EDUCAÇÃO & realidade

The Contribution of Internships for the Understanding of the Role of Chemistry Teacher

Ana Luiza de Quadros[I]
Daniela Martins Buccini Pena[I]
Mariana Luiza de Freitas[I]
Naira Helena Simões do Carmo[I]
[I]Universidade Federal de Minas Gerais (UFMG), Belo Horizonte/MG – Brazil

ABSTRACT – The Contribution of Internships for the Understanding of the Role of Chemistry Teacher. The modern teaching tendencies are essential for the production of significant learning. Given the need for a greater understanding of the meaning making, this study investigated the teaching practice of teachers in training and the moments of participative evaluation, when theoretical knowledge is associated with practical knowledge. We observed that there was high interaction between intern teachers and students, leaving room for student participation, even though the teachers had difficulty in implementing a dialogical discourse. During the participative evaluation, we perceived the evolution of the conceptions of teachers' and students' roles in classroom dynamics.
Keywords: **Teacher Training. Participative Evaluation. Teaching Tendencies.**

RESUMO – A Contribuição do Estágio no Entendimento do Papel do Professor de Química. As tendências contemporâneas de ensino vêm sendo consideradas essenciais para a produção de aprendizagens significativas. Considerando a importância do uso dessas tendências na construção de significados, o presente trabalho envolveu a inserção de professores em formação na docência e a avaliação compartilhada da prática docente, aproximando os saberes teóricos e práticos. Percebemos que esses professores desenvolveram aulas nas quais houve grande interação com os estudantes, abrindo espaço para a participação, mas tiveram dificuldades com o estabelecimento de um discurso dialógico. Na reflexão sobre a ação, percebemos evolução das concepções sobre o papel do professor e dos estudantes na dinâmica da sala de aula.
Palavras-chave: **Formação de Professores. Avaliação Compartilhada. Tendências do Ensino.**

Introduction

The National Curricular Parameters for Secondary Education (NCP) drafted in response to the changes proposed in the Law of Directives and Bases of National Education, Act No. 9394/96, stress that in the face of the influences of information and communication technology and social changes, education must overcome decontextualized and fragmented teaching and become an instrument of education for critical citizens capable of participating in a society that has become more and more technological (Brasil, 1999).

The greatest challenge in this new way of thinking education is the teaching practice itself. The NCP drive the discussion of some teaching trends that the scientific community in the area considers essential for the production of significant learning and to lure young people to basic science. Although numerous trends are divulged in the specialized literature, in this study we will focus on trends that are more specific to internship experiences. When dealing with contemporary teaching trends, we refer mainly to theme-based teaching (an influence of the Science, Technology and Society movement - STS) and the communicative approach (the teacher's discourse, classroom interaction and the role of language).

This study was based on the hypothesis that the introduction of these trends into teaching depends directly on the way that teachers understand and use them. The teacher is the main *actor* in the classroom, one capable of imparting dynamism and bringing science and people's way of life together. However, there apparently is a great difficulty in breaking away from the traditional teaching model in which the teacher organizes and conveys knowledge and the student acquires it passively.

Quadros et al. (2005) propose the existence of a simplistic view of the teaching process in which having knowledge of specific contents is sometimes considered sufficient for their teaching. Schnetzler (2002) criticizes the teaching model based on technical rationality and states that in this view teaching requires only knowledge of specific contents and some basic application techniques. These studies propose that a simplistic view of what being a teacher is and what knowledge is must be questioned and overcome early in teacher training courses, and this does not always happen. To help teachers deal with the complex situations involved in teaching and learning it is necessary that teaching conceptions evolve.

Considering the need for greater understanding of teaching training, this study analyzes the proposal of a school action project developed by students from the Chemistry Teacher Training course of Universidade Federal de Minas Gerais - UFMG. We investigated how a group of in-training teachers appropriated some contemporary teaching trends,

mainly regarding the construction of interactive and dialogic classes and how they built the relationships established in the classes where they accomplished their internship.

Theoretical Framework

Teaching Training and Science Teaching

The inefficiency of teacher training courses in producing an epistemological rupture regarding teaching practice is pointed out by some authors (Ciríaco, 2009; Tardif, 2002; Quadros et al., 2005) as a cause of the maintenance of a teaching model based on the transmission/reception of information, while others (Pereira, 2000; Santos, 2005) attribute this to the fact that teacher training curricula are still strongly tied to bachelor degree courses. In the last case, didactic-pedagogical lectures end up being *diluted* in the curriculum in contrast to the extensive predominance of lectures in specific areas of knowledge, when these lectures are not geared to the work market that the students are graduating into. According to Maldaner, "[...] universities have had difficulty in bridging the gap between pedagogical education and professional specific area education" (Maldaner, 2000, p. 46). The need to pay greater attention to teaching training courses as a privileged space/time for the construction of actions for the improvement of the quality of education in our country is thus clearly evident.

Martin and Romanovski (2010, p. 2010) analyzed five teacher training courses in Paraná state, Brazil, and reported that the conception that *a solid theoretical grounding ensures the practice* is still markedly noticed in the investigated subjects. Considering that practice in the form of internship is generally done in the final years of a course, the indissociability between theory and practice might not be consolidated. On the insufficient relationship between theoretical knowledge and practice in training courses, Silva and Oliveira (2009) stated that teaching trainers, both in specific areas and in the pedagogy area, may be coresponsible for the lack of articulation between specific and pedagogical lectures. This certainly makes the perception of the future teachers regarding indissociability between theory and practice difficult, resulting in troubled internships.

We consider that greater knowledge of how teacher training is provided and its underlying factors is necessary. Quadros et al. (2005) proposed that teacher training takes place not only in teacher formation courses, but throughout the whole formation. The influence of the traditional transmission/reception model which we take on may exert such a marked influence that it may even define our own practice. We consider this a necessary rupture which must happen in the initial years of teacher training.

We believe in the reconstruction of a teaching model based on the indissociability between theory and practice. Thus, we looked into the influence of Vygotsky's and Bakhtin's studies on classroom relations and Mortimer and Scott's (2002 and 2003) communicative approach as a reference framework for this indissociability.

Vygotsky's and Bakhtin's Studies: a quick look

Vygotsky (1994) proposed that the development of higher psychological functions is a mediated process involving two basic elements: the instrument and the sign. The instrument is an element external to the subject, while the sign acts as a *psychological instrument*, assisting the human beings in their psychic activities.

Considering the historical evolution of the meaning of words, Vygotsky states that when a listener first hears a word, the meaning the hearer attributes to that word does not necessarily coincide with the meaning attributed by the speaker. As a result, the construction of meanings of a word is a process mediated by language. Thus, language plays a major role in the thought process and is considered as a par-excellence sign mediator.

Bakhtin (2006), in turn, developed the concepts of enunciation, which, according to him, is the most useful unit in the understanding of the verbal communication phenomenon because an enunciation takes the context where communication occurs into account. Thus, the same word may be used in different enunciations with different meanings. Concerning words, Bakhtin states that "[...] it is due to this exceptional role of instrument of consciousness that a word works as an essential element that accompanies every and whatever ideological creation. A word accompanies and comments the whole ideological act" (Bakhtin, 2006, p. 37).

Bakhtin deals with *everyday life ideology* - which is the totality of mental activity centered on daily life - and with *ideological systems*, which are socially constructed and are of a more formal character. Applying these concepts to the school context, everyday ideology becomes the students' ideas and previous knowledge and the ideological system, scientific knowledge. Intellectual development occurs when these two contexts are associated through discourse genre.

> When scientific discourse is used in the classroom, it becomes important for the teacher to be able to switch between discourse genres and produce enunciations that project students' possible responses. The dialogic environment will only be established in the classroom if the teacher is able to choose the utterances to be used from the totality of enunciations that may be created by our discursive imagination (Quadros, 2010, p. 81).

In this perspective, the student is considered as a subject who has many explanations for *things* in the world derived from everyday culture. When a student enters school, the student is expected to appropriate the explanations from science, in a cognitive process.

In his studies, Vygotsky investigated the so-called Zone of Proximal Development. For Vygotsky, the learner has an actual level of development represented by what he/she is able to perform independently, and a level of potential development, which includes whatever the individual will be able to perform with guidance and support. The Zone of Proximal Development is the distance between these two levels of development and where the construction of new meanings can be worked on.

For Vygotsky, development occurs through the construction of intellectual tools, through social interaction with other individuals. Therefore, a new level of actual development can be constructed. Social interaction is not restricted only to the teacher-student communication; it also comprises the environment where the interaction occurs and is influenced by the problems, characteristics and subjects related to that environment (Fino, 2001).

Vygotsky investigated the process of *negotiation* of meanings. According to him, the meaning of a word used in a classroom will be different for the different subjects present. Interaction facilitates the process of signification because "[...] it allows the person to capture meanings and check if the meanings grasped for the signs in question are those socially shared" (Moreira, 2008, p. 5).

During class, the teacher develops a process of construction of meanings by interacting with the students through language. Every time a word is used in the collective context of the classroom, its meaning has to be recovered so that the different subjects have an opportunity to internalize this concept and check whether their understanding is socially shared. This process is facilitated by the creation of an interactive and dialogic environment (Moreira, 2008).

For Mortimer and Scott (2002, p. 248)

> [...] the learning process is not seen as a substitute for old conceptions that the individual had before the teaching process via new scientific concepts, but a negotiation of new meanings in a communicative environment where the different cultural perspectives are brought together in a process of mutual growth.

The teacher has to be able to carry out this negotiation and promote the intellectual evolution of the learners. To implement this negotiation process, the classroom becomes a space/time of interaction between subjects and the type of discourse used by the teacher becomes essential.

The Concept of Communicative Approach

Mortimer and Scott's (2002) concept of communicative approach takes two discourse dimensions into account and provides a view of how the teacher works with the students to develop meanings in the classroom. Based on Bakhtin's work, they consider two types of discourse in a first dimension: the dialogic or *internally persuasive*, when the teacher considers what the students have to say from the students' point of view. Various points of view are thus taken into account for exploration in the classroom. The second type of discourse is authoritative; the teacher considers what the student has to say only from the scientific point of view. "In this case, a single meaning is valued and validated by the scientific authority, and one which the student cannot negotiate - do or die" (Quadros, 2010, p. 86). While authoritative discourse has the function of being true to a point of view, dialogic discourse has the function of producing new meanings.

The second analytical dimension deals with interaction or participation in the discourse, which can be either dialogic or authoritative. An approach can be more interactive when a subject participates in the discourse, a situation where the teacher can interact with students by asking questions and listening to doubts, allowing questioning and the presentation of the students' ideas. It can also be less interactive when only one person participates, generally when the teacher does not allow the students to participate and only the teacher has a voice in the classroom.

By combining these two dimensions, the authors use four categories to codify the communicative approach, namely:

> *Interactive and dialogic:* when the teacher offers the students a space/time to participate in the discourse, presents his/her own viewpoints and values the students' viewpoints by discussing them in class;
>
> *Interactive and authoritative:* when the teacher gives the student space/time to participate in the discourse but values only the viewpoints that are close to that of science;
>
> *Non-interactive and dialogic:* when the teacher does not give the students space/time to participate in the discourse but rather presents various viewpoints himself/herself and discusses the validity of each one.
>
> *Non-interactive and authoritative:* when the teacher is the only *speaker* in the classroom and presents only the scientific viewpoint to subjects dealt with in the classroom. In this case, student participation is only peripheral (Mortimer; Scott, 2002).

We consider that dialogic classes facilitate the construction of meanings when the teacher listens to and discusses the students' viewpoints. However, the teacher will use an authoritative discourse when-

ever he/she presents the scientific viewpoint and conducts the class so that the theme of interest is not lost among other discussions. The switches between these four discourses are called *turning points* (Mortimer; Scott, 2011; Quadros et al., 2015).

Mortimer and Scott (2002) pointed out that all these types of approaches have a place in the classroom. The teacher's choice of how to conduct the subject and the type of approach to use will depend on the different objectives and needs that appear during class.

Theme-Based Teaching of Chemistry

We believe that theme-based teaching is a good option to facilitate interaction and discussion of different viewpoints among the teacher and students and among the students themselves. Discussion in theme-based teaching has advanced in Brazil after the publication of the NCP. The importance of taking everyday life into account in chemistry classes was already subject of discussions in specialized areas when the NCP were published. Studies such as those by Lufti (1988), who used the theme Foods to teach chemistry, and by Santos and Schnetzler (1997), who exploited contributions of the STS movement in the teaching of chemistry, are examples of ongoing discussions in the area. However, these studies placed greater emphasis on teaching departing from the context of the student. Teaching chemistry based on themes became part of the discourse in the field of education in general. In the document *Guidelines for the National Curriculum Parameters,* PCN+ in the Brazilian Portuguese acronym, (Brasil, 2002), the section on Chemistry in Secondary School proposes some themes that teachers might use to teach chemistry concepts considered important for students at this level of education.

The use of themes to develop the knowledge of chemistry in the classroom is seen as a good opportunity for the students to perceive the direct relationship between chemistry and the social context and get interested in this science and participate more in classes. As noted by Quadros (2004), we traditionally deliver a large amount of scientific information and expect the students to be able to make correlations that allow them to explain natural phenomena or apply this knowledge to everyday problems. However, research has shown that students hardly appropriate these concepts and tend to maintain previous alternative conceptions taken to class (Quadros, 2004).

To teach chemistry based on themes means to work on a phenomenon or fact from the social context of the student, the understanding of which will allow the introduction of chemical concepts, and which, therefore, concerns chemistry. Scientific concepts are required to explain a fact/phenomenon. The introduction of these concepts takes place in the social plane (interaction of ideas) and the individual plane, through the appropriation of new ideas.

In this study we analyzed classes taught by a group of in-training teachers from the Chemistry Teacher Training course of Universidade Federal de Minas Gerais in an attempt to assess their performance as teachers in classes where theoretical knowledge related to discourse in class and theme-based teaching were implicit, and also how their performance was influenced by shared lecture analysis.

Methodology

The Context where the Study was Carried Out

The project *Motivating Practices in Public Schools in Minas Gerais* has, since 2011, been conducted as student advancement courses in conditions similar to those of the Scholarship Program for Initiation to Teaching (*Programa Institucional de Bolsa de Iniciação à Docência - PIBID*). Like PIBID, this project involves 15 chemistry teacher training students, here called in-training teachers (and some volunteers) and three elementary/secondary education teachers, all of whom are CAPES [Coordination for the Improvement of Higher Education Personnel] scholarship recipients. In-training teachers enrolled from the second to the penultimate semester of the course were selected through public notice.

In the Motivating Practices project, the classes are planned and taught in public schools in Minas Gerais to students from multilevel secondary education grades interested in attending the course. The classes are taught at a time distinct from those of the students' classes at school. The project is conducted as a student advancement course. In the first part of the course, the theme is water and is divided into water cycle, water in nature, water and plants, soil and foods. The second part deals with themes such as air quality (with emphasis on rarefaction of the ozone layer, acid rain and global warming), pheromones and cosmetics, energy, radioactivity, green house effect and plastics. Each theme is covered in four to six hours of class.

To prepare the in-training teachers to teach the first part of the course, they were asked to watch video recordings of classes taught by coordinators, then carry out a critical analysis and prepare themselves to teach the content. When they were ready to take classes over, the classes were prepared so that the students' ideas were listened to and they were instructed to discuss the students' ideas extensively in interactive and dialogic classes (Mortimer; Scott, 2002). To prepare for the second part of the course, the in-training teachers were also involved in theme planning.

The Classes Taught that are Part of this Study

The objective of the first theme was the study of the water cycle and its interactions in nature. The first class activity involved the con-

struction of a terrarium, which was used in the study of water evaporation, condensation and precipitation focusing on factors that contribute to water phase changes. In the study of evaporation, the students set up a water heating system so that they could observe water evaporation at low temperatures and the moment when the temperature stabilizes. This led to the construction of a concept of boiling temperature together with the students. In this discussion, the concepts of altitude, atmospheric pressure, vapor pressure and other concepts related to water evaporation in nature needed to be handled.

To understand condensation, another important phenomenon in the water cycle, the discussion on the physical state of the *light vapor* observed when water is boiled was introduced. Despite the different initial explanations, the knowledge socially shared in those classes was the coexistence of two physical states: liquid and gas. Following this line of thought, the discussion focused on cloud formation, resulting in a phase diagram. The class was closed with a discussion on lyophilized products.

The second theme – water in nature – covered the concepts of density and solubility. The first part of the class involved a discussion on solubility and miscibility. Next, an experiment with coffee, milk and water was performed by mixing all three so that they formed three phases[1]. An experiment on liquid layers in which liquids with different densities layered in a test tube was also conducted[2]. Another experiment on *chemically activated bobbing up-and-down movement* using an effervescent tablet and a naphthalene ball in a glass of water was also performed[3]. All these experiments were performed to enable a discussion on the concept of density.

The difference between freshwater and saltwater led to the discussion of distillation and deionization. An experiment was conducted using a conductometer and a 1.5 A lamp bulb to obtain evidence that these two types of water are different. The understanding of ions, ionic bond and other concepts were furthered.

In the third theme – water and plants – the relationship between water and plants was discussed. The concept of solubility was reviewed and photosynthesis was discussed extensively. Breathing and digestion were also studied to strengthen the understanding of reactions that take place in plants involving glucose formed during photosynthesis. This discussion was closed with information on formation of the other plant components, mainly sugars, amino acids, proteins and cellulose.

The Steps of the Work

This study involved the qualitative analysis of the performance of a group of in-training chemistry teachers in extracurricular internships. According to Garnica (1997), the qualitative approach is a circular

path around what one wants to understand by looking onto the quality and the elements that are significant to the researcher. Qualitative methods are commonly described as differentiated models of empirical approach and are geared specifically to the so-called human phenomena.

We have looked into how these in-training teachers appropriated practices which present these contemporary trends through video recordings of a set of classes. The camera was set at the side of the classroom in order to minimize interference in classroom. We observed that elementary education students were curious and disquieted in the presence of the camera in the beginning of the course, but got used to and felt at ease with it after 10 to 15 min.

Video recorded classes were selected from those taught by five in-training teachers, here fictitiously named Patrícia, Pedro, Marcelo, Marcos and Nara. Classes were selected at random from classes taught in all project partner schools. For confidentiality sake, elementary education students were assigned numbers in each segment transcript. Thus, *student 1* in fragment one is not necessarily the same *student 1* in fragment two.

We selected class episodes which presented moments that we considered significant to characterize the in-training teacher's performance in all classes. The teachers' and students' utterances in the selected episodes were transcribed and analyzed to identify moments when the in-training teachers appropriated (or not) contemporary teaching trends focusing mainly on in-class discourse. Analysis priority was placed on the type of discourse used by the in-training teachers based on the communicative approach (Mortimer; Scott, 2002). Additionally, the use of everyday language among in-training teachers and the extrapolation of class programming were pointed out.

The following conventions were used in the transcription of fragments (parts) of the episodes: double slant bars (//) indicate utterance pauses and brackets [...] identify a phrase or set of phrases suppressed in the dialog for the sake of space.

Results and Discussion

Our analysis was divided in terms of the characteristics that we considered the most important in the teacher training process. We started with discourse analysis (interactive, dialogic and the occurrence of difficulties) based on the use of creativity and moments when everyday language showed up among in-training teachers. We concluded by emphasizing peer evaluation and its importance, as we consider this evaluation to be a strength of the project as a whole. Next, we present analyses of each of the selected episodes.

Ease in the Construction of Interactive and Authoritative Classes

We observed that the in-training teachers succeeded in constructing classes that allowed student participation. In most of the analyzed elementary education episodes, the classes were interactive and authoritative, that is, the in-training teachers allowed room for active student participation and took student utterances into consideration when they agreed with the scientific explanation. Chart 1 contains a fragment exemplifying the use of authoritative discourse.

In this fragment, in-training teacher Patrícia discussed data contributed by one student on the presence of sulfur dioxide (SO_2) in air, taking the opportunity of the ongoing discussion on water vapor (air relative humidity) and gases present in air. The student brought in an air quality graph that showed high SO_2 concentrations in air in June and July, a dry period in the data collection area. In a given moment in class, the dialog in Chart 1 took place.

Chart 1 – Interactive Discourse between In-Training Teacher Patrícia and the Students

Patrícia: Why is the SO2 concentration higher in June and July? What do you think? [Silence] Patrícia: What happens in June and July? What are these months good for? Student 1: Flying kites. [laughs] [...] Student 1: It is dryer. Student 2: The wind blows harder. Student 1: If the wind blows harder, then the capacity of circulation of pollutants is greater. Patrícia: This is the point: what mechanism results in a decrease in these gases in the atmosphere? Student 3: Water. Student 1: Rain. Patrícia: Very good! If it is dry in this period, what happens to the gas concentration? Many students: Concentration increases. Patrícia: Concentration increases. That's right. Rain is a regulatory mechanism. When it rains, the rain drags part of these gases away.

In a fragment from this segment of Patrícia's dialog we notice that she interacted with her students by asking questions and listening to their answers. When Students 1 and 2 answered the teacher's questions, the answers were dismissed. In this moment, the teacher reformulated the question and said: "*This is the point...*". When Student 1 answered again that the rain may decrease the SO_2 concentration in the air, Patrícia praised the answer by saying "Very good...". The next question, when

Patrícia associated rain to the concentration of gases, several students answered it and Patrícia appraised the answer again.

According to Mortimer and Scott's (2002) communicative approach, this is an interactive discourse, since it allowed room for the students to participate, but it was authoritative because the teacher ignored the students' utterances when they diverged from the scientific explanation and gave a positive feedback when it was similar.

We realized that in most of the transcribed class episodes, the in-training teachers adopted the interactive discourse totally. They included the students in the classroom dynamics and very often stimulated their participation. However, when a student offered up an answer, the teacher either appraised it or dismissed it when it was not close to the scientific answer. During the sharing of the teacher peer evaluation, the teachers were instructed on the possible types of discourse and the need to discuss student answers with the whole class to increase the opportunity for social interaction and the appropriation of new explanations at an individual level.

A Feeling of Strangeness towards Dialogism

As previously seen, the in-training teachers did not assimilate the dialogic discourse easily during this extracurricular internship. However, when they did, we noticed that sometimes this discourse caused a feeling of strangeness among elementary education students.

Next we highlight two class fragments from moments when students' feelings of strangeness were somehow made explicit when discussing their own ideas. In the first fragment, Marcelo discussed the results of an experiment in which the students heated water to a constant temperature. The objective was to collectively construct a concept of water boiling temperature. In the transcription excerpt below, Marcelo asked about the observations made during the experiment and some students mentioned the small bubbles of gas that formed. When Marcelo asked at what temperature this happened, he listened to the student's answer and, then, continued the dialog presented in Chart 2.

Chart 2 – Student Feeling of Strangeness towards the Discussion of Ideas

Student 1: It started to bubble at 35 ºC. Marcelo: Can anyone explain what these bubbles are? Student 1: It's water evaporating, isn't it? (Some comments) Marcelo: Any other answers? Student 1: Isn't it right? Marcelo: Keep cool (laughter). I'm just asking, anyone else? Anything else? (The teacher writes the students' answers on the blackboard. Then he asks about the bubbles that start to come out at the end of the experiment when the water starts to boil.)

In this first fragment, Marcelo did not make any comments when he listened to the answer of Student 1, "*It's water evaporating, isn't it?*" As the teacher did not confirm the student's answer and asked for other answers, she spoke up again and asked "Isn't it right?", demonstrating that she expected confirmation from the teacher. The fact that the teacher did not comment on the student's answer seems to have suggested that it was wrong. This student demonstrated that she is used to having her answers immediately appraised when they agree with the scientific explanation or dismissed when they are not.

In another class, to explain that oxygen gas is found dissolved in water, Pedro started a discussion on the gas that fish breathe and its origin. He interacted with the students, waited for answers and collected the following dialog fragment:

Chart 3 – Student Feeling of Strangeness towards the Discussion of Ideas

Pedro: And fish in the lake. How do fish breathe? Do they swim to the surface? Student 2: Fish get oxygen from water molecules. Pedro: They get oxygen from the water molecules. Any other idea? Student 3: Do they? Pedro: No // I asked the question! (laughter)

In this second fragment, Student 2 stated that the oxygen that fish breathe is the oxygen from water molecules. As the teacher asked for other answers, Student 3 interrupted with "Do they?", apparently questioning the teacher's not evaluating his/her colleague's answer as wrong. In this case, the teacher's lack of appraisal led Student 3 to think that the teacher considered the answer to be correct.

In these two moments in class, Marcelo and Pedro created an environment where the students could express their ideas, which were then the object of discussion. We could notice the students' feeling of strangeness because of the teacher's non-appraisal of their answers. In this school it is probably teacher practice to appraise the students' comments as right or wrong.

Moments when the Dialogic Discourse Prevailed

In another class analyzed, we observed Patrícia's interaction on discussing the difference between the concepts of dilution and dissolution. This episode took place at the end of the work on the water cycle, after various physical properties had been discussed. Patrícia was getting ready to introduce the concept of density. She started this episode by adding cooking salt to water and asking what had happened. One of the students said that it had *diluted*. The teacher discussed it with them and part of the dialog that took place is presented in Chart 4.

Chart 4 – Dialogic Discourse in Patrícia's Classes

Patrícia: Dilution? You are saying that there was dilution. What is your concept of dilution? (Silence) Patrícia: Is dissolution the same as dilution? (Student 1 answered in a low voice.) Patrícia: Speak a bit louder. Student 1: Is to dilute to reduce the concentration? Patrícia: And to dissolve? (The student did not answer.) Student 2: Is to dissolve to consume? Patrícia: What do you mean by consume? Student 2: To become homogeneous. Patrícia: Do you agree that this is a homogeneous mixture? Students: Yes. Patrícia: What did I do then, dilute or dissolve it? Students: You dissolved it. Patrícia: Do you all agree that it actually dissolved? When would I be diluting? [...] Patrícia: If I throw a solid into water and after some time I don't see it anymore, did I dissolve the solid?

In this segment we can observe that the teacher did not appraise the student's answer that salt *diluted* in water, but considered the student's comment, even though the concept was distinct from the expected scientific concept. The teacher took advantage of this concept to discuss the difference between dilution and dissolution and after the discussion she went back to the initial question and many students answered that it was dissolution. According to Mortimer and Scott (2002), the discourse can be considered dialogic because instead of appraising the student's answer, the teacher continued the discussion. In this fragment, the teacher appropriated dialogic discourse and tried to develop the meaning of the concepts of dilution and dissolution. We can see in this set of classes that sometimes the students do not differentiate between these concepts.

In the next fragment, the teacher, Nara, discussed the vapor released when water was heated up, seeking to identify what this vapor might be. We selected a dialog fragment from the discussion, which is transcribed in Chart 5.

Chart 5 – Dialogic Discourse in Nara's Classes

Nara: What did you observe during the boiling process? Student 1: A little smoke. Nara: Smoke? Did you observe a small amount of smoke? (Many students nodded in agreement) Nara: There was only water here. Then, what was comings out? Student 2: vapor. Nara: That's right. Vapor! What is the physical state of this vapor? Student 1: Gas. Student 2: Liquid and gas. Nara: Gas and liquid. You mean there are both? Is that right? Student 2: No, it's not. In between the two. Nara: Ah // in between gas and liquid? In an intermediate state? Student 2: Yes. Nara: Does anyone think it is something else? Student 3: I think it is liquid and vapor. Nara: First he said (pointing to a student) that all we see is liquid. Is he right? (silence) Nara: What do we know about gases? Can we see gases? (The students shook their heads) Nara: If we see a little smoke, it can't be only gas, right? Because we can't see a gas. // If it is liquid, it is liquid water. Liquid water, how does it rise? Student 4: Heat, heat. Student 5: They are liquid water droplets. Nara: Even tiny droplets, how do they rise? Do they have strength to go up? Student 4: It's the gas around them Student 5: That's it, heat // it's the vapor Nara: What gas? Student 4: Vapor Nara: Water vapor? Then it can be liquid water droplets and water vapor. Or do you think it is a gas from the atmosphere? Student 4: It's water vapor. Nara: And you who mentioned an intermediate physical state, what do you think about their explanation?

In this fragment, Nara starts by appraising Student 2's answer by saying "*That's right!"* in agreement to the student's answer. After that, Nara changed her behavior and chose to develop the dialog and hear various ideas. She left to the other students the task of analyzing the ideas brought along to the context by their colleagues. We noticed that when the student stated that water vapor is an intermediate physical state between liquid and vapor, the teacher chose to discuss the other ideas and only after the discussion was over did the teacher return to ask that student's opinion about the other ideas that had been presented. The teacher certainly expected the student to become aware that there are more consistent explanations and this would contribute to that student's conceptual growth. To this end, the teacher chose to include the student in the discussions taking place on the social plane, with the clear intention of the student appropriating another explanation, on the individual plane.

Moments when the Teacher was Creative

We could also observe the evolution of the in-training teachers' in class preparation during the course. The third theme worked on in this study was *Water and plants*. It was developed and discussed in the group, just like the other themes, before being taught in elementary education. The in-training teachers were expected to conduct their classes according to the class plan and following the instructions received. However, some in-training teachers went beyond the class plan and complemented their classes by adding what we consider to be creative elements. The term *creative* is used here in the sense of introducing something innovative in relation to what had been planned.

Marcos started the explanation on what a plant uses the glucose it produces for by using the açaí fruit as an example. He previously researched some biomolecules present in the fruit. Starting with the glucose molecule, he showed that carbohydrates, the combination of many of these molecules, could be formed by plants. He used the same rationale for lipids and showed that açaí has large amounts of oleic acid. He taught about carbon, hydrogen and oxygen present in this biomolecule and presented the idea that it might be formed by plants from glucose. When he showed the structure of an amino acid that makes up proteins and vitamin B12, also present in açaí, Marcos proposed to his students that as they have molecules different from those that make up glucose, the plants need to get them from other sources. Marcos thus introduced the subject of nutrients and demonstrated that plants cannot obtain them through photosynthesis.

The class plan instructed to show how plants use glucose formed through photosynthesis. However, Marcos demonstrated that he had prepared himself and searched for additional information using some of the chemical compounds in açaí to raise the students' interest. This episode shows that the teacher prepared his class creatively and thus enriched the proposed discussions and further stimulated student interest. Teaching chemistry based on themes has numerous possibilities. To teach about chemical reactions that occur in photosynthesis in plants, Marcos showed possibilities that had not been considered by the group that organized the theme.

Moments when Everyday Language Prevailed

Although the objective was immersing the students in scientific culture, everyday language was used in many classes by both the students and in-training teachers. Next we analyze a fragment that demonstrates the use of everyday language in class.

In the class taught by Marcelo, we noticed the use of common sense language. The concept of density was under discussion and the teacher asked the students whether the addition of sugar to coffee would change the liquid volume, as shown in Chart 6.

Chart 6 – Dialog where the Teacher used Common Sense Language

Marcelo: When I added sugar, what did I do to the coffee in fact? (Silence) Marcelo: Imagine that, let's think this through. Suppose I have this amount of coffee here (drawing on the blackboard), if I add two spoons of sugar, will the coffee rise much or will it stay more or less at the same level? (points to the drawing on the blackboard). [...] Marcelo: But, will such a large amount mix in?

Marcelo resorted to common sense language when he used the expression *rise much* instead of saying *increase the volume of coffee*. At another moment, when dealing with the miscibility of coffee and milk, Marcos added a much larger volume of coffee to a small volume of milk. When Marcos told the students that there was a larger mass of coffee than of milk, he used the expression "Won't it mix in?", when he might have used the term *miscibilize*. Other in-training teachers also used various everyday life expressions, even though they were clear about scientific language. The use of words such as *mix* in the sense of *solubilize* or *miscibilize* was constant in the first phase of the project.

The students live in a culture called everyday culture and one of the functions of schools is to introduce scientific culture to the students. According to Bakhtin (2006), these dimensions refer to everyday ideology and the ideological system. Our experience shows that the students resist changing their personal conceptions. In this analysis, we observed that when the in-training teachers take over the teacher role, they also tend to use some everyday concepts. The everyday ideology prevails when the student is introduced to the ideological system of science, which makes the teacher's role and the role of teacher training courses even more important.

This tendency to use everyday language only became weaker after the class peer evaluation. Guidance from the professor who coordinated the project was needed for the in-training teachers to become aware of this practice. This will be explained better in the next item.

Importance of Peer Evaluation

Pursuant to the laws in force, the in-training teachers gave their informed consent to the video recording of their classes so that the coordinator could follow these classes and the in-training teachers could *watch themselves* teaching.

Weekly meetings were held every Friday afternoon with the participation of all those involved in the project (in-training teachers, the school supervising teachers and coordinator). The week's classes were evaluated in these meetings.

The most obvious observation in these evaluations was the in-training teachers' feeling of strangeness regarding the high level of student motivation in elementary education. During the undergraduate course classes on teaching and learning in elementary school, the in-training teachers usually mentioned the elementary school students' lack of interest and little motivation and participation in class. However, as early as in the in-training teachers' first week in the schools, they reported positive comments from the students. The in-training teachers allowed room for student participation and valued the ideas that they presented. The many times relaxed environment favored the students' participation even more.

During these meetings, selected fragments were presented to the in-training teachers to show great participation and motivation from the elementary education students. Upon realizing that those were their own class video recordings, the in-training teachers always demonstrated a feeling of strangeness in the face of seeing themselves giving classes. Some customs and habits peculiar to each one always led to moments of group relaxation. However, the analysis always focused on the in-training teacher's performance in class, the degree to which it contributed to student participation and provoked (or not) the evolution of ideas.

In some meetings, fragments that showed non-interactive and authoritative classes developed by the in-training students which did not stimulate student participation were shown. In this case, it was necessary to emphasize the theoretical frameworks in practice that were intended to be constructed and to compare them to the actual practices. The following classes showed greater care in not evaluating student ideas promptly. Chart 7 shows two utterances that illustrate this care.

Chart 7 – Utterances that Represent Care in Discourse use in Class

Pedro: Okay then guys, let's work on the explanation with the whole class. Look, there is // what do you think about her question?
Marcos: Exactly. This process // Repeat so that everyone can hear.

In the first fragment, Pedro listened to the student's question and got set to clear up this doubt for all students. However, he stopped himself and passed the student's question to the whole class. In the second fragment, Marcos listened to the student's utterance, which he agreed to by saying *Exactly* and signaled that he would start to explain. However, he apparently realized that the other students might not know what the student was talking about, and so he asked the student to repeat what he had said for the benefit of the others. Based on this and other similar episodes, we believe that many of the in-training teachers came to learn the difference between interactive and dialogic discourse as proposed by Mortimer and Scott (2002).

Another major aspect of peer evaluation concerns the language used by the in-training teachers. We have selected some fragments from the classes of practically all in-training teachers showing that everyday language was used sometimes to the detriment of scientific language. Once more we pointed out the objective of teaching science to students and the need to introduce them to this culture. This introduction is indicated so that the students can appropriate scientific language. As teachers, they should avoid using everyday language in class and familiarize the students with scientific concepts. When elementary education students use everyday language in class, the teachers must establish a link between these two contexts (Bakhtin, 2006) and for that, the teachers themselves have to stop using everyday language in class. We observed an improvement in the teachers' use of scientific language in the following classes. They probably were not even aware that they were using everyday language to teach science.

Final Remarks

This study was designed based on the hypothesis that licentiates base their practice on the practice of the teachers that they had had and that is why they tend to prepare classes with the objective of conveying knowledge without offering opportunity for active student participation in class. Our objective was thus to analyze whether in-training teachers from this specific course appropriated contemporary teaching tendencies in classes planned in a way that these tendencies were implicit.

In the beginning of the training course we emphasized the need for involving the students in class and leaving behind the information transmission/reception model. However, this is the teaching model with which most in-training teachers were taught and the only one many have experienced. Introducing them to different ways of teaching revealed to be a privileged way of showing that it is possible to leave behind the model based on the transmission of knowledge. During class evaluations carried out in the project weekly meetings, the in-training teachers showed surprise at the students' feedback. Based on the analysis performed, we have no doubt that these in-training teachers promoted full student participation in class and received the students' feedback in the form of interest and motivation, a fact which made them greatly pleased with their own work.

Although we have observed many interactive classes, we noticed difficulty in implementing dialogic classes. We attribute this mainly to the fact that the in-training teachers were not clear on what a dialogic class is nor the learning advantages that it may bring along. For many of them, active student participation already represented a dialogic discourse in itself. We found that the idea of evaluation of any and every student comment, valuing only the answers that were similar to the sci-

entific viewpoint, which characterizes the discourse as interactive and authoritative, was very frequent.

Even though we had implemented a distinct teaching practice, we propose here that this teaching practice was not sufficient to achieve classes with frequent transitions between dialogic and authoritative discourses, even when such transitions were planned. The teaching evaluation meetings were fundamental for each in-training teacher to realize that their work could be improved. Class video recording and peer evaluation made them aware of their own conceptions and how much they interfered with their teaching.

Each of the in-training teachers was certainly changed as their own teaching practice changed. Even though we are aware that this is a preliminary evaluation, we dare proposing that the participating in-training teachers will hardly feel comfortable using the traditional teaching approach again.

This study revealed the complexity underlying teacher training. Our experience has shown us that undergraduate students do not always appropriate the teaching and learning theories extensively taught in their courses. It was the indissociability between theoretical and practical knowledge that allowed the in-training teachers in this study to improve their teaching practice in the classroom as teaching staff members. The in-training teachers presented changes in the understanding of the teacher's role as a result of their experience and the peer evaluation, which will certainly reflect on the construction of their teaching practice.

Received on November 19, 2014
Accepted on November 29, 2015

Translation from Portuguese: Laerte J. Silva
Translation Review: Ananyr Porto Fajardo

Notes

1 Experiment available at: <http://www.pontociencia.org.br>.

2 Mateus (2001, p. 40).

3 Mateus (2001, p. 40).

References

BAKHTIN, Mikhail. **Marxismo e Filosofia da Linguagem**. São Paulo: Hucitec, 2006.

BRASIL. Ministério da Educação (MEC), Secretaria de Educação Média e Tecnológica (Semtec). **Parâmetros Curriculares Nacionais para o Ensino Médio**. Brasília: MEC/Semtec, 1999.

BRASIL. Ministério da Educação (MEC), Secretaria de Educação Média e Tecnológica. **PCN+ Ensino Médio**: orientações educacionais complementares aos

Parâmetros Curriculares Nacionais. Ciências da Natureza, Matemática e suas Tecnologias. Brasília: MEC/ SEMTEC, 2002.

CIRÍACO, Maria das Graças Silva. **A Formação de Professores de Química**: Reflexões Teóricas. 5º Encontro de Pesquisa em Educação da UFPI, UFPI, 2009. Disponível em: <http://www.ufpi.edu.br/subsiteFiles/ppgedarquivos/files/eventos/evento2009/GT.13/05_Maria%20das%20Gra%C3%A7as%20Silva%20Cir%C3%ADaco.pdf>. Acesso em: 14 nov. 2014.

FINO, Carlos Nogueira. Vygotsky e a Zona de Desenvolvimento Proximal (ZDP): três implicações pedagógicas. **Revista Portuguesa de Educação**, Minho, v. 14, n. 2, p. 273-291, jul./dez. 2001.

GARNICA, Antonio Vicente Marafioti. Algumas Notas Sobre Pesquisa Qualitativa e Fenomenologia. **Interface Comunicação, Saúde, Educação**, v. 1, n.1, p. 109-122, ago. 1997.

LUTFI, Mansur. **Cotidiano e Educação em Química**: os aditivos em alimentos como proposta para o ensino de química no 2º grau. Ijuí: Ed. Unijuí, 1988.

MALDANER, Otavio Aloisio. **A Formação Inicial e Continuada de Professores de Química**. Ijuí: Unijuí, 2000.

MARTIN, Lucia Oliver; ROMANOWSKI, Joana Paulin. A Didática na Formação Pedagógica de Professores. **Educação**, Porto Alegre, v. 33, n. 3, p. 205-212, 2010.

MATEUS, Alfredo Luís. **Química na Cabeça**. Belo Horizonte: Editora UFMG, 2001.

MOREIRA, Marco Antônio. Negociação de Significados e Aprendizagem Significativa. **Ensino, Saúde e Ambiente**, v. 1, n. 2, p. 2-13, jul/dez. 2008.

MORTIMER, Eduardo Fleury; SCOTT, Phill. **Meaning Making in Secondary Science Classrooms**. Maidenhead: Open University Press, 2003.

MORTIMER, Eduardo Fleury; SCOTT, Phill. Entering and Exiting Turning Points in Science Classroom. Text for the Symposium Analysis of Physical Classroom Activities: theoretical and methodological issues. In: ESERA CONFERENCE, 2011, Lyon, France. **Proceedings of...** Lyon, France, ESERA, 2011.

MORTIMER, Eduardo Fleury; SCOTT, Phill. Atividade Discursiva nas Salas de Aula de Ciências: Uma Ferramenta Sociocultural para Analisar e Planejar o Ensino. **Investigações em Ensino de Ciências**, v. 7, n. 3, p. 283-306, set. 2002.

PEREIRA, Júlio Emílio Diniz. **Formação de Professores**: pesquisa, representações e poder. Belo Horizonte: Autêntica, 2000.

QUADROS, Ana Luiza; PENA, Daniela Martins Buccini; FREITAS, Mariana Luiza; CARMO, Naira Helena Simões. A Apropriação do Discurso Dialógico e os Pontos de Transição: uma análise a partir da experiência de professores de Química em formação. **Revista Brasileira de Pesquisa em Ensino de Ciências**, Belo Horizonte, v. 15, n. 2, p. 321-337, 2015.

QUADROS, Ana Luiza de. **Aulas do Ensino Superior**: uma visão sobre professores de disciplinas científicas na Licenciatura em Química da UFMG. 2010. 291 f. Tese (Doutorado) – Programa de Pós-Graduação em Educação, Faculdade de Educação, Universidade Federal de Minas Gerais, Belo Horizonte, 2010.

QUADROS, Ana Luiza de; CARVALHO, Emerson; COELHO, Flávia dos Santos; SALVIANO, Luciana; GOMES, Maria Fernanda; MENDONÇA, Paula Cristina; BARBOSA, Rosemary Karla. Os Professores que Tivemos e a Formação de Nossa Identidade Como Docentes: um encontro com nossa memória. **Ensaio**: pesquisa em educação em ciências, Belo Horizonte, v. 7, n. 1, p. 9-18, jul. 2005.

QUADROS. Ana Luiza de. A Água Como Tema Gerador do Conhecimento Químico. **Química Nova na Escola**, São Paulo, v. 10, n. 20, p. 26-31, nov. 2004.

SANTOS, Ana Cristina Souza. Complexidade e Formação de Professores de Química. I Encontro Brasileiro de Estudos em Complexidade, 2005, Curitiba. **Anais...** Curitiba: 11 a 13 de julho de 2005.

SCHNETZLER, Roseli Pacheco. Concepções e Alertas Sobre Formação Continuada de Professores de Química. **Química Nova na Escola**, v. 8, n. 16, p. 15-20, nov. 2002.

SANTOS, Wildson Luiz Pereira dos; SCHNETZLER, Roseli Pacheco. **Educação em Química**: compromisso com a cidadania. Ijuí: Unijuí, 1997.

SILVA, Camila Silveira; OLIVEIRA, Luiz Antonio Andrade. Formação Inicial de Professores de Química: formação específica e pedagógica. In: NARDI, Roberto (Org.). **Ensino de Ciências e Matemática I**: temas sobre a formação de professores. São Paulo: Cultura Acadêmica, 2009.

TARDIF, Maurice. **Saberes Docentes e Formação Profissional**. Petrópolis: Vozes, 2002.

VYGOTSKY, Lev Semenovich. **A Formação Social da Mente**: o desenvolvimento dos processos psicológicos superiores. São Paulo: Martins Fontes, 1994.

Ana Luiza de Quadros holds a MSc in Education in Sciences from UNIJUI and a PhD in Education from UFMG. She is a Professor of Chemistry Teaching at the Chemistry Department - ICEx - UFMG and at FaE/UFMG Postgraduation Program in Education.
E-mail: ana.quadros@uol.com.br

Daniela Martins Buccini Pena holds a Bachelor's degree in Chemistry from UFMG (2012). She worked as a teacher at high school and vocational level. Presently she is a MSc student at the Post-graduation program in Education at UFMG School of Education.
E-mail: danielabuccini@gmail.com

Mariana Luiza de Freitas is a Bachelor's student in Chemistry at UFMG. She works as an undergraduate research scholarship recipient in a project linked to the school where she studies.
E-mail: mariana@hamy.com.br

Naira Helena Simões do Carmo is a Chemistry Technician by Centro Federal de Educação Tecnológica de Minas Gerais (2007) and holds a Bachelor's degree in Chemistry from Universidade Federal de Minas Gerais (2015). She worked as an undergraduate research scholarship recipient during the accomplishment of the present work.
E-mail: nhsc01@yahoo.com.br