

How the discourse of new professors is made up in the classroom¹

Anderson Cezar Lobato²
Ana Luiza de Quadros²

Abstract

Although schools are inserted within a dynamic social context surrounded by technologies, many secondary education science and chemistry professors still adopt the information transmission/reception model. This study was conducted in order to analyze changes in the discourse and understanding of the professor's role in the classroom based on the professors' experience in a teaching immersion project focused on the planning and teaching of theme-based classes and sharing of the researcher's evaluation of the classes. To this end, we analyzed the classes taught by two professors undergoing professor training in the said project. Data collection was performed through class video recording and semi-structured interviews. Data analysis was based mainly on the professors' discourse and their capacity to involve the students in the class dynamics. We observed that involvement with theme-based classes was important to the participating professors. In addition, evaluation sharing showed to be fundamental for improving the professors' understanding of their role in the classroom. The data collected lead us to believe that the improvement achieved will reflect on the practice of the professors-to-be.

Keywords

Professor training – Teaching practice immersion – Classroom professor discourse – Science/Chemistry.

Introduction

At present, schools are inserted into a more dynamic social context and more and more surrounded by technologies in comparison to a few decades ago (PRETTO, 2013). Our experience at school has shown that some education methods and techniques are still the same as those used a few decades ago, that is, the classes continue to be centered on the professor as a detainer of information.

Improving education as a whole requires a more focused look on what happens in the classroom and on the professors' actions. Despite acknowledging that improvement

1- The authors acknowledge support from Fundação de Amparo a Pesquisa de Minas Gerais (Fapemig).

2- Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brasil.

Contacts: quimicoufmg@yahoo.com.br; aquadros@qui.ufmg.br

DOI: <http://dx.doi.org/10.1590/S1678-4634201709162258>

depends on multiple actions, we are aware that the discursive action of the professors is a key element to produce changes in the classroom. As classroom interaction increases, so does the possibility of constructing meanings for what is taught (MORTIMER; SCOTT, 2002).

Considering the importance of the role of professors in the construction of meanings, we will look into the early training of chemistry professors. Our experience shows that the practice of many newly graduated professors is very often not grounded on teaching theories learned in the early professor training courses. Some newly graduated professors end up adopting a practice style based on the transmission/reception of information.

The issues that guide this work are: does the understanding of the professor's role undergo any change after professors join an immersion teaching training program that might reflect on the construction of the professor's practice? Does the discourse used by professors promote the discussion of different points of view? How do professors justify decision making in the complex environment that a classroom is?

Theoretical Framework

Some studies (DRIVER; NEWTON; OSBORNE, 2000; POLMAN; PEA, 2001; ELMESKY; TOBIN, 2005; among others) illustrate the interest in the inquiry into learning environments that favor the participation of students and give them chances to express their ideas in debates and to discuss their different points of view. Studies in science education have investigated issues related to language and interactions between subjects in relation to the construction of knowledge in general and of scientific thought.

For Mortimer (1994), science explains world phenomena and its language is loaded with concepts that are new to the students. Studies in science education (CAPECCHI; OAK; SILVA, 2002; SCOTT; ASOKO; LEACH, 2007; MORTIMER; SCOTT, 2002; FREITAS, 2002; JIMÉNEZ-ALEIXANDRE; ERDURAN, 2007; DRIVER et al., 1999) approach the role of social interaction in the development of meanings and how this interaction is mediated by language. The discursive interactions that occur in classroom have been seen as a possible way to extend the construction of meanings.

Keeping the specificity of the study conducted in mind, we based our analysis on: a) contributions from Vygotsky and Bakhtin, b) language and discursive interaction studies, c) class analysis methods proposed by Mortimer and Scott, and d) reflection on the professor training process.

a) Vygotsky's and Bakhtin's contributions: a brief look

The centrality attributed to language as a mediator of the social constitution of the human conscience is a point in common to studies by both Vygotsky and Bakhtin. According to Vygotsky and Bakhtin, the subject is constituted when immersed in the social environment. When scientific concepts are explained in the classroom using words, the abstractions are assimilated by the minds of those who learn them. Vygotsky (2001) deals with the meaning of "negotiation" process. He sees the classroom as a privileged space where the negotiation of meanings can take place. This premise is based on the notion that the learner has meanings for the concepts constructed in everyday life or at a stage

earlier to school that constantly need to be reelaborated in the school space. The culture that allows the creation of meanings is, according to Vygotsky, a kind of “negotiation floor” where meanings are constantly recreated and reinterpreted.

The different cultural perspectives can be discussed in the social plan after the dialogic environment has been established in the classroom. When the learner makes contact with these different perspectives, the learner may become aware of the limitations of his or her own explanations and appropriate a new explanation.

For Bakhtin (2003), meaning is constructed at the encounter and the confrontation of different voices expressed in the dialogic act. The understanding of the meanings that the subjects produce based on their experiences requires a contextualized analysis of the enunciations produced and of the reaction that such enunciations provoke in the other subjects.

Bakhtin considers dialogue a relationship that occurs between interlocutors in a social action in a specific space and time. The word, therefore, gains new meanings according to the context where verbal interactions occur.

The centrality attributed to language as a mediator of social constitution of the human conscience is a point in common in the studies by both Vygotsky and Bakhtin. According to Vygotsky and Bakhtin, the subject is constituted when immersed in the social environment. As a result of the studies by Vygotsky, Bakhtin and other equally important researchers that belong to the Constructivist line of thought, the attention in the classroom is driven to the students. In Vygotsky’s and Bakhtin’s perspective, the student becomes an active subject in the classroom dynamics.

b) Studies on language and discursive interactions

Important studies have considered the classroom as a dynamic environment in what concerns the interactions between the students and the professor and between the students themselves. Relevant investigations have been conducted about language in science classrooms. One of such studies (GALAGOVSKY; BONÁN; ADÚRIZ BRAVO, 1998) pointed out the fact that the professor does not consider himself or herself a communicator, and, because of this, he or she does not exploit discourse in the classroom properly. The language used to inform sometimes tends to be a void discourse. In another study, Seah (2016) analyzed the relationships between the students’ written explanations and the class content and the professors’ expectations in respect to these explanations. Since the students rarely met the professors’ expectations and the explanations constructed by the students did not reflect the content worked in the classroom, this author suggests that the conceptual focus used in the classes does not suffice to promote the construction of meanings. Tan (2011) looked into the beliefs of professors from Malaysia and how they influence pedagogical practices in the classroom. According to him, when the professors assumed the role of knowledge transmitters, they limited the students’ learning opportunities. He also points out that mandatory curriculum items, exam pressure and time restrictions also shaped classroom interactions. Both Seah (2016) and Tan (2011) pointed out the need to lend support to professors so that their teaching can be more effective and the use of discourse and language becomes relevant.

More specific investigations involving discursive interactions and, more precisely, discourse analysis, have been carried out. Candela (1999) states that students gradually appropriate new forms of expressing themselves and become more independent and confident as discursive practices are stimulated in science classes. This author presents a tool for the analysis of students' questions that classifies them as clarification or extension questions, extrapolation questions and contestation questions.

Buty and Plantin (2009) analyzed the capacity of elaborating arguments as evidence of learning in science and proposed teaching characterized by social interaction between the subjects. Buty, Badreddine and Régnier (2012) proposed the analysis of discourse based on the epistemological aspects of the discourse, the form that such representations are used, the type of discursive interactions and the forms of engagement of the actors in the situation.

Other studies worthy of mentioning are Lemke (1990), Martins, Ogborn and Kress (1999), Driver, Newton and Osborne (2000), Nascimento and Vieira (2009), Sasseron and Carvalho (2008), Roth (2003), Jiménez-Aleixandre, Bugallo Rodríguez and Duschl (2000). In the present study, we will apply the analysis of discursive interactions proposed by Mortimer and Scott (2002; 2003), which is presented in the next topic.

c) Discursive interaction analysis proposed by Mortimer and Scott

Based on the studies by Bakhtin and Vygotsky on classroom interactions, Mortimer and Scott (2003) proposed a method of analysis of verbal discourses that take place in the classroom. According to them, this tool can be both useful in the analysis of discursive processes and help in science class planning. They group five aspects of the analytical tool under: teaching focuses, type of approach and actions. Those five aspects deal with the professor's role and are represented in Chart 1.

Chart 1 - Aspects of Mortimer and Scott's analytical tool

Analysis Aspect	
i. Teaching focuses	1. Professor's intentions 2. Content
ii. Approach	3. Communicative approach
iii. Actions	4. Interaction patterns 5. Professor's interventions

Source: Mortimer and Scott (2002, p. 285)

In our analysis, we adopted the communicative approach and the interaction patterns, which we describe in detail below.

The communicative approach “affords a perspective of how the professor works on [his or her] intentions and the content to be taught by means of different pedagogical interventions

that result in different patterns of interaction” (MORTIMER; SCOTT, 2002, p. 287). When the discourse is analyzed and classified as proposed by the authors, the professor’s intentions become explicit, particularly regarding the students’ role and the class content.

Mortimer and Scott (2003) proposed two dimensions of analysis of discourse. In the first dimension, they considered the participation or not of the students in the discourse. The class can be classified as being interactive (the professor asks the students questions and gives the students time to answer) or non-interactive (only the professor speaks or allows peripheral participation of the students). The second dimension involves the points of view to be considered. When the professor considers the students’ ideas, taking into account their individual points of view, the discourse is dialogical. When the professor considers what the students have to say only from the scientific viewpoint, then the discourse is authoritarian.

The combination of these two dimensions results in four discourse classes:

- *Interactive/dialogic*: professor and students exploit the ideas and formulate questions. Additionally, they present, consider and work on the points of view together;
- *Non-interactive/dialogic*: the professor reconsiders various points of view in his discourse, pointing out similarities and differences. However, only the professor speaks.
- *Interactive/authoritarian*: the professor introduces the class dynamics to the students through elicitation and by allowing the presentation of diverging ideas. However, only the ideas that are close or similar to the scientific point of view are considered.
- *Non-interactive/authoritarian*: the professor presents the scientific point of view and does not allow or give the students time to participate.

Interaction patterns gradually immerse when the professor and students take turns speaking in the classroom. The authors identified different patterns of interaction and classified them using letters, which formed a pattern. Thus, I-R-E corresponds to Initiation (I), Response (R) and Evaluation (E). In these cases, the professor usually initiates, after which the student responds and the professor then evaluates. More complex patterns can be formed and other letters are used to describe them: (F) professor’s feedback and (C) for continuation or further elaboration by the student, resulting in sequences like I-R-C-R-C and I-R-F-R-F. Interventions are the ways through which the professor facilitates the construction of knowledge in the classroom, which may involve, for example, checking the students’ understanding, sharing new meanings, selecting and shaping meanings. In this perspective, interaction patterns are perceived as an important dimension of discursive categories within a certain social sphere.

d) The initiatives used in the classroom

Considering the three-element patterns of interaction, Mehan (1979) proposed four types of initiation, namely: choice elicitation, product elicitation, process elicitation and metaprocess elicitation. We consider that the type of initiation or elicitation made by the professor or the students has a major influence in the duration and nature of the responses and the professors’ potential to generate interaction chains through feedback or continuation.

In the description of choice elicitation, Mehan (1979, p. 43) states that choice elicitation “demands that the respondent agrees or disagrees with a statement made by the elicitor”. Product elicitation “requires that the respondent give a factual response such as a name, a place, a date, a color” (Mehan, 1979, p. 44). Now, process elicitation “requires the respondent’s opinion or interpretation” (MEHAN, 1979, p. 45) and, finally, metaprocess elicitation “requires that the students reflect on the process of making connections between elicitations and responses”. These elicitations are called metaprocesses because they require students to elaborate on the basis of their own thoughts” (MEHAN, 1979, p. 46).

An elicitation that requires a choice or a product (MEHAN, 1979) tends to produce short one-word responses, while questions that require a process description or explanation tend to elicit full utterances or produce a chain of more complex interactions.

e) Reflection as an educational process

Reflection seems to be an innate quality of human beings. The notion of reflective professor possibly has its origins in John Dewey’s work from the first half of the last century. However, it was Stenhouse (1975, 1981) and Schön (1983, 1987) who elaborated the concepts of reflective and investigative professor and their use in the professor training context.

Donald Schön’s (1983, 1987) work represents a cornerstone in the current understanding of reflection. His ideas have influenced and still influence the field of education, particularly professor training. Schön dealt with reflection in action, reflection on action and reflection on reflection in action. The first type of reflection occurs during practice, while the second type takes place after the practice, when the practice is revised. Now, the reflection on reflection in action takes into account orientation towards future actions seeking to identify the problems and guide actions for improvement.

The reflective and investigating professor movements arrived in Brazil mainly through the works organized by Antonio Nóvoa (1992) entitled *Professors and Professor Training*. Nóvoa (1992, 1997) is one of the representatives of the reflective practice focused on professor training.

Zeichner (2008) stated to have worked aiming at the training of professors who reflected more on their practice. According to him, the publication of Schön’s (1983) work and the term “reflective teaching”

[...]quickly became buzz words adopted by professor educators from the most varied political and ideological approaches to justify what they did in their programs, and, after some time, its meaning started to lose specificity (ZEICHNER, 2008, p. 538).

In the face of these different versions of the concept of “reflective teaching” and of the various strategies used to promote this kind of teaching, a more specific and categorical criticism became part of the discussions on reflection: that the focus was driven to the individual reflection of the professors rather than teaching social context. The professors were led to consider that the teaching problems were exclusively theirs (to be solved by

reflection). In spite of that, the training of reflective professors has been supported by various authors, such as Kemmis (1985) and Zeichnerhner (1993), who deal with reflection as a catalyst of better practices.

In our understanding, the moments of reflection on practice allow the identification of the conceptions of the roles of professors and students, and lastly, of everything that happens in the classroom. According to Oliveira and Serrazina (2002), the reflective process is characterized by a permanent movement between happening and understanding in order to lend meaning to the experiences. As understanding of the practice improves, there may be insights into what it means to be a professor.

Alarcão (1996) stated that when we think about professor training, the reflection is directly related to dialogue: with oneself, with others - including those who built knowledge before us and are a reference - and with the very situation.

Even though not expecting that reflection be sufficient to improve professors' actions, we believe that it is always an important prerequisite. Our experience in higher education and research on the action of professors at this level of education has shown us that a professor who does not reflect on his or her practice, limiting the idea of reflection to the concepts discussed here, tends to repeat what he or she does, even when the results are not satisfactory. When the teaching practice produces few positive learning results, the professor tends to blame someone else, that is, the student.

For the professor to practice reflecting on what he or she does and what happens in the classroom, we believe that it is advisable to insert them in the dialogue with the teaching situation that he or she experienced with the others (in this case, both professor trainers and professor training classmates) and with him or herself. The initial training courses are a privileged time/space for this to happen.

We used this theoretical framework as a reference in an attempt to find evidence to help us understand how classroom discourse takes place with in-training professors.

Method

We adopted a qualitative perspective to investigate the construction of discourse in the classrooms of in-training professors in a teaching initiation project that stimulated the valuation of the student in the classroom. To further clarify how this investigation was conducted, we first describe the project that it involved and then the work steps.

a) Teaching immersion project

The teaching immersion project involved a total of 15 in-training student teachers, three elementary education professors and a coordinator from the professor training institution, all of who were recipients of Capes scholarships. The project introduced the in-training student teachers to teaching by means of courses offered to the partner schools. The courses were offered at a time different from that of the students generally in multilevel classes organized by the schools. The courses were not formally linked to the regular school curriculum and course enrollment and participation were voluntary.

The course was organized based on topics of interest in the area of chemistry and on the students' interests. This course organization was chosen based on the need of science teaching to contribute to the integral education of students, to the development of critical sense and of the capacity to understand and discuss everyday life concrete situations and phenomena. This approach was based on the assumptions of the STS (Science, Technology and Society) movement.

Four-hour weekly meetings were held under the project in the school where the project was carried out for the proposal of themes and initial organization by a more restrict group. The themes were developed jointly to form a class sequence. The classes were taught in course format and videotaped for later analysis.

In the initial set of classes, some contemporary teaching and learning trends were already implicit (theme-based and interactive classes, dialogic discourse, and others). The in-training student teachers were instructed to elicit the students, to listen to their ideas and discuss them, thus making the classroom a space for the development of ideas.

The project coordinator(s) watched and evaluated the week's class video recordings and selected and shared relevant fragments with the group. The approaches, language, the types of discourse used in class that stood out and other important aspects from the video segments of each in-training student teacher were objects of lively reflection and discussion.

b) Investigation steps

b.1) Selection of the subjects

Classes from two in-training student teachers who participated in the project were selected based on the following criteria: no previous teaching experience and good in-class teaching performance.

These subjects were chosen after observation by the researcher during the two years that they participated in the project, and also based on the project coordinator observation/opinion. Thus, two in-training student teachers were chosen and given the fictitious names of Guilherme and Felipe.

Both in-training student teachers were still taking the teacher education course when their classes were video recorded, but they were enrolled in different school semesters. Guilherme was enrolled in the second semester of the chemistry teacher education course when he joined the project. Felipe was a senior student enrolled in the last semester of the course and left the project when he graduated. Therefore, when Felipe taught under the project and his classes were analyzed, he had already taken most of the set of teaching practice courses in the curriculum and had done the first compulsory class observation internship.

b.2) Class selection and analysis

To answer the first point of investigation of this study, (whether the understanding of the role of teachers training changed and whether it affected teaching practice after

the participant had joined the project) we analyzed the professor's and students' talking time, the interaction pattern, the communicative approach and the types of elicitations that the professor made in the beginning of his teaching practice and after some time taking part in the project. We labeled the class taught in the beginning of the project as Class A, and as Class B for the same class taught one year later by Guilherme, and after eight months by Felipe. Class A had only a class plan and instructions that mentioned including the students in the class dynamics, making elicitations, waiting for responses and conducting varied activities, in which some contemporary teaching tendencies were implicit. Class B, in turn, had a class plan and instructions as well, but also included the sharing of experiences, evaluation sharing and discussions/reflections on the professor's in-class action. Talking time was analyzed with software Videograph®.

The video recorded classes were transcribed for ease of analysis. Some characteristic marks of oral language, such as the use of "tô", reduced verb form for "estou" (to be), and "pra", reduced form of preposition "para" (to/for) were preserved in the Portuguese transcription because they were characteristic of the language used by the subjects investigated; however, these language marks could not be reproduced in their translation into English. Additionally, we have used brackets to indicate talk references. Some intonation elements were also considered and represented with question and exclamation marks appropriately. When we selected only a segment of a given talk, we used suspension marks between brackets to indicate the suppression of previous or subsequent segments accordingly. We acknowledge that interferences may have been made during transcription; however, we attempted to keep them minimal.

b.3) Interviews

To answer the second question of this investigation on how the professors justified their decision-making in the complex classroom environment, we used the data obtained in the class transcript analysis. We investigated the knowledge that the two in-training student teachers believed to have resorted to in their decision-making, and the advantages that they believed to have resulted from their actions.

Based on a semi-structured interview to enable the survey of subjective points, the interviews were conducted individually, video recorded and later transcribed for ease of analysis.

Results and discussion

Our results are divided into two main parts: class transcript analysis and interview analysis. We describe each one next.

Class transcript analysis

When we analyzed the transcripts of the classes from the beginning (Class A) and from the end of the teaching immersion project (Class B), we expected the teaching practice

to reflect any possible changes observed in the understanding of the professor’s role. In these class transcripts, we analyzed the categories: student talking time, interaction pattern, type of initiation and communicative approach as follows.

a) Student talking time

The professors had been instructed to articulate strategies that facilitated discursive interactions. For this, it is important to allow time for the students to organize and express their ideas in class. With the aid of software Videograph®, we analyzed the total talking times of each group of actors, professors and students, during each of the classes. The results are given in Table 1.

Table 1 - Professors’ and Students’ talking time in Classes A and B (Guilherme and Felipe).

Class	Professor	% of total time	
		Guilherme	Felipe
Class A	Professor	38.45	38.04
	Students	16.96	18.60
Class B	Professor	41.09	41.90
	Students	37.98	34.80

Source: Research data.

The professor and student talking times do not add up to 100% because of other class situations, such as setting up of experimental activities and dialogues unrelated to the class content. In Class B from both professors, we observed that talking turn taking must have increased, since the professor’s talking time increased slightly and the students’ talking time was significantly longer. Our video analysis showed that the professors elicited greater student participation and gave more opportunities for the students to organize their ideas and construct their explanations. This probably contributed to make them more at ease to participate in the in-class discussion.

b) Interaction Pattern

In Class A, the professors used I-R-E-type triadic patterns more frequently, while in Class B they adopted a more elaborate pattern. Example segments taken from Guilherme’s class transcripts are given in Chart 2.

Chart 2 - Example of interaction triadic pattern from Class A (Guilherme).

Turn	Interlocutors	Transcription
35	Professor	What do we have to absorb?
36	Student E	Pull
37	Professor	Pull, right?

Source: Research data.

Chart 3 - Example of interaction triadic pattern from Class B (Guilherme).

Turn	Interlocutors	Transcription
13	Professor	How long do you think it will stay? Explain it to us.
14	Student D	Because there is only one amount of oxygen inside there, it takes the oxygen and turns it into carbon dioxide and transforms the oxygen, then it has one hour.
15	Student C	No, the plant releases carbon dioxide.
16	Professor	Tell everyone what you have just said.
17	Student C	The plant also releases carbon dioxide because it breathes during the day.
18	Student D	But it releases a greater amount of oxygen than of carbon dioxide.
19	Student C	Yes, that's it.
20	Professor	OK, let's understand it better...

Source: Research data.

The example transcription in Chart 2 shows that Guilherme used direct elicitations, which resulted in short responses, which he immediately evaluated. In this example, we have an I-R-E interaction pattern. In Chart 3, the professor passed the turn to the students and gave room for ideas to come up, which were acknowledged by the professor. When student C (turn 15) talked, he spoke in a low voice and the professor asked him to repeat what he had said so that everyone could hear him (turn 16). This showed that the professor's attitude in Class B was different from that in Class A.

Classes A and B from both professors were very interactive. However, the discourse used in each class was very different in terms of the dialogic/authoritarian dimension. In Class A, dialogic discourse was practically inexistent. At some moments in Class B, the professors valued, exploited, articulated and discussed the students' ideas, and also led some students to even review their points of view when they realized that they were inadequate. We noticed that the type of discourse used by the professors was more interactive/authoritarian in Class A, while in Class B there were times when the students' points of view were considered and the class became more interactive/dialogic.

c) Types of initiation

The analysis of the types of initiation used by the professors was based on Mehan (1979). Initiations have a major influence on the duration and nature of the students' responses and their potential to generate interaction chains by means of feedback or continuation from the professor. Choice or product elicitation prompts short responses, almost always, generating I-R-E-type interactions. Initiations that require explaining processes or metaprocesses elicit more complete enunciations, leading to longer interactions between the class participants.

In this analysis, we considered the first 20 min of each class. As the total number of elicitations was different in the two classes, the numbers and percent frequencies of each type of initiation are given.

Table 2 - Types and frequency of elicitations in professor Guilherme’s Classes A and B.

Professor's types of elicitations	Frequency		Percentage	
	Class A	Class B	Class A	Class B
Choice	38	29	58.5%	50.9%
Product	20	7	30.8%	12.3%
Process	7	21	10.7%	36.8%
Metaprocess	0	0	0.0%	0.0%

Source: Research data.

Table 3 - Types and frequency of elicitations in Felipe’s Classes A and B.

Professor's types of elicitations	Frequency		Percentage	
	Class A	Class B	Class A	Class B
Choice	18	13	52.9%	32.5%
Product	11	15	32.3%	37.5%
Process	5	12	14.7%	30.0%
Metaprocess	0	1	0.0%	2.5%

Source: Research data.

Comparison of the in-training student teachers’ performance during the initial phase of the project and after some time had passed revealed important changes. Since the beginning, they had been instructed to seek student participation in class and to resort to numerous questions to stimulate it. However, as they got more involved in the project, they modified the types of elicitations they made.

To illustrate these elicitations, in Class A, Guilherme asked the students the following question: “where is charcoal used at home besides in barbecues?”, which is an example of a product elicitation. In Class B, he used initiations that required more elaborate responses, as for example: “If charcoal is used in filters with the function of cleaning water, how does it work?”.

The professors seemed to have perceived that the insertion of the student into the class dynamics also depended on the type of initiation that they used.

d) Communicative approach

Teaching practice implies the development of class management skills, and also requires the mobilization of different kinds of knowledge in situations that appear in that environment. At the beginning of their participation in the teaching initiation project, the professors tended to answer the students’ questions immediately. We have selected a segment illustrative of the two professors’ practice in the beginning of the project.

Table 4 - Felipe's answer to a student's question (Class A).

Turn	Interlocutors	Transcription
45	Student C	Like this, how am I going to know if it is the alcohol or the bottle that is absorbing [heat]?
46	Professor	Look, it's like this; your question is this: in the beginning of the class we talked about heat, what energy transfer from a body at a higher temperature to a body at lower temperature is. When we talk about liquids, including volatile liquids, they evaporate. Water on the ground evaporates. Both ground and tap water are at room temperature, but it evaporates, right? To evaporate, it absorbs energy and uses this energy to evaporate, in this case, thermal energy too. Then, the cold in here [inside the bottle] is the alcohol withdrawing energy from the bottle and the bottle withdrawing energy from my hand, right? [...]

Source: Research data.

Student C's question created an opportunity for discussion with the other students. We observed that the professor did not share the question with the other students and immediately answered it. Events like this were shared with the in-training student teachers during the in-group class analysis.

However, a change is noticeable in Class B. The questions that had been previously answered in Class A were shared and discussed with the class. We have selected a segment that illustrates this fact. When a student asked Felipe a question, Felipe seemed to be ready to give an explanation. However, he paused and shared the question that the student had asked (turn 151).

Table 5 - Felipe shared a student's question with the whole class (Class B).

Turn	Interlocutors	Transcription
151	Professor	Then, guys, let's tell everybody, let's explain to the whole class. Look, there's... what do you think about his explanation? Do I gain heat from the environment?
152	Student C	No.
153	Student F	Then mine is wrong.
154	Professor	No explanation is wrong. They are suppositions and we will check if the suppositions, yours, his, hers... is... which one is closer to the best accepted scientific one. This is what we're going to check here.

Source: Research data.

Classes A and B were both interactive. However, they differed in the use of dialogic discourse. We noticed that the approach that they used in Class A classes was closer to the interactive/authoritarian approach. However, in Class B classes there were several moments when the professors considered the students' points of view. When they constructed

explanations, the students produced more complete statements. Therefore, the approach used in Class B classes varied between interactive/authoritarian and interactive/dialogic.

It was already possible to notice changes in the professors' practice as the discourse used in Class B classes varied more than in Class A ones.

Did the understanding of the professor's role change?

As previously said, the two professors who participated in this investigation did not have any previous teaching experience and during practically their whole professor education they had experienced a practice more focused on transmission/reception of information. The data analysis showed that the professors' initial attitude towards the students' questions in the first classes was to answer without sharing the questions and discussing them with the other students. When their questions were answered, the professors tended to evaluate. By doing so, they gave the students fewer opportunities to think their own conceptions over and develop their own thinking.

Considering the importance of the professors' discourse in the construction of meanings, according to Mortimer and Scott (2003), we observed that in the initial classes (Class A), the professors used the interactive/authoritarian approach more often. In contrast, in Class B, which was taught after their participation in the project for some time, triadic interaction patterns were less frequent and the approach was more interactive/dialogic in many moments. The professors stimulated dialog in the classroom and allowed discussion of the students' points of view. They gave the students opportunity to express themselves and stimulated the elaboration and discussion of their ideas in class.

In relation to interactivity, we noticed that in the beginning of the project, because they had been instructed to stimulate the students' participation in class, the professors asked numerous questions, which made the class rather interactive. However, the questions were mostly choice and product type. As a consequence, the answers were short and usually evaluated by the professors. Now, in Class B of each professor, initiations that required process description, or explanation, were more frequent, which in turn elicited more complete responses from the students and led to greater interaction.

Regarding the aspects investigated in this study, our results show that changes in the student teachers' understanding of the professor's role can reflect positively on the construction of the teaching practice.

Evaluation sharing led to individual reflections which were shared, involving the teaching immersion project group as a whole. Sometimes these reflections made references to the theoretical material presented by the project coordinator. We believe that with these activities, the initial in-training student teachers experienced teaching practice in a richer and more motivating way, bringing theory and practice together.

Watching segments of their own classes was important for the professors to realize their tendencies and exercise reflecting on their own practice (SCHÖN, 1987). The meanings of teaching and of the professor's role for the two professors who participated in the project were gradually broadened as they had an opportunity to reflect on their own practice. The indissociability of theoretical knowledge and teaching practice seems to have

helped these professors to broaden their understanding of their role in the classroom. As they succeeded in making the students participate more in class, the in-training student teachers made initiations that required a greater effort from the students and contributed to the diversification of the discourse used.

Interview analysis

The semi-structured interview was prepared based on the shared analysis of the class video recordings. It also had questions that sought to clarify the professors' decision-making in class. Some aspects were pointed out by both professors: the indissociability of theory and practice, the professor as an observer of his or her own practice, the importance and influence of teaching initiation projects and the consolidation of their choice of teaching as their profession.

The poor integration observed between theory and practice in the early professor training and the perception of this relationship during the teaching initiation project were mentioned in the interviews. Guilherme joined the project when he was enrolled in the second semester of the initial professor training course. Therefore, at that point, he had not taken any course on teaching and learning. After taking one of such courses and after some time participating in the project, he commented:

I took courses like Didactics which I expected would teach me a lot of things for the classroom. However, it was only theory and no practice and I saw colleagues who did not understand what was under discussion there very well, exactly because they did not have classroom practice. (Guilherme)

When he described the difficulties that his colleagues had, Guilherme admitted that he did not relate the theoretical knowledge discussed in the course with the teaching practice he was already experiencing. In a certain way, he felt "different" in those classes because he participated in the project. This shows us that the in-training student teachers generally may fail to realize the relationship between the teaching practice program courses and the teaching practice itself.

The data collected in the class analysis showed that Guilherme and Felipe started to give the students more room to express themselves and promoted a class discourse that was more dialogic. When asked about what led them to make the class more dialogic, they pointed out evaluation sharing, as illustrated by the following transcript segments.

We realized that by doing it we lead the students to think by themselves about what they had said and also the others to think about and discuss it. (Guilherme).

In a class the students were indifferent and so I started to discuss one of their statements. This was good... you get to engage the students. (Felipe).

As for the importance of teaching immersion projects and the consolidation of the career choice, we highlight one statement made by Felipe.

I think that if I had not succeeded when I tested it [referring to the theoretical knowledge used in the project classes], I think that I would have given up the course and that I wouldn't have got into the master program either. I started the master program because I fell in love with the practice I experienced in the project and later continued with in my classes in the public school and I now investigate in my own work. (Felipe).

Felipe entered an education graduate program six months after leaving the project (when he graduated). Apparently, at first, he did not find teaching an attractive career and the experience that he had in the project was so significant that it both defined his career choice and stimulated him to further educate himself by starting on a master degree program. However, the fact of acknowledging himself as a researcher of his own practice is what seemed most significant to us.

Besides these factors that were mentioned by the two in-training student teachers that we have pointed out, there are many others that were mentioned individually, such as the initial fear of dealing with the students' ideas in the classroom (or not knowing how to deal with them), theme-based class planning and mainly the broadening of their understanding of the roles of the different actors in the classroom. Guilherme's statement exemplifies this:

I begin to think more about the class, right? And not only about the student. I have enlarged my vision a little, because I observe the student and his face to invite him to participate. Then, I opened my eyes to the whole class and not only to the student who was responding. Those who I did not see before, I then started to see, after participating in the project classes (Guilherme).

It seems to us that the sharing of the researchers' class evaluations, a recurrent practice in the project in which Guilherme and Felipe participated, was decisive for the improvement of their understanding of the professor's role. It was at those moments, when they reflected on the classroom practice based on the class video recordings, that they appropriated the theoretical knowledge.

How did the professor justify decision-making in the classroom?

The professors' answers in the interviews show us that to experience a practice in which the theory was still implicit was important for each of them. However, the analysis of their own practice was fundamental for the resignification of the theoretical knowledge, as they related it to the experiences that they were having.

They showed that they had appropriated a process of observation and reflection of their own practice. Nevertheless, it was the reassurance of their choice of teaching as a career that seemed the most important to us. Both of them entered the chemistry teaching course, but it was the experience in planning and developing theme-based classes that, apparently, led them to consider the possibility of taking up a career that pleased them more. Felipe, for example, said he was proud of himself exactly because he could acknowledge elements that he had studied in this practice, and, because of his process of

personal reflection, he started to see interactions and dialogism as fundamental factors for the development of the students' learning.

Final Comments

We sought to analyze possible changes in the discourse and understanding of the professor's role in the classroom in a teaching immersion project in which theme-based classes were planned and taught and the participants were instructed to draw the students into participating in the class dynamics in a process where theoretical knowledge and teaching practice were directly associated.

Our investigation showed that teacher education is part of a collective construction of pedagogic interaction spaces. This was evidenced both in the classes analyzed and in the interviews. The classes were characterized by significant changes in the type of discourse that the professors used and by the use of strategies to draw the students into the class dynamics, such as initiations that required more from the student, more elaborate interaction patterns and longer student talking time. In the interviews, the professors mentioned the importance of the joint class planning and evaluation sharing. We believe that class planning and development were important, but that the reelaboration of the knowledge on the role of the professor was driven by the reflection on one's own practice, which we call evaluation sharing.

This kind of dynamics contributed to the results achieved and the personal reflection on the professors' own actions and supports our claim for the introduction of field work during the whole teacher training course rather than only at later stages. The problematization of the misconceptions brought up by the professors and their experiences in developing classes possibly allowed and possibly changed their way of acting as professors in the classes analyzed. When the in-training student teachers shared an education guided by a work proposal that prioritized dialogue, the classroom interactions and the reflection on their own practice, they set their own education into motion. The data obtained in this investigation show a need to think over the initial teacher education courses and that in-training teachers do field work in the very early stages of their education.

Finally, we argue that this experience afforded changes in the understanding of the in-training student teachers, who certainly will reflect on their practice when they become professors themselves. For the in-training student teachers to adopt another way of teaching, different from that under which they had been taught, they need to experience this another way, with the support of trainers.

References

ALARCÃO, Isabel (Org.). **Formação reflexiva de professores: estratégias de supervisão**. Porto: Editora Porto, 1996.

BAKHTIN, Mikhail. **Estética da criação verbal**. São Paulo: Martins Fontes, 2003.

BUTY, Christian; BADREDDINE, Zeynab; RÉGNIER, Jean-Claude. Didática da ciências e interações em sala de aula: algumas diretrizes para uma análise dinâmica. **Ensaio**, Belo Horizonte, v. 14, n. 1, p. 147-165, 2012.

BUTY, Christian; PLANTIN, Christian. Introduction: l'argumentation à l'épreuve de l'enseignement des sciences et vice-versa. In: BUTY, Christian; PLANTIN, Christian (Ed.). **Argumenter en classe de sciences: du débat à l'apprentissage**. Lyon: INRP, 2009. p. 17-41.

CANDELA, Antonia. **Ciencia en el aula: los alumnos entre la argumentación y el consenso**. México, DF: Paidós Educador, 1999.

CAPECCHI, Maria Candida Varone de Moraes; CARVALHO, Anna Maria Pessoa de; SILVA, Dirceu. Relações entre o discurso do professor e a argumentação dos alunos em uma aula de física. **Ensaio**, Belo Horizonte, v. 2, n. 2, p. 189-208, 2002.

DRIVER, Rosalind; NEWTON, Paul; OSBORNE, Jonathan. Establishing the norms of scientific argumentation in classrooms. **Science Education**, Flórida, v. 84, n. 3, p. 287-312, 2000. DOI: 10.1002/(SICI)1098-237X(200005)84:3<287::AID-SCE1>3.0.CO;2-A.

DRIVER, Rosalind et al. Construindo conhecimento científico na sala de aula. **Química nova na escola**, São Paulo, n. 9, p. 31-40, 1999.

ELMESKY, Rowhea; TOBIN, Kenneth. Expanding our understanding of urban science education by expanding the roles of students as researchers. **Journal of Research in Science Teaching**, Chapel Hill, v. 42, n. 7, p. 807-828, 2005. DOI: 10.1002/tea.20079.

FREITAS, Maria Teresa de Assunção. A abordagem sócio-histórica como orientadora da pesquisa qualitativa. **Cadernos de Pesquisa**, São Paulo, n. 116, p. 21-39, 2002.

GALAGOVSKY, Lydia R.; BONÁN, Leonor; ADÚRIZ BRAVO, Agustín. Problemas com el language científico em la escuela: un análisis desde la observación de clases de ciencias naturales. **Enseñanza de Las Ciencias**, Barcelona, v. 16, n. 2, p. 315-321, 1998.

JIMÉNEZ-ALEIXANDRE, María Pilar; BUGALLO RODRÍGUEZ, Anxela; DUSCHL, Richard A. "Doing the lesson" or "doing science": argument in high school genetics. **Science Education**, Flórida, v. 84, n. 6, p. 757-792, 2000. DOI: 10.1002/1098-237X(200011)84:6<757::AID-SCE5>3.0.CO;2-F.

JIMÉNEZ-ALEIXANDRE, María Pilar; ERDURAN, Sibel. Argumentation in science education: an overview. In: JIMÉNEZ-ALEIXANDRE, María Pilar; ERDURAN, Sibel. **Argumentation in science education: perspectives from classroombased research**. Springer, 2007. p. 3-27.

KEMMIS, Stephen. Action research and the politics of reflection. In: BOUD, David; KEOGH, Rosemary; WALKER, David (Org.). **Reflection: turning experience into learning**. London: Kogan Page, 1985. p. 139-163.

LEMKE, Jay. Multiplying meaning: visual and verbal semiotics in scientific text. In: MARTIN, James R.; VEEL, Robert (Ed.). **Reading science: critical and functional perspectives on the discourses of science**. London: Routledge, 1998. p. 87-113.

LEMKE, Jay L. **Talking science: language, learning and values**. New Jersey: Ablex, 1990.

MARTINS, Isabel; OGBORN, Jon; KRESS, Gunther. Explicando uma explicação. **Ensaio**, Belo Horizonte, v. 1, n. 1, p. 1-14, 1999.

MEHAN, Hugh. **Learning Lessons: Social organization in the classroom.** Cambridge, MA: Harvard University Press, 1979.

MORTIMER, Eduardo Fleury. **Evolução do atomismo em sala de aula: mudança de perfis conceituais.** 1994. Tese (Doutorado em Educação) – Faculdade de Educação da Universidade de São Paulo, São Paulo, 1994.

MORTIMER, Eduardo Fleury; SCOTT, Philip H. Atividade discursiva nas salas de aula de ciências: uma ferramenta sociocultural para analisar e planejar o ensino. **Investigações em Ensino de Ciências**, Porto Alegre, v. 7, n. 3, p. 283-306, 2002. Disponível em: <http://www.if.ufrgs.br/ienci/artigos/Artigo_ID94/v7_n3_a2002.pdf>. Acesso em: 20 nov. 2015.

MORTIMER, Eduardo Fleury; SCOTT, Philip H. **Meaning making in secondary science classrooms.** Maidenhead: Open University Press, 2003.

NASCIMENTO, Sylvania Sousa; VIEIRA, Rodrigo Drumond. Uma visão integrada dos procedimentos discursivos didáticos de um formador em situações argumentativas de sala de aula. **Ciência & Educação**, Bauru, v. 15, n. 3, p. 1-15, 2009.

NÓVOA, António. Formação de professores e profissão docente. In: NÓVOA, António (Org.). **Os professores e sua formação.** Lisboa: Dom Quixote, 1992. p. 13-33.

NÓVOA, António (Coord.). **Os professores e sua formação.** Lisboa: Dom Quixote, 1997.

OLIVEIRA, Isolina; SERRAZINA, Lurdes. A reflexão e o professor como investigador. In: GTI (Org.). **Reflectir e investigar sobre a prática profissional.** Lisboa: APM, 2002. p. 29-42.

POLMAN, Joseph L.; PEA, Roy D. Transformative communication as a cultural tool for guiding inquiry science. **Science Education**, Flórida, v. 85, n. 3, p. 223-238, 2001. DOI:10.1002/sce.1007.

PRETTO, Nelson de Luca. **Uma escola com/sem future: educação e multimídia.** Salvador: Eudfba, 2013.

ROTH, Wolff-Michael. Competent workplace mathematics: how signs become transparent. **International Journal of Computers for Mathematical Learning**, Mannheim, v. 8, n. 3, p. 161-189, 2003. DOI:10.1023/B:IJCO.0000003873.36183.2d.

SASSERON, Lúcia Helena; CARVALHO, Anna Maria Pessoa de. Almejando a alfabetização científica no ensino fundamental: a proposição e a procura de indicadores do processo. **Investigações em Ensino de Ciências**, Porto Alegre, v. 13, n. 3, p. 333-352, 2008.

SCHÖN, Donald. **Educating the reflective practioner.** São Francisco: Jossey-Bass, 1987.

SCHÖN, Donald. **The reflective practitioner.** London: Basic Books, 1983.

SCOTT, Philip; ASOKO, Hilary; LEACH, John. Student conceptions and conceptual learning in science. In: ABELL, Sandra K.; LEDERMAN, Norman G. **Handbook of research in science education.** New Jersey: Lawrence Erlbaum Association, 2007. p. 31-54.

SEAH, Lay Hoon. Understanding the conceptual and language challenges encountered by grade 4 students when writing scientific Explanations. **Research in Science Education**, Southport, n. 46, p. 413-437, 2016. DOI:10.1007/s11165-015-9464-z.

STENHOUSE, Lawrence. **An introduction to curriculum research and development**. London: Heinemann, 1975.

STENHOUSE, Lawrence. **Investigación y desarrollo del currículum**. Madrid: Morata, 1981.

TAN, Michael. Mathematics and science teachers' beliefs and practices regarding the teaching of language in content learning. **Language Teaching Research**, Wellington, v. 15, n. 3, p. 325-342, 2011. DOI: 10.1177/1362168811401153.

YVOTSKY, Lev S. **A Construção do pensamento e da linguagem**. São Paulo: Martins Fontes, 2001.

YVOTSKY, Lev S. **Pensamento e linguagem**. São Paulo: Martins Fontes, 1989.

YVOTSKY, Lev S. The socialist alteration of man. In: VAN DER VEER, René; VALSINER, Jan (Ed.). **The Vygotsky reader**. Cambridge: Blackwell, 1930/1994. p. 175-184.

ZEICHNER, Kenneth M. **A formação reflexiva de professores: idéias e práticas**. Lisboa: Educa, 1993.

ZEICHNER, Kenneth M. Uma análise crítica sobre a "Reflexão" como conceito estruturante na formação docente. **Educação & Sociedade**, Campinas v. 29, n. 103, p. 535-554, 2008.

Received on: April 08, 2016

Accepted on: November 22, 2016

Anderson Cezar Lobato is a secondary education chemistry professor and a chemistry teaching professor in the College of Education of the Federal University of Minas Gerais (UFMG). He holds a master degree in education and investigates teacher education with emphasis on the communicative approach.

Ana Luiza de Quadros holds a doctor degree in education and is a professor in the Chemistry Department of the Institute of Exact Sciences of the Graduate Program of the College of Education of the Federal University of Minas Gerais (UFMG). She investigates teaching and learning in chemistry and the training of chemistry and science teachers with emphasis on STS.