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ARTICLE

COLLECTIVE REFLECTION IN TEACHER EDUCATION: AN EXPERIENCE IN THE CHEMISTRY TEACHER TRAINING COURSE IN UFVJM

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ABSTRACT:

What motivated this investigation is the idea that although students of teacher training courses engage in important theoretical discussions, they do not always act differently from what their teachers used to. Our project placed Chemistry teachers in training into procedures to prepare and develop their own classes based on contextualized themes that were deployed in three classes in High School. These classes were analyzed collectively, in evaluation meetings, seeking to promote a reflective process. For this, the classes and evaluation meetings were recorded in video. In this article we analyze the contributions of the reflective process in understanding the role of the teacher in a classroom. We observed expressive results in the appropriation of their theoretical studies (discursive interactions, nature of Science and pedagogical link-making), based on the teaching performance of each student. This study brings important implications in understanding the teacher formation, mainly for curricular stage.

Keywords:
Teacher training;
Reflective process;
Collective evaluation.

A REFLEXÃO COLETIVA NA FORMAÇÃO DE PROFESSORES: UMA EXPERIÊNCIA NO CURSO DE LICENCIATURA EM QUÍMICA DA UFVJM

RESUMO:

A percepção de que os egressos do curso de formação de professores, apesar de realizarem estudos teóricos importantes, nem sempre atuam de maneira diferente daquela que seus professores atuavam nos levou a realizar esta investigação. Envolvemos professores de Química em formação na elaboração de aulas a partir de temas do contexto, que foram desenvolvidas em três turmas de instituições do Ensino Médio. Essas aulas foram analisadas coletivamente, em reuniões de avaliação, para que um processo reflexivo acontecesse. Para isso as aulas e as reuniões de avaliação foram gravadas em vídeo. Neste trabalho analisamos as contribuições da reflexão no entendimento do papel do professor em sala de aula. Observamos resultados expressivos em termos de apropriação de estudos teóricos (interações discursivas, natureza da Ciência e relações pedagógicas), realizados com base na prática docente de cada um. Este estudo traz implicações para a formação de professores, principalmente para o estágio curricular.

Palavra-chave:
Formação de professores;
Processo reflexivo;
Avaliação compartilhada

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LA REFLEXIÓN COLECTIVA EN LA FORMACIÓN DE PROFESORES: UNA EXPERIENCIA EN EL CURSO DE QUÍMICA EN UFVJM

RESUMEN:

La percepción de que los egresados del curso de formación de profesores, a pesar de que realizan importantes estudios teóricos, generalmente no actúan de manera diferente a lo que hicieron sus maestros nos llevó a realizar esta investigación. Involucramos a los profesores de Química en formación en la preparación de clases desde temas del contexto, las cuales se desarrollaron en tres clases de escuelas de secundaria. Se analizaron esas clases en conjunto, en reuniones de evaluación, con el fin de promover el proceso reflexivo. Para ello, se llevaron a cabo grabaciones en video de las clases y las reuniones de evaluación. En este artículo analizaremos las contribuciones de la reflexión para comprender el rol del profesor en las clases. Los resultados fueron expresivos en cuanto a la apropiación de estudios teóricos (interacciones discursivas, naturaleza de las Ciencias y relaciones pedagógicas), realizados con base en la práctica docente de cada uno. Esta investigación trae implicaciones para la formación de profesores, principalmente para la práctica curricular.

Palabras clave:
Formación de profesores;
Proceso reflexivo;
Evaluación colectiva.

INTRODUCTION

The poor integration between scientific and teaching professional knowledge and of such knowledge with the school reality has characterized teacher training in Brazilian undergraduate courses (Schnetzler, 2010). According to the author there is a dichotomy in courses for the formation of Chemistry teachers between specific disciplines in the field of Chemistry and pedagogical ones. While the trainers responsible for specific chemical content disciplines provide little or no attention to the "what, how and why" to teach, teachers of pedagogical disciplines tend to deal with theories that show the complexity of the teaching process, without relating them directly to chemical knowledge.

By offering the undergraduates joint but unrelated disciplines, perhaps we are transferring them a simplistic view of teaching. As these are two different types of pedagogical discourse – of Chemistry and of Pedagogy – it is likely that the licentiate bachelors, when taking up teaching, will choose what seems personally most convenient. For the association between these two discourses to happen during the initial training, whose curriculum is fragmented into disciplines, it is necessary to think of strategies that minimize such fragmentation.

Quadros and Mortimer (2018) resume this discussion stating that the Chemistry teacher training courses, despite working with contemporary teaching trends, "have not always managed to have their graduates acting differently from what their teachers used to do" (p. 36). To strengthen this training numerous proposals have emerged in the specialized community. Several authors (such as Alarcão, 2011; Echeverría; Benite; Soares, 2010; Pérez Gómez, 1997; Nóvoa, 1995, 2009; Schön, 1995, 2000; Zeichner, 1997, 2003) have defended teacher training as a practical professional and reflective. In this work we focus on the practical and reflective professional in a collective environment because it seems to us consistent with what we propose as a training process. In this work, we aimed at analyzing possible contributions of the reflective processes for the improvement of the teaching practice of Chemistry students.

THEORETICAL FRAMEWORK

Among the existing paths available in the literature as possibilities to improve teacher training, we considered some points on the proposals presented by António Nóvoa and Donald Schön. Nóvoa (2009; 2014) argues it is necessary to build a more comprehensive conception of teacher training, in which the daily life of the teaching profession is an essential part. To this end, the author advocates teacher training to be built within the profession, closer to school reality and problems experienced by teachers. Regarding teacher training, he warns that there is an excess of speeches and a great lack of practices. According to the author the speeches are coherent, but have not been able to do what is necessary. Given this reflection, Nóvoa defends three measures that are far from exhausting the possible answers, but can help overcome many dilemmas: a) getting teacher training into the profession; b) promoting new ways of organizing the profession; c) reinforcing the personal dimension and the public presence of teachers.

Regarding the first measure, which especially interest us, Nóvoa (2014) defends the need for teachers in service to have a predominant place in the training of their colleagues and emphatically claims there will be no change if the training teacher team and the community of teachers in service do not become permeable and embedded. Nóvoa advocates teacher training in which shared reflection is not just a simple expression, but an in-depth study of real-school life cases, especially related to school failure. He stresses that there must be collective analyzes of adopted pedagogical practices and mainly there be a genuine desire for change. We agree with Nóvoa's (2014) argument that teacher training institutions often ignore or know little about the reality of schools. In the face of this "it is essential to reinforce teacher training frameworks and practices based on investigations that have as problems the teaching action and school work" (Nóvoa, 2014, p. 19). According to the author, there is no point in writing texts and texts showing the praxis and reflective teachers as teaching knowledge references if we do not assign greater presence of the profession in the teachers' training. According to Nóvoa it is about affirming that our theoretical proposals only make sense if they are built within the profession, considering the need of teachers to be active in their classrooms, thereby reflecting on themselves and their own work (2014, p. 20).

Regarding the second measure, Nóvoa (2014) mentions Pat Hutchings and Mary Taylor Huber (2008) referring to the importance of strengthening communities of practice, which are conceptual spaces built by groups of educators to discuss issues related to teaching and learning. In addition, they must develop common perspectives for the challenges of both their personal and professional training as well as of students. Regarding communities of practice, Nóvoa (2014) warns that they are able to reinforce a feeling of belonging related to professional identity. Such feeling is "essential for teachers to fully understand the change processes and transform them into concrete intervention practices" (Nóvoa, 2014, p. 21). According to the author, it is the collective reflection established within the communities of practice that gives meaning to the professional development of teachers. However, clarifies that if there are no changes in public policies towards teachers as well as in schools conditions, none of this will be achieved. Communities of practice and their reflections will be useless if there is no school organization to facilitate them. According him, it is useless to propose training based on the partnership between schools and universities if regulations make this approximation difficult.

And finally, the third measure concerns the reinforcement of the personal dimension and the public presence of teachers, evidencing the construction of personal/self-knowledge within professional knowledge. For Nóvoa (2014), this knowledge is important to understand the specificity of the teaching profession and for teachers to build lifelong learning paths. The author evidences that the continuous training of teachers started as a right, became a necessity and is now seen as an obligation. Nóvoa (2014) highlights the fact that many of these continuing education programs have been useless for teachers. According to the author it is necessary to refuse this consumerism of courses that characterize the "training market", always fueled by the feeling of outdated teachers. The solution offered by the author is the "investment in the construction of networks that support trai-

ning practices based on sharing and professional dialogue" (2014, p. 23). Another aspect highlighted is the need for training places (universities and schools) to reinforce the public presence of teachers. The author explains that much is said about schools and teachers, but who do that are journalists, politicians, columnists, etc. As teachers do not speak, they reinforce a type of silence of a profession that has lost visibility in the public space.

Donald Schön seems to have inspired "a whole generation of Brazilian researchers to propose a new model of professional training based on reflection about practice also to teachers" (Fontana; Fávero, 2013, p. 3). The publication of the book Educating the Reflective Practitioner in 1987 allowed Schön to expanded the concept of reflection in action, developed previously in 1983. Using training in some higher education courses as a starting point for his studies and under the strong influence of John's work Dewey (1959), Schön brought to the discussion the then current situation and the perspectives of professional education, which contributed a lot to give visibility to the theories about the epistemology of practice. Schön's studies (2000) centered on reflective practice and aimed at the formation of a reflective professional, deal with three distinct types of reflection: knowing in action, reflection in action and reflection on reflection in action. As we deal with teacher training, we synthesize these types of reflections thinking also about the professional teacher.

Schön (2000) used the expression **knowing in action** to refer to types of knowledge that we reveal in our intelligent actions, such as walking or cycling. Schön explains that in these two examples the act of knowing is in the action and we reveal it through our skilled and spontaneous performance. He also clarifies that the fact that we are not able to make them verbally explicit is a characteristic of us. As Feitosa and Dias defend, in the case of the teaching profession (2017), knowing in action corresponds to a set of internalized knowledge acquired through experience and intellectual activity. The authors explain that such knowledge is mobilized by teachers in concrete work situations in their daily actions in an unconscious and mechanical way. Knowledge in action refers to "the teacher's observations and reflections in relation to the way he/she moves in his/her practice" (Feitosa; Dias, 2017, p. 17). By becoming aware of the actions he/she develops in the classroom, the teacher can be led to change hisher practice, looking for other ways to produce learning. If he/she looks critically at what happened in his/her class, he/she will possibly come up with new strategies, especially if that view is anchored in teaching and learning theories.

Reflection in action takes place, as the name suggests, during the action. Therefore, it deals with a knowledge that is already present and that gave rise to the actions taken. Schön (2000) explains that we can reflect on the action by thinking retrospectively about the act performed, with the aim of discovering how the act of knowing in the action may have contributed to an unexpected result. In this regard, the author points out that we can carry out this reflection in two different moments: after the fact, in an atmosphere of tranquility, or in the middle of the action, without interrupting it. Regarding the second moment, Schön argues that it occurs "in a period of time that varies with the context, during which we can still interfere in the developing situation, [in which] our thinking serves to give a new shape to what we are doing while we still do it" (2000, p. 32). Cases like this characterize the process of reflection in action, which can be described as reflecting during an ongoing task. Reflection in action allows us to think critically about what may have caused an unexpected situation and, in this reflection, think about action strategies and understanding phenomena to be able to deal with these situations at the moment they are occurring. Therefore, reflection in action has a critical function that allows questioning the assumptions of the acts of knowing during the action. Reflection in action is a process that we do without saying what we are doing (SCHÖN, 2000, p. 35). Feitosa and Dias (2017) comment that through this reflection the teacher builds new knowledge, "becoming a flexible and accessible professional to the challenges imposed by the complexity of the interaction with the practice, creating strategies to enhance reflection in action" (p. 17). However, the dynamism of teaching activity makes reflection in action difficult to describe. In a chapter published in the book "Teachers and their training", Schön (1995) reports an example of how a reflective teacher can develop the process of reflection in action:

> First there is a moment of surprise: a reflective teacher allows him/herself to get surprised by what the student did. Secondly, he/she reflects about it, i.e., thinks about the student's action and simultaneously tries to understand the reason why he/she was surprised. Thirdly, he/she reformulates the problem raised by the situation [...]. And finally, he/she performs an experiment to test his/her new hypothesis. For example, he/she asks a new question or establishes a new task to test the hypothesis formulated on the student's way of thinking. This process of reflection in action does not require words (Schön, 1995, p. 83).

In turn, the **reflection on reflection in action** considers a reflective process already on and occurs after the teacher's reflective action. According to Schön (1995), the teacher may think about what happened after class, what was observed and the adopted practice. In this case, the teacher mentally reconstructs the action in order to analyze it, realizing what happened before and after the action and how the "problems" that arose were solved (Feitosa; Dias, 2017). Reflection on reflection in action is "an action, an observation and a description that requires the use of words" (Schön, 1995, p. 17). We agree with Feitosa and Dias (2017) when they state that, by developing this type of reflection, teachers can develop new ways of acting, thinking and solving problems, as it is possible to become aware of errors and try to act differently.

Pimenta (2005) states that after the publication of the book Educating the Reflective Practitioner, research on reflective practice proliferated, both in initial and continuing teacher education programs. Nevertheless, there have been criticisms to Schön's reflective teacher concept, as some authors pointed it out as an empty term in the field of teacher education, having been appropriated in a generalized and decontextualized way, and thus became a fad (Shigunov Neto; Fortunato, 2017). Accordingly, Pimenta (2005) states that the concept has been confused with an adjective and does not stand as a theory for understanding teaching work. She says that these criticisms focused on the following aspects: (a) Schön considered the reflexive activity as a process in itself, isolated from the process as a whole, which certainly creates a serious problem, as this isolated situation precludes a real diagnosis of the context in which the situation occurred; and (b) the reflective teacher proposal would be centered only on the activity itself, without taking into consideration the contextual dimension that surrounds the teaching activity.

Although we consider these criticisms, we emphasize that, in contrast to the technical rationality in teacher training, it is certain that being a teacher will always depend on the context. What a teacher does in one classroom may not be adequate for another, and a solution to a problem in one school may not be the same in another, although the nature of the problem is the same. Therefore, teaching is very unpredictable, relational, and human. Thus, solutions need to be thought out for the situation in which they occur and the reflective process has a lot to contribute to this.

We appropriated some characteristics of teacher training advocated by Nóvoa (2009; 2014). We start from the hypothesis that practice as a curricular component (PCC) and curricular internships, as they are conducted in Brazilian teacher training courses, could serve as a locus for the teacher to start reflecting on his/her own practice in the light of contemporary teaching and learning trends. In this work future teachers participated in didactic experiences to promote reflection and self-reflection about what was experienced. Thus, we involved our teachers in training in the act of knowing in action, so that they could reflect on the action retrospectively in relation to the act performed. As a result, we expected that they would be more reflective, both in planning and conducting their following actions. To this end, we also considered the principle of reflective learning proposed by Schön (2000), who advocates the training of professionals who know how to reflect on their own practice, expecting that such reflection would become an instrument to develop thought and action. In most cases the reflection was based upon theories of teaching and learning. Thus, in this work, the theoretical studies developed by Nóvoa (2009; 2014) are complemented by the studies of Schön (1987; 1995; 2000) as the training takes place in practice, using the reflective process.

METHOD

Lüdke and André (2013) affirm that the interest of Education researchers in using qualitative methodologies is increasingly evident. According to Minayo (1994), this type of research explores the meanings, aspirations, beliefs, values and attitudes, in short, the "relationships, processes and phenomena that cannot be reduced to operationalization of variables" (p. 22).

Bogdan and Biklen (1994, p. 47) highlight five characteristics of qualitative research: I. The data source is the natural environment, in which the researcher introduces himself and spends a great deal of time in schools, families and other places with the objective to elucidate educational issues; II. The investigation is descriptive, i.e., the data collected is in the form of words or images and not just numbers; III. The focus is the process, in which the interest in negotiation of meanings is greater than in the results and the product; IV. The data are analyzed inductively; V. Meaning plays an important role and researchers are interested in understanding how these meanings are constructed and gain sense. The authors remind us that not all qualitative investigations bring all these characteristics, i.e., some are devoid of one or more characteristics.

This qualitative study, which presents some case study characteristics, was concocted at the Federal University of the Vale do Jequitinhonha and Mucuri (UFVJM), located in municipality of Diamantina, in the northern region of the state of Minas Gerais. It involved a group of teachers in training of the licentiate course in Chemistry and three High School institutions. We contacted all High Schools of Diamantina and three of them were available to conduct this activity. We combined the shifts in which the activities would take place throughout the semester and left the selection of the participating classrooms and students to each school. Then we presented the proposal to a group of undergraduates who were granted with scientific initiation scholarships. Among various interested students, only seven were available to participate in this investigation.

The investigated group was composed of young people whose age varied between 20 and 25 years old and was taking the Chemistry course at UFVJM. One of whom was in the 2nd semester (Sara), one in the 3rd (Cristina), two in the 4th (Roberta and Sandra) , two on the 6th (Amélia and Paulo) and one on the 10th (Lúcia). Therefore, we had students at the beginning of the course, who did not have any experience as a teacher and a single student who had already taken curricular internship subjects, this being her experience as a teacher. One student had formal activity in the labor market, which was unrelated to teaching, but this did not impair his participation. We note that the curriculum of the Chemistry course is organized in eight semesters, but it is not common for students to fulfill all credits in the stipulated period. We organized this investigation in three stages, as follows.

a) Workshop involving teaching based on contextual themes

We addressed three thematic didactic sequences were addressed (Quadros, 2016; Quadros; Silva, 2016; Quadros, Silva; Silva, 2016) and a fourth sequence involving the content of chemical bonds. These sequences were developed in a workshop, by one of the authors of the proposal and involved eight teachers in training. The workshop was videorecorded so that they could access the tips and suggestions given by the author of the material to prepare their classes.

b) Course planning and development

From the workshop, the eight undergraduate students began planning a course to be taught to three classes of high school students, with each partner school participating with a class. This course was organized in four shifts, which would take place every two weeks, with four to five hours each, totaling a minimum of 16 classes of 50 min duration each. In each of these shifts, a sub-theme would be used to introduce some chemical concepts. Figure 1 shows the sub-themes and the main concepts that were part of this planning.

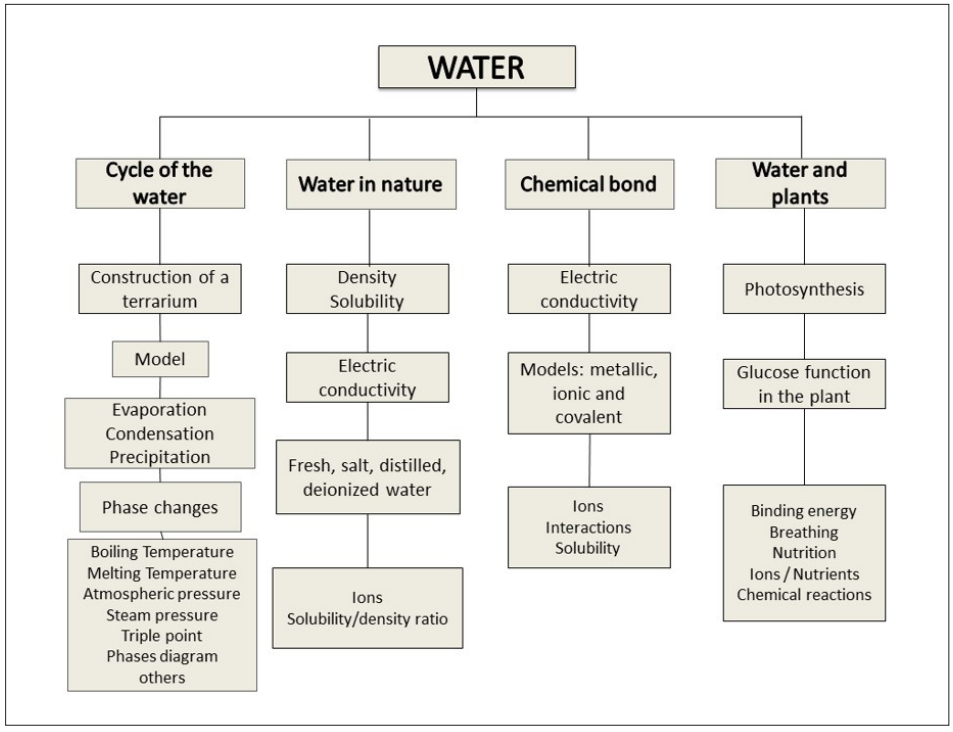

Figure 1. **Main concepts presented in the course**

Source: authors

In addition to the organization of the theme and the sub-themes to be developed, the teachers in training studied with the teaching advisors of some contemporary teaching and learning trends that should guide the classes. The classes took place in the opposite shift from the formal students' classes. The groups of students were organized by the teachers of each High School, some of them with students from different grades, as a way of reinforcing learning. Each group, which had an average of 30 students, received the material "Collection of Study Themes in Chemistry (student version)". Considering that each sub-theme was developed in a sequence of 4 to 5 class hours, in a single shift, each team was formed by three teachers in training, who divided the planning into parts, each being responsible for one of these parts. The classes were videorecorded to facilitate the analysis.

c) Shared and reflective class evaluation meetings

As the course classes for High School students took place every two weeks, the team – a teaching advisor the teachers in training – met during the interval week for the evaluation of the class that took place the previous week. Before each meeting, the teaching advisors analyzed the videos of the classes and selected fragments that were presented and analyzed together during the meetings. This was to promote reflection on the action of each teacher in training while in classroom and to confront this practice with some contemporary teaching and learning trends.

These meetings were also recorded on video and used as a parameter so that the teaching advisors could analyze the practice of teachers in training during the following classes. In some cases, even though classes explored different sub-themes, it was possible to identify changes in practices arising from the reflective process. In this work, we explored two categories that involved theoretical studies carried out during the workshop and the planning of classes (discursive interactions and nature of Science) and two other categories that emerged from the classes developed by the teachers in training (pedagogical relationships and conceptual difficulties).

RESULTS AND DISCUSSION

In this work we analyzed: (a) the way teachers in training appropriated the discursive interactions when they assumed teaching and were involved in a reflective process about their own practice; (b) the understanding that they had and the one they built in relation to science; (c) how they dealt with pedagogical relationships; and (d) some conceptual difficulties they presented when developing classes. We now pass to the understanding we had regarding these factors/characteristics.

a) Discursive interactions in the classroom

During the planning period of the classes, the teachers in training conducted studies on discursive interactions, based on the proposal of Mortimer and Scott (2002; 2003). According to these authors, the development of meanings from the content developed in class also depends on the discourse, for which they point out two dimensions. First, considering verbal interaction, the class can be more interactive (active participation of students) or less interactive (the speech is centered on the teacher). Second, the discourse can be dialogic (when different ideas are considered) or authoritative (when only the scientific idea is considered).

From this study, teachers in training were instructed to encourage and promote the active participation of students, using questions. Therefore, many questions took part of the class planning. After the first set of classes (Water cycle), these questions were analyzed and we observed that the students' answers were not always considered. The teaching advisor selected fragments of Paulo's class in which this was observed, presented them to teachers in training at the shared and reflective evaluation meeting. An excerpt from the dialogue after they watched the video follows.

> **Teaching advisor:** *What is Paulo doing here?*
>
> **Sara:** *He's answering his own questions!*
>
> **Paulo:** *I wanted just to do that, for I was going to come back to these qustions later on. I planned, it was on purpose.*
>
> **Teaching advisor:** *Did you notice that when you asked, the student in the corner started answering? Did you notice that?*
>
> **Paulo:** *Yes...* ((answering half-heartedly)).
>
> *The teaching advisor showed the video again.*
>
> **Roberta:** *The student answered at that point.*
>
> **Paulo:** *Sure! That's exactly what happened.*
>
> (Excerpt of the reflective and shared evaluation meeting of Module I)

From this discussion, the teaching advisor took up Mortimer and Scott's (2003) proposal, emphasizing the difference between a more interactive class, and a less one; and between an authoritative discourse and a dialogical one. In the following classes, we noticed that not only Paulo, but also the other teachers in training started to deal better with the students' answers. An excerpt from Sara's class follows.

> **Sara:** *Is nature made up only of substances?* (waiting for answers).
>
> **Sara:** *What else do you think it's made of?* ((no answers)). *This group is very quiet. Aren't you going to answer? [....]*
>
> **Sara:** *If I have one substance and put it together with another, what do I get?*
>
> **Student 1:** *A mixture.*
>
> **Sara:** *Speak louder please!*

Student 1: *A mixture.* ((Students applaud)).

Sara: *So, what is a mixture?*

Student 2: *When you have more than two substances.*

Sara: *Do you all agree?*

(Excerpt from class of Module II – School A).

We could see that Sara, in the next set of classes, encouraged student participation. She redid her own questions, waited for the answers and, upon hearing the word "mixture", did not evaluate the answer, choosing to check the students' understanding of that concept. This is an example of change in the practice of teachers in training, probably due to an awareness of their own practice. We believe that the reflective process (NÓVOA, 2014) that took place in the collective environment was important for this change to occur. The teachers in training reflected on the own practice (SCHÖN, 1995), compared it with theoretical studies and were able to notice other possibilities for teaching action.

During the last collective meeting held by the group, Paulo asked for the floor and made a comment in relation to asking students questions, giving them time / space for them to respond. He said: "I planned questions to ask students and then I needed to understand that they needed time to answer. But I never imagined that they would ask us so many questions". This comment received the support of other teachers in training, which may be an indication that they realized that students have doubts in relation to what is treated in the classroom and that the dialogical discourse (Mortimer; Scott, 2003) can favor the identification of these doubts and the reorganization of the class, so that they can be resolved.

b) Aspects related to the nature of science

Many researchers (Cachapuz *et al*., 2005; Gil-Pérez *et al*., 2001; Mansour, 2009; Silva; Machado; Tunes, 2010) have pointed out the unpreparedness of science teachers in dealing with the nature of scientific knowledge. We believe that a more adequate understanding of science is an important condition for teachers and for society in general. Thus, perceiving and reflecting on their beliefs regarding science proved to be feasible for teachers in training to evolve in their conceptions.

When we analyzed the classes, we noticed that in some moments the teachers in training had mistaken beliefs regarding to science. Lúcia, for example, when developing the classes of Module II, dealt with different materials and stated that if those materials were observed with the aid of a microscope it would be possible to see the difference among the atoms present in them. We prepared a slide transcribing this and other speeches, without identifying the authors, to be worked on at the second meeting. The teaching advisor who conducted the meeting took up some basic concepts involving the nature of science and emphasized the impossibility of doing what the teachers in training had suggested in class, and how much they could be causing High School students to have a wrong idea of Chemistry.

She also highlighted the chemical science as a way of explaining the physical world and returned to the photosynthesis equation, already explored in the workshop, as an example of mistaken scientific explanation, which needed to be reviewed by science from more advanced studies. During the second meeting the teaches in training only followed the explanations of the teaching advisor and apparently agreed, as they did not comment on the statements highlighted on the slide.

In classes involving the Chemical Bonds content, which had been planned so that the bonds were taught as an explanation for the property of electrical conductivity, we sought to observe the performance of the teachers in training when developing them. Right at the beginning of class, at School A, Roberta carried out the electrical conductivity experiment and, in all of her statements, emphasized the word "model" when dealing with the types of chemical bonds. The two fragments transcribed below give an idea of Roberta's statements, considering that she participated in classes at two schools (A and C):

Roberta: *There are several models for the chemical bond. The ionic, metallic, and what else*

Student: *Covalent.*

Roberta: *That's right, covalent.*

[...]

Roberta: *Now Sandra is going to explain to you the next bond. Remember that these are models that science has created to explain the properties of materials.*

(Excerpt of class about Chemical bonding - School A)

Roberta: *The nail conducted electricity. Science created models to explain things like that. Which is the bonding model for metals?.*

Students: *Metallic.*

Roberta: *Some liquids also conduct [...]. Why do they conduct?*

Student: *Because they have ions.*

Roberta: *And what model did you come up with to explain it?*

Student: *Ionic bonding.*

Roberta: *And those that don't conduct? Why?*

Student: *They have no ions.*

Roberta: *And how do you call the model created to explain it? Do you know?*

Student: *Covalent.*

(Excerpt of class on chemical bonding - School C)

As with Roberta, Lúcia also developed part of the chemical bonding class, but at school B. In the previous module, as we have already said, she had referred to the use of the microscope to observe chemical "entities" (different atoms). In class, Lúcia spoke of chemical representations as models for an infinitely small world, which cannot be seen. About this chemical representation, A student asked her if it could be "wrong", to which Lúcia replied: *"Not wrong really, but it would be right to say that the model would no longer be able to explain".*

In a way, she communicated to students the idea that Chemistry has its own way of explaining the existing materials in nature. Other teachers also provided evidence that they understood better the nature of science and tried to build a discourse consistent with that knowledge. It is possible that the discussion and reflection held at the second meeting contributed to make them aware of their own discourse, so they could improve it. The reflection (Schön, 2000) carried out collectively became an instrument for the development of thought and action.

c) Pedagogical relations of continuity

Considering the need of the student to relate knowledge to itself and to the context (social, scientific, and/or professional), research (Quadros, Silva, Mortimer, 2018; Silva *et al*., 2016) has evidenced that the division of this knowledge into units and themes requires the teacher to proceed to pedagogical relations among several concepts present in the curriculum, which requires the teacher to be familiar with the curriculum organization.

Scott, Mortimer, and Ametller (2011) developed studies involving pedagogical relations, dividing them into three main groups: a) relations to support knowledge construction that relate science and context; scientific and everyday explanation; science and phenomena; among different concepts; among different levels of representation; and analogies; b) relations of continuity, which involve the teacher relating content and concepts that are being worked on at that moment with content and concepts that have already been worked on at previous moments; and c) relations to encourage emotional involvement. The authors state that these relationships are fundamental to the teaching and learning of science, and that knowing them can enable teachers to reflect on and analyze their own teaching practice.

At this point we focused on the relations of continuity, which provided us with an idea about the teachers in training's understanding of the didactic proposal of the thematic material used and how they established these relations in the classes they developed. To provide continuity, the teacher must establish a relationship between the content being worked on and others that have already been worked on previously in the classroom. We noticed that in some moments the relations of continuity were happening, so we decided to take this issue to the group discussion, in the second class evaluation meeting. We selected some class fragments and then transcribed a fragment from Paulo's class, in which he tested the electrical conductivity of several liquids.

> **Paulo:** *Let's test with distilled water* ((he tests and students follow along)).
>
> **Paulo:** *Distilled water is not enough to light the lamp. Where do we find distilled water in nature? Do you remember? It is from the first module; let's see if your memory is fine.*
>
> **Student:** *What did we learn in the first module?*
>
> **Paulo:** *The water cycle, water evaporates and condenses.*
>
> **Student:** *Ah... the rainwater!*
>
> (Excerpt of class on chemical bonding – School B)

After watching these fragments the teachers in training did not speak, apparently because could not identify the intention of the teaching advisor. Then, she asked Paulo why he had chosen to ask questions about distilled water, as this subject had already been covered. We transcribe part of this dialogue between the teaching advisor and Paulo.

> **Teaching advisor:** *At that point in the class, was there a need to return to this discussion? Was this foreseen in the planning?*
>
> **Paulo:** *No, but ...*
>
> **Teaching advisor:** *Why did you choose to do that?*
>
> **Paulo:** *Because... I don't know if I can explain, but I thought the following: the modules cannot be worked independently. They* ((students)) *will not finish a module knowing all the concepts of chemical bonding. But this module is not independent, it is linked to content that we worked on in previous modules. So, I used the distilled water as a way to see whether they understood the contents independently or were managing to connect the subjects of one module with those of another.*
>
> (Excerpt of the meeting of shared analysis and reflection on the Chemical bonding classes)

In constructing his explanation, Paulo made clear a knowledge he built regarding the didactic material: the classes are related among themselves. Thus, he built continuity relations exactly to identify whether the students were able to perceive the relation among the contents of different classes. From this we conducted a study of these relations with the teachers in training, based on Scott, Mortimer and Ametller (2011), emphasizing how much such relations can help learning, as they relate different contents and, by doing so, it is possible to decrease the much criticized fragmentation of contents. In several other moments of the didactic sequence these relations of continuity appeared, some already indicated in the didactic material used and others constructed by the students. Thus, the theoretical study was carried out in function of a practice perceived by the teaching advisor, both as a way to highlight the protagonism of Paulo and others, and reinforce the inseparability of theoretical studies with teaching practice.

d) Conceptual difficulty

Throughout the analysis of the classes we noticed some conceptual problems present in the discourse of the teachers in training, which may have arisen due to certain "nervousness" when taking on the teaching job. In order to draw their attention to conceptual deviations observed in their classes, the teaching advisor presented,

in the second meeting of shared and reflective evaluation, some slides containing the main errors committed by them, without identifying their authorship. We did not present such fragments as we thought it could cause embarrassment. During this meeting, the teaching advisor showed the group a slide with a figure drawn on the board (by the undergraduate Lúcia) during the development of the Module II classes. The figure represented a beaker containing a mixture of oil and water, and next to the beaker there was an indication that it was an example of a "heterogeneous solution". The teaching advisor asked the teachers in training if they noticed any conceptual errors in the figure. At this point, Lucia said that she was the one who made the mistake and that the correct writing would be "heterogeneous mixture" next to the beaker, but that she had not noticed the error until then. We noticed that Lucia realized this conceptual error only when the teaching advisor showed the picture.

Continuing the discussion, the teaching advisor stated that, with the exception of Sara, all the teachers in training were confused with the concept of mixture during the explanations, as they asked the students several times why water and oil did not "mix". In the workshop and lesson planning it had been emphasized that the concepts of miscibility/immiscibility should be employed when evaluating the formation of mixtures by two or more substances in the liquid state and that heterogeneous mixing between two liquids only happens if they are immiscible. Therefore, they were instructed to explain to the students that water and oil form two phases because they are immiscible. Amelia and Lucia, during the meeting, were quite surprised to realize what had happened during the lesson.

> **Teaching advisor:** *We just discussed that water and oil form heterogeneous mixtures. So, you agree that water and oil are a mixture?*
>
> **Amelia:** *Yes* ((also nodding her head positively)).
>
> **Teaching advisor:** *The question "Why water and oil don't mix?" came up in class* ((laughter))
>
> **Amelia:** *As they are a mixture, right, what a thing!*
>
> **Teaching advisor:** *Do you understand what I am saying?*
>
> **Lucia:** *Yeah, it seems we've used ordinary thinking, ok? We didn't realize it.*
>
> (Excerpt of the reflective and shared evaluation meeting of Module II)

It seems to us that the workshop and the planning were not enough for the teachers in training to overcome the explanations based on ordinary thinking. Like Lúcia, others did not realize that they used a language that could confuse students in Basic Education. It is possible that some concepts worked on in class were not clear enough for them, despite being basic. However, having called attention to the fact may have contributed to the professional development of these teachers (Nóvoa, 2014), due to the collective reflection established. Only Sara had paid attention to this aspect during her explanations. The following is a transcript of an excerpt from her class.

> **Sara:** *And what happened in the second experiment?* ((referring to the water and oil experiment)). *How many phases can we see?*
>
> **Students:** *Two phases.*
>
> **Sara:** *That's right, why?*
>
> **Students:** *They didn't mix together.*
>
> [...]
>
> **Sara:** *But we can't just say that water and oil don't mix. Didn't we do that mixing?*
>
> **Student:** *Yes, but....*
>
> **Sara:** *Didn't we say that a mixture is anything that contains more than one substance? We have more than one substance there* ((pointing to the beaker containing water and oil)). *Only they are not miscible. When this happens, we can say that oil is not miscible in water.*
>
> (Excerpt of class of Module II - School A)

Sara had been criticized by her colleagues at the first collective meeting for reading part of the content during her class and asking students to follow along. During the collective analysis, colleagues considered the students in the class in which Sara gave the first class to be very discouraged. It is possible that these criticisms contributed to Sara rethink her own practice and prepare herself better for the class. When the teaching advisor stated that only Sara had dealt with the concept of heterogeneous mixing as she had been instructed, she said she watched the workshop video again, as a means of preparation. Schön (2000) argues that, when developing reflection, the teacher can develop new ways of acting, since it is possible to become aware of mistakes and try to act differently, which seems to have happened to Sara.

CONCLUSION

We developed this work with the intention of analyzing possible contributions of collective reflection processes to the teaching practice of teachers in training. Although we are aware that this does not guarantee changes in their future practice when they take up the profession, we believe that reflecting on their own practice is a process that needs to be established at some point and initial training is a privileged time/space for this to happen.

We used Nóvoa and Schön's studies in a complementary way, taking the teachers in training to a teaching experience accompanied by a reflective process and anchored in theoretical studies. This reflective practice took place collectively and considering several aspects of the classroom. Of course, a more extensive work could also consider other aspects that involve education as a whole.

At no time were we looking for "solutions" to situations that occurred in class, since they need to be thought out for the situation in which they occur. However these "solutions" require reflection in relation to pedagogical practice and, as Nóvoa (2014) says, they depend on a will to change. The data obtained from the analysis of the classes and the reflective meetings showed us that, when inserted in a class proposal based on contextual themes that considered some contemporary trends of teaching and learning, the teachers in training realized the meaning of theoretical knowledge for the teaching practice. And this production of meaning was based on collective reflection in action. This reflection showed the teachers in training that the students in basic education participated more and gave better feedback in terms of understanding when the teacher used certain strategies. This made them advocate the need for changes in the lessons, although we realized that the conflict between the amount of content and more innovative actions was always present.

By having theoretical discussions anchored in practice, the teachers in training could more easily analyze their own practice and realize how much theoretical studies could contribute to real changes in that practice. This result has important implications for teacher training courses, both in the dimension of practice as a curricular component and the curricular internships, as they represent a privileged opportunity to relate theoretical studies to teaching activity, strengthening teacher training.

Therefore, we agree with Nóvoa (2014) when he states that theoretical proposals (as was the case of teaching from context themes) will only be appropriate from a reflection of teachers on their own work. We believe that this reflection should begin in the initial training which, being collective provides the sharing of experiences and learning.

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