relatively simple and straightforward way.

Thus, in spite of the preliminary status of the results obtained, we claim that our approach has successfully resisted a significant test. Thus, we sustain that we are approaching teacher mediation in a productive way that will allow us to propose an innovative framework that is theoretically well grounded, contains appropriate research methods and instruments, and will produce comprehensive tools for improving teachers' practices.

One fundamental claim of our research is that a teacher can improve systematically his/her teaching quality by learning from his/her mediation practice. We consider that our preliminary results sustain that claim and that we have a grounded basis to proceed the research in a way that will provide tools to teachers, to guide their choices in identifying critical aspects for teaching practice that are more adequate to the objectives set by the teacher and/or the official curriculum, namely the expectable learning outcomes.

- This paper deals only with a sample of data, contexts, and analytical levels and perspectives. Here is an overview of how our work will proceed:
- The data and results presented come from the context of secondary school. We have data from four other contexts: 1st year Physics in an Polytechnic school of Engineering; 1st year Physics in a University undergraduate program en Food Science; 1st year Physical Sciences in an undergraduate program in Teacher Education (for grades 6-9); 1st year Chemistry in a University undergraduate program in Applied Ecology.
- We will thus deal with a total of five contexts. For each one, we will have about ten accounts. Thus, we will have a total of more than fifty accounts.
- In this paper, we dealt with only two levels, from a set of four. Our work will proceed on the two last ones referred in sub-section "analytical approach".
- In this paper, we dealt with only one perspective. Our work will proceed on the other nine ones, referred in section "theoretical approach".
- In future we will propose a tool to teachers improve their teacher mediation based on the accounts and the emergent categories.

With the extensions and developments referred above, the research will proceed with the goal of proposing an innovative framework that is theoretically well grounded, contains appropriate research methods and instruments, and will produce comprehensive tools for teachers' practices.

Conclusions

Directly from our preliminary results about the dimension "The work really demanded from students" we can point out three main conclusions:

Every task with educational interest must give to students an acceptable control over their activity and they must know exactly what they need to do to achieve an answer or solution. The task must be revealed from the beginning to students, because if they do not understand what is expected from them, they can not be independent in their activities and they can't have disciplinary engagement. The teacher needs to make clear, from the beginning, what the purposes of the task are and what is expected from students to produce. If the task is presented at different moments, gradually along the lesson, students could feel that what is expected for them changes constantly and they can not go on doing their work without calling for the teacher's help.

It is also essential that students have access to the contextual meaning of the task. If the teacher presents the task by using a language that students do not understand, their immediate actions are not those expected by the teacher. In this way, the work really demanded to students and the work that they effectively accomplish is, to a certain extent, different and diverges from teacher's intentions when he/she proposes the task.

When the teacher presents an open question it is important to avoid students' natural tendency to answer immediately, because by doing that, the nature of the requested work is changed and students do not have the necessary time to obtain a deeper answer. This seems to be a critical issue and the teacher needs to guide students to think and reflect upon the answers in a deeper way, pro-

viding time for reflection, inviting students to write first their ideas and allowing them to produce disciplinary engagement.

From our theoretical framework to analyse the teacher mediation and its use to deal with data we point out three general conclusions:

The reported theoretical and methodological frameworks have been encouragingly tested and led to interesting preliminary results.

Those frameworks may be useful to researchers that intend to work out problems and goals in similar scopes.

We have reasons to sustain that we will proceed with our research in a productive way that will allow us to attain our goals.

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