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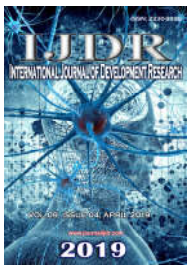

RESEARCH ARTICLE OPEN ACCESS

EXPERIMENTAL BIOLOGY WORKSHOPS: AN EXPERIENCE IN UNIVERSITY EXTENSION AT A SCHOOL IN THE SEMIARID OF BAHIA

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ABSTRACT

The scientific knowledge is subjected to a process of production whose dynamics involves transformations in the understanding of the treatment of nature, which impedes from being characterized as ready, true and finished. Moreover, this is a challenge in the field of scientific education. In this sense, it is one of the functions of Science teaching to enable the student to appropriate the structure of scientific knowledge and its explanatory and transformative potential. For this, we use an inherent strategy of Biology teaching - "experimentation", an important piece in the evolution of Sciences, as well as becoming part of a process which shelters concept and scheme networks which are interrelated. In this article, we present the experience report from the use of this methodology as a tool to assimilate Biology concepts for students of the 12th grade of high school, in a public school. The results point out that the teaching of Biology through research is in need of a change in the epistemological, cognitive and motivational conception on the importance of this tool.

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INTRODUCTION

The curricular components Biology, Physics and Chemistry in the form of science education are the way to promote scientific education in high school. Due to multiple factors such as: poor teacher formation and absence of means and stimuli in their updating, non-existent pedagogical material, absence of equipped laboratories, lack of recognition of the social function of the teacher. These are areas, which require greater human investment. Currently, the education in Science has as challenging goal the shaping of professionals for a society in constant transformation, which requires, more and more, social, ethical, and political commitments, in an interdisciplinary perspective. Therefore, it is necessary to think of educational tactics that provoke an effort in the sense of stimulating the development of creativity in the teaching of natural sciences, as well as the horizontal interaction among the several areas of knowledge.

> El reconocimiento de esta creciente importancia concedida a la educación científica exige el estudio detenido de cómo lograr dicho objetivo y, muy en particularmente, de cuáles son los obstáculos que se oponen a su consecución. En efecto, la investigación en didáctica de las ciencias ha mostrado reiteradamente el grave fracaso escolar, así como la falta de interés e incluso rechazo que generan las materias científicas (GIL-PEREZ, 2005, p.17).

This is related to the fact that scientific education - including universities - has basically been reduced to the presentation of already elaborated knowledge, without giving the students the opportunity to appropriate the activities characteristic of scientific research. It is known that Biology surrounds us on the inside and outside. Sometimes, students from Elementary and High School, (we risk saying even at higher education)generally, do not understand very well how that happens, among so many concepts, complex phenomena. The vast majority longs that the access to knowledge be done in a ludic way, and as such, the purely theoretical classes normally do not arouse as much interest from this audience as the classes, which associate the theory to practice. In other words, when the students do not have direct contact with the study objects dealt with in theoretical classes, normally the result is their complete lack of interest in studying or deepening the knowledge related to the focus subject, being tagged by them as "boring".

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Moving particles, interacting molecules, cells (re)constructing themselves, is nature giving a spectacle. It was thinking of this that we tried to carry out an extension project entitled *The Biology near you: "experimental"*[1] *workshops for high school students*, to make this understanding meaningful, in a more practical way, observing the surroundings, sharpening their curiosity and arousing interest towards the area of biology and chemistry, to these students and at the same time allow the direct contact of the graduating student in Biology with the teaching practice. To Capelleto (1992), allowing the student to reason and perform the various stages of scientific research (including, as far as possible, the discovery) is the primary purpose of a laboratory class. When the teacher listens to the students, knows their interpretations and how they can be instigated to look at the object under study from a different perspective (BRASIL, 1998, 2013), so the project worked as support in the understanding of fundamental concepts of biology and at times of Chemistry addressed in the classroom. The teaching of biology should guarantee to the student the access and understanding that leads to biological knowledge, thanks to the use of research methods, especially those of a scientific nature, and to the analysis of social, political and economic aspects involved in the production, dissemination and application of such knowledge. In this way, the project aimed at two fronts of action:

- Allow the high school student of a public school to assume a more critical, investigative and transformative stance;
- Allow the licentiate in biology to integrate the knowledge of the specific academic content to the pedagogical knowledge based on the teaching / learning process, through the contact with the knowledge produced on the school's "ground[2]".

Regarding the Teaching of Biology to the high school student of the public school, we highlight the importance of the use of investigative experimental activities in the development of cognitive abilities and their greater participation in the learning process.

The National Curricular Parameters (PCN, 1998, p.43) brings, as an essential perspective of the study of biology, the affirmation:

> More than providing information, it is essential that the teaching of biology turns to the development of competences which allow the student to deal with the information, understand it, elaborate it refute them, when that is the case, finally understand the world and act in it with autonomy, making use of the knowledge acquired from biology and technology. It is therefore necessary to select contents and choose methodologies coherent with our educational intentions. Using interdisciplinarity, relating the knowledge of the several disciplines to the understanding of biological facts or processes. Describing the processes and characteristics of the environment or living things, observed under the microscope or the naked eye.[3]

In the perspective of the formation of future science and biology teachers, to promote a shift from a view of a merely theoretical dimension to the discussion of knowledge and educational practice, taking into account the specificities of educational work and thus transforming itself into an element of analysis and production of knowledge, which assures the appropriation of knowledge and competences in the professional exercise. This proposal reinforces the understanding which is up to the Biology student to reflect and question the role of the school, the teaching, the working conditions, and their responsibility to look for alternatives to develop a good work.

> [...] it is necessary to emphasize the importance of the definition of a teacher training policy which prioritizes, amongst other aspects: the theory / practice unit, the different dimensions of the teacher competence, the formation of a reflective teacher, the need for an interdisciplinary approach, the development of the teacher's interest in everyday research, research, as well as the specific knowledge related to the nature of the teaching profession(BRITO, 2006, p. 41).[4]

Extension monitoring made it possible for the high school student in formation a greater integration with the extensionist activity in the field of teaching, providing the opportunity for them to experience in practice the learning they build in their Licentiate in Biological Sciences course. Thus, the proposal of "experimental" workshops allowed the student in training to reflect on their pedagogical practice, while at the same time they can deepen their knowledge about specific biology contents for High School, understanding the relation of content and form students in the current educational context.

Teaching of biology: "experimental" workshops: The Curriculum Guidelines for Secondary Education established by the Ministry of Education and Culture (BRASIL, 1999), point out principles and purposes for the process of completion of this formative stage: understanding the scientific and technological foundations present in contemporary society, relating the theory with practice. In this sense, the document recommends that this stage should provide the student a formation of "[...] unitary basis, in the sense of a method of thinking and understanding the determinations of social and productive life which articulates work, science, technology and culture in the perspective of human emancipation". (BRASIL, 1999: 39).

[1] The term is in quotes due to our understanding of the polysemy of the words *Experimentation* and *Education in Science.* From the philosophy of language of Bakthin (2004), we are instigated to know the concept we use in our epistemological field and as this polysemy implicates in different modalities of experimental work to scientific education. To this author, the meaning of the word is determined by its context; there are countless meanings as long as there are possible contexts.

[2] School's ground as space of construction and affirmation of the identity of workers in education.

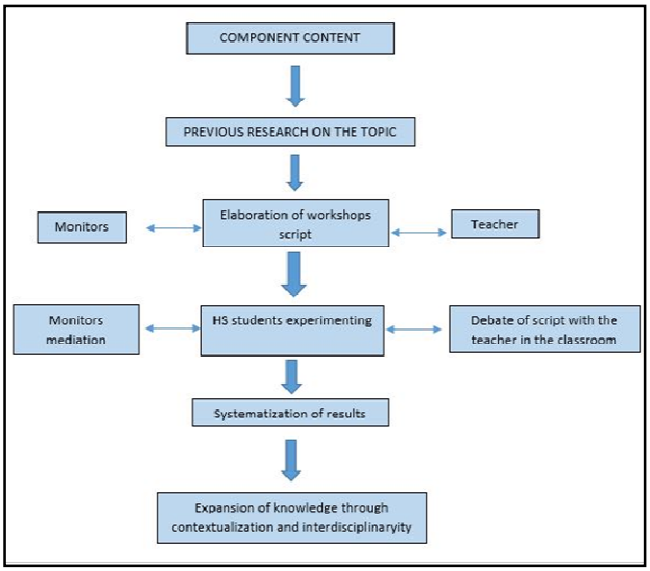
[3] Original: Mais do que fornecer informações, é fundamental que o ensino de biologia se volte ao desenvolvimento de competências que permitam ao aluno lidar com as informações, compreendê-las, elaborá-las, refutá-las, quando for o caso, enfim compreender o mundo e nele agir com autonomia, fazendo uso dos conhecimentos adquiridos da biologia e da tecnologia.É preciso, portanto, selecionar conteúdos e escolher metodologias coerentes com nossas intenções educativas. Usando da interdisciplinaridade, relacionar o conhecimento das diversas disciplinas para o entendimento de fatos ou processos biológicos. Descrever os processos e características do ambiente ou de seres vivos, observado sem microscópio ao olho nu.

[4] Original:[...] é necessário enfatizar a importância da definição de uma política de formação do professor, que priorize, entre outros aspectos: a unidade teoria/prática, as diferentes dimensões da competência do professor, a formação do professor reflexivo, a necessidade de um enfoque interdisciplinar, o desenvolvimento do interesse do professor pela investigação do cotidiano, pela pesquisa, como também os saberes específicos ligados à natureza da profissão docente (BRITO, 2006, p. 41).

Even though the Biology component is part of people's daily lives, the teaching of this component is so far from reality that it does not allow the population to realize the close link between what is studied in the Biology component and the daily life. This dichotomous view makes it impossible for the student to establish connections between scientific production and its context, hindering the necessary holistic vision that should guide learning about biology. In the socio-interactionist perspective, there is an enormous reinforcement of the importance of the school and the role of the teacher as organizer of the learning situations towards the acquisition of complex cognitive competences each time more emphasized: creativity, problem solving, analysis and prospecting. In it, the human being is conceived as someone who transforms and, at the same time, is transformed into the relations produced in a given culture. From this point of view, we perceive a dialectical interaction. An active subject in their relation to the environment reconstructs (in their thought) continuously and incessantly the world and themselves. From this perspective, biology teaching should allow students not only the condition to understand life as a manifestation of organized / integrated systems, but to be able to establish relationships that allow them to recognize that such systems change themselves over time as a function of the evolutionary process, and simultaneously allow to broaden the critical view which allows them to make decisions using this area of knowledge (BRASIL, 2006, 2015b). In this way, the contents should make sense, give meaning and contextualize with the daily life experienced in order to occur a meaningful and efficient learning (AUSUBEL, 2000).

The thematic experimental workshops functioned as an educational action, a facilitator instrument of integration, which is not restricted to the intellectual or cognitive level, because beyond the information and knowledge worked by the students, they involved changes of concepts already rooted in the school culture. (FAGUNDES, BARBOSA, 2007). The thematic workshop was characterized by presenting the biological contents from topics already discussed in the classroom in order to make biological knowledge more relevant to students due to the interconnection between contents and social context. The workshops were based on "experimental" activities, organized in a way as to provoke reflection on biological concepts and their applications in concrete situations. The treatment given to the content provided subsidies for the interdisciplinary construction of biological, physical and chemical knowledge allowing the development of citizenly attitudes based on scientific education. Since its implementation at school, a significant number of articles have criticized experimental activities (HODSON, 1996; BARBERÁ & VALDÉS, 1994), and even nowadays they are target for criticism seen that it is directly related to teacher training and their conception about experimental activities, so rooted in empiricist conceptions.

In this sense, we take as a starting point the previous organizers, that is, what is already known by the student, as a way of enhancing the internalization of scientific contents. Still, it was crucial to understand the determination of relevant aspects of the content to be developed considering contextualization and interdisciplinary. That is, it is foundational that what is being prepared is consistent with the reality of these students. For the preparation of the Workshops, we used as a basis the scheme presented by Marcondes (2008) to build our scheme of action:



Source: Elaborated by the author, 2018

Figure 1. Workshops organization scheme

In the development of the workshop, we commune with Delizoicov (2009) in proposing an interactionist activity that provides an initial rupture for the final apprehension of scientific knowledge. In this didactic model of dialogical character, the structuring axis was the problematization of knowledge. For the author:

> It is problematized, on one hand, the knowledge about the significant situations that are being explained to the students. On the other hand, it is appropriately identified and formulated the problems that lead to awareness and the need to introduce, address and appropriate scientific knowledge are identified and formulated appropriately. From that the dialogue among the different knowledge, with the consequent possibility of establishing translator dialogicity in the teaching / learning process of the Sciences. (p 197)[5]

We used the three pedagogical moments described by Delizoicov (2009, p. 209), them being: initial problematization with the presentation of a real situation, lived or experienced in its reality in order to know their thoughts on the subject; organization of knowledge, whose function is to select the content and to approach it in a way to allow them to understand the scientific phenomenon to be studied e to complete the pedagogical model; the application of knowledge, whose moment systematized the knowledge searching the generalization and extrapolation to situations which are not directly linked to the proposed theme.

Methodological Path: The "experimental" workshops of the extensionist project were offered to the 12th grade students from the public teaching system from *Senhor do Bonfim* County, in Bahia. In this work, we report the follow up of a group of six monitors to mediate the activities.

[5] Original: Problematiza-se, de um lado, o conhecimento sobre as situações significativas que vai sendo explicitado aos alunos. De outro, identificam-se e formulam-se adequadamente os problemas que levam a consciência e necessidade de introduzir, abordar e apropriar conhecimentos científicos. Daí decorre o diálogo entre conhecimentos, com consequente possibilidade de estabelecer dialogicidade tradutora no processo de ensino/aprendizagem das Ciências. (p. 197)

Table 1. Data of the "experimental" Biology workshops

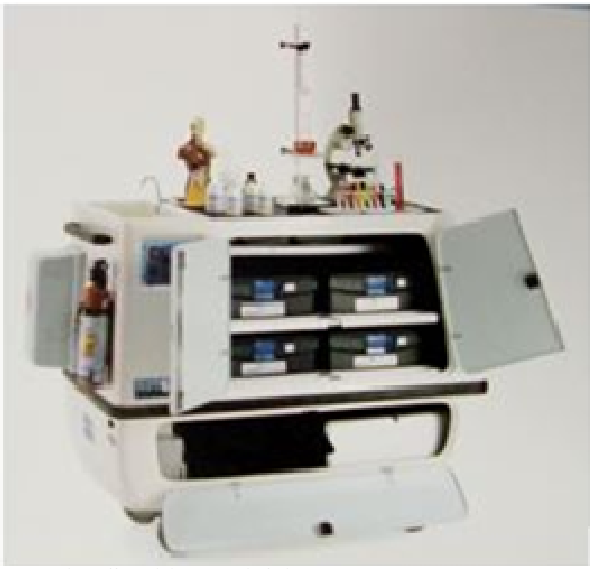
DATE[1]	SCRIPT	REAPONSIBLE MONITOR	OBJETIVE
16/08/16 17/08/16	Memorizing glassware/ equipments: the Biology/ Chemistry at stake	Two students of seventh semester	Promote the knowledge of glassware/ equipments and their functions in the use of practice in laboratories creating a familiarity with them.
23/08/16 24/08/16	Microscopy	One student from the seventh semester and one student from the third semester	Provide correct handling for identification of cells
13/09/16 14/09/16	Experimenting factors which modify the speed of reactions	Two students of seventh semester	Observe the influence of grain size and temperature on the speed of a chemical reaction.
20/09/16 21/09/16	Extracting DNA	One student from the seventh semester and one student from the third semester	To relate the biology of cells to the chemistry of molecules in understanding the concepts of basic genetics.
10/11/16 11/10/16	Extracting iron from morning cereals	Two students of seventh semester	Identify the presence of iron in the cereal and its importance to the organism.
13/11/16 14/11/16	Does the steel sponge have iron?	Two students of seventh semester	Discuss the constitution of matter and the formation of substances from oxidation reactions, introducing aspects related to everyday life.
20/11/16 21/11/16	There is always space for one more: interactions solute –solvent	Three students from the third semester	To observe the interactions of the common alcohol and the "kitchen" salt in water through their solubility.

Source: Elaborated by the author, 2018

The topics developed in these workshops were previously discussed between the teacher of the component, who is at the same time teacher of the academics and the academics of the course of Biological Sciences. The topics chosen took into account the contents of the component in a contextualization with the reality of the student, that is, their daily life, trying to address environmental, social, political, economic, technological problems related to Biology in a permanent dialogue with Chemistry and Physics. We know that experimental activities can take place in the laboratory, in the classroom, in the kitchen or in the school yard, so workshop No. 01 and 04 occurred part in the classroom, part in the laboratory, No. 08 in the kitchen and the rest in the laboratory. The project took place during the second semester of 2016 with three classes of a state public school in *Senhor do Bonfim* County, making a total of 87 students in the three classes. The workshops were offered in the school itself, which had ample rooms, accessible kitchen (previously scheduled visit) and a Laboratory, ample and equipped with instruments and equipment for the areas of Chemistry, Physics and Biology. The State School laboratory has six small windows that allow good ventilation and are all located on one side of the room. It has a central fixed bench, a side bench, which houses equipment such as microscopes, centrifuge, scale. It has two sinks, with cabinets at the bottom, 11 benches, 04 iron cabinets where most of the glassware, hardware and reagents in the school are stored. It has a fire extinguisher. The school also has a Mobile Didactic Laboratory (Figure 1), with kits for the development of experimental activities in the areas of Biology, Physics and Chemistry. During the preparatory visit for the Workshops, we identified that many chemicals were out of date and had never been used. To solve the problem, we suggested that the school's management sought a legal way to dispose of the products safely.

The workshops happened every fifteen days with half of the class to avoid accidents and better appropriate the knowledge. Each workshop, coordinated by the monitors, was from fifty minutes to an hour and twenty minute through reading the script, experimenting and debates, with an active participation of the members. In the observation script, each team, made of four to six students, should take notes of their observations and make in analysis of the data which were obtained during the activities, looking for interpreting under the light of what had been discussed in class and taking into consideration the different everyday life experience of the students.

To Bernstein (1996), the contextualization refers to the transferring of the teaching instruments from one context to another, where initially there is a process of decontextualization characterized by the selection of texts adequate to the context in which the subject is inserted. The contextualization has as purpose to promote a meaningful learning, for it is based in the notion that the context makes the mediation between thought and learning. During the workshops, the exchange of ideas was stimulated, coordinated by the classroom teacher, amongst the components of the group, coming from the problematization and systematization of knowledge. The activities were finalized with the same questionings proposed in the beginning of the activity, with the intent of verifying the conceptual gain of the students.



Source: http://autolabor.com.br/educacao

Figure 2. Mobile Laboratory

RESULT AND DISCUSSION

At the School, eight workshops were developed, however, at the moment, for didactic purposes, we will approach only the first and the last one. In workshop #1–MEMORIZING GLASSWARE/ EQUIPMENTS: THE BIOLOGY/ CHEMISTRY AT STAKE, our first practice had as objective to explore the playful aspect presenting as proposal of game. Memorizing Glassware/ Equipment is based on the Traditional

Source: Photo has been taken by the author, 2018.

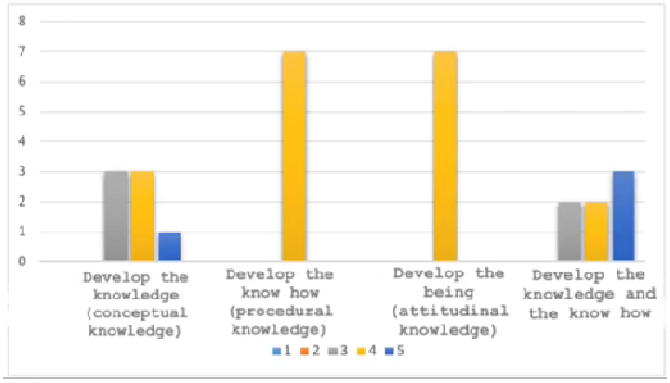
Figure 3. Memory two game produced by the students

Figure 4: a) DNA of banana b) Experimental activity: DNA extraction of a banana

Memory Game, in which the content was turned to glassware and laboratory equipment in the use of Biology, Chemistry and Physics that existed in the school laboratory. This workshop had not been planned, but in the elaboration of a first in-class discussion, the students reported that they had difficulty in experimental activities because they did not know the glassware and instruments / equipment that are used for the practical activities, even having already used this equipment in previous years. It was still found that a portion of the students were studying at this school for the first time. In this way, a reorganization of the initial planning was necessary. The development of the teaching workshop was structured in the following sequence: 1) initial survey to understand the students previous knowledge, 2) theoretical development in the classroom/ laboratory involving equipment/ instruments and glassware, 3) confection of card game by the students with support from the monitors, 4) execution of the memory game as knowledge as knowledge activator, 5) evaluation through the identification in the laboratory of the glassware or instrument/ equipment, by means of a competition among the students. In the evaluation, each pair received a kit with three glassware and one instrument and/ or equipment and had from 5 to 10 minutes to identify name, function and use. At the end, the monitors calculated 80% of accuracy of the pairs in the identification of the kits. According to Santana e Rezende (2008), the playful activity is an important tool in which the mediator, in this case, monitors and teachers, need to offer possibilities to the elaboration of knowledge, respecting the several singularities. Those activities, when well explored, give opportunity to the interlocking of knowledge, the socialization and the personal, social and cognitive development. Workshop #4 –DNA EXTRACTION aimed to explore what students know about the concept of DNA as a molecule responsible for the characteristics of all living beings. Exploring previous knowledge, from a problem situation experienced in an episode of the series CSI: Crime Scene Investigation, watched in class, debating techniques of criminal investigation and technologies of genetic manipulation we move to the following step. It was important to discuss with the students the issue of cell dimensions so as not to create in the students the mistaken expectation that the activity would allow them to visualize the "double helix" of DNA. At the same time that we did the extraction, they also acted as researchers. The second part of the "experimental" activity was a simulation of the DNA test, construction of the simulation of the gel, the DNA, and the restriction enzyme (ROSSI-RODRIGUES; GALEMBECK, 2012, page 87). At the end, the evaluation form for the teams was the presentation of proposals for a solution to the case. We allowed them several proposals from the same team, as it was difficult for them to maintain a consensus on the case. Some provocations appeared to sharpen the senses and stimulate the passage from

concrete to abstract, since we spoke in a simulation aiming to make the object under study interesting and, at the same time, to encourage their proactivity.

As for the graduation students, it was interesting giving them the opportunity during their training that the experimental activities are not restricted to manipulative skills and from that we asked: what are the objectives in making experimental activities in High School? On a scale from 1 to 5, in which 1 means a little important and 5 means very important, we registered the following result:



Source: Elaborated by the author, 2018

Graphic 1. Perception of graduation students on the importance of making "experimental" activities

The result shows that the model of training which we execute still today and has long have great influence in the elaboration of the curriculum of teacher training courses indicates remnants of the paradigm of the technical rationality. The fact that 100% of the graduation students attribute a great importance to the procedural knowledge, refers us to what is discussed by Pimenta (1999 p. 30), when he states that

> Training always goes through the mobilization of several types of knowledge: knowledge of a reflexive practice, knowledge of a specialized theory, knowledge of a pedagogical militancy. What puts the elements to produce the teaching profession, endowing it with specific knowledges that are not unique, in the sense that they do not make up a finished body of knowledge, because the problems of professional teaching practice are not merely instrumental [...][6]

It is in this sense that we understand that the formative process is still based on a linear structure, in which the teacher acquires, initially, the scientific-cultural knowledge of their area of study and then the contents related to the didactic-pedagogical formation related to their teaching performance, conception ratified by Tardiff (2000, 2002), Imbernon (2000) e Guarnieri (2000). As positive point we can infer at the same time, that as we register 100% of importance to the development of attitudes, the graduation students are broadening the systemic view on the reflection of their practice. This constitutes in itself a terrain of complexities, uncertainties and conflicts of values. From this, we can realize that it is not enough to only reflect on the analogies among knowing, being and doing, but it is also necessary to analyze the interrelationships. Leal (2004) considers that the know-how is above all knowing how to BE a teacher, every day of the week,, in any way, making a commitment of educating students to be subjects, authors of their own story, for this it is not necessary to know only biology, but to have the soul of an educator, turning to life and utopias.

[6]Original: A formação passa sempre pela mobilização de vários tipos de saberes: saberes de uma prática reflexiva, saberes de uma teoria especializada, saberes de uma militância pedagógica. O que coloca os elementos para produzir a profissão docente, dotando-a de saberes específicos que não são únicos, no sentido de que não compõem um corpo acabado de conhecimentos, pois os problemas da prática profissional docente não são meramente instrumentais[...].

Final Considerations

It was possible to comprehend the importance of the teaching workshops as a didactic resource to be utilized, realizing that the reflection about the practice is extremely important and that from it is possible to develop distinguished activities, which promote significant results to the teaching of Biology, Physics and Chemistry. The extension project has as one of its goals to improve the learning of the students on the matter of some Biology topics, clearly detected in the evaluations after each workshop. The attendance in the activities were also important, since the first semester there were a significant number of absences in classes. It was risen an interest to participate in the activities and in the e investigation of the observed phenomena. Each proposed activity, the subsequent concepts, anchored in the subsumptions, were always worked from the most general to the most specific, seeking to make the integrative connections between the new concepts and the pre-existing ones. It was important in the process of the workshops to perform an evaluation on the retention/ learning of the students, considering the many contents worked on always approaching as much as possible to the students reality. What the student already knows is, to Ausubel (2000), is the most important isolated factor to learning. The second goal was to take the graduation students' reflection to (re)criate and think of their practice, appropriating themselves of concepts, methodologies, techniques and resources, without however, absorbing them as a mere prescription, but having the capacity of adjusting the already produced knowledge in that school environment to elaborate the workshops, also considering the elements which composed the school space. It was in that sense that the proposal invested in the activity so that when those graduation students take on a class, with all its complexity, they can instigate in their students the adventure in search of knowledge, without fear of mistakes. As they were inserted in that school context, the teaching strategies through workshops of investigative nature stood out as fundamental in the educational process enabling the broadening of the sense of what is the teaching of Biology and the challenges, which pushes us in the perspective of scientific education.

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