CHEMISTRY WORKSHOP IN BRAZILIAN HIGH SCHOOL USING THE THREE PEDAGOGICAL MOMENTS METHODOLOGY

OFICINA DE QUÍMICA EM ESCOLA DE ENSINO MÉDIO NO BRASIL USANDO OS TRÊS MOMENTOS PEDAGÓGICOS COMO METODOLOGIA

Aline Joana R. W. A. dos Santos
University Federal of Pelotas, UFPel
Pelotas, Brazil
aline.wohmuth@ufpel.edu.br

Leandro Lampe
University Federal of Pelotas, UFPel
Pelotas, Brazil
leandroolampe@gmail.com

Fábio André Sangiogo
University Federal of Pelotas, UFPel
Pelotas, Brazil
fabio.sangiogo@ufpel.edu.br

Carolina Rodrigues Preto
University Federal of Pelotas, UFPel
Pelotas, Brazil
carol.r.preto@gmail.com

Abstract. This paper deals with the importance of educational methodologies which enable linear and propaedeutic education to be eliminated, while problematization and dialogicity are stimulated. It describes a study that focuses on the evaluation of Three Pedagogical Moments (3 PMs) with planned and implemented activities in the workshop "Coarse salt bath and the study of solutions", which was carried out with high school students in chemistry classes. Workshops are developed and carried out as the result of a partnership between a university and a high school in Pelotas, a city located in southern Brazil. The production of the empirical material was based on students' responses to a questionnaire and notes in a field diary performed by the team. Results of the content analysis showed the learning potential offered by the thematic workshop related with daily lives and chemistry teaching to students and it was observed as differentiated and alternative methodology from traditional classroom classes. Due to obtained results in the activities developed at thematic chemistry workshop organized and based in the 3 PMs, the Project have continued with the elaboration and development of other workshops that are available on the project website.

Keywords: teaching and learning process; alternative methodology; Brazil; daily lives

Resumo. Este artigo trata da importância de metodologias educacionais que possibilitem a eliminação da educação linear e propedêutica, estimulando a problematização e a dialogicidade. Descreve um estudo que tem como foco a avaliação de Três Momentos Pedagógicos (3 MPs) com atividades planejadas e implementadas na oficina "Banho de sal grosso e o estudo de soluções", que foram realizadas com alunos do ensino médio em aulas de química. As oficinas são desenvolvidas e realizadas a partir de uma parceria entre uma universidade e um colégio de Pelotas, cidade localizada no sul do Brasil. A produção do material empírico baseou-se nas respostas dos alunos a um questionário e anotações em um diário de campo realizado pela equipe. Os resultados da análise de conteúdo evidenciaram o potencial de aprendizagem oferecido pela oficina temática relacionada ao cotidiano e ao ensino de química aos alunos e, isso foi observado como metodologia diferenciada e alternativa às aulas presenciais tradicionais. Devido aos resultados obtidos nas atividades desenvolvidas na oficina temática de química organizada com base nos 3 MPs, o Projeto vem dando continuidade à elaboração e desenvolvimento de outras oficinas que estão disponíveis no site do projeto.

Palavras-chave: processo de ensino e aprendizagem; metodologia alternativa; Brasil; cotidiano

INTRODUCTION

Basic education teachers' continuing education in Brazil has been considered essential by the Coordination for the Improvement of Higher Education Personnel (CAPES) (Paiva et al. 2016), although the opposite has been observed, because it is evident that government resources and investments in basic and higher education have not been enough to improve the education process. A way to overcome limitations stems from educators' possibility of thinking and proposing alternatives to qualify students' and teachers' education in schools, as well as

professors' and undergraduate students' education in universities, aiming at quality education (Rushton et al. 2016). Thus, differentiated projects and alternative didactic-pedagogical practices that propose improvement in the quality of basic education deserve reflection and/or analysis, since they contribute to improve undergraduate students' investigative potential to develop new practices and their motivation in the course, which is an important factor in teaching and learning processes of teachers-to-be (Teixeira-Dias et al. 2005).

Workshops can provide students with opportunities to build new knowledge by enabling interactivity in the study of chemistry topics related to everyday contents that involve their daily lives. This kind of activities can lead students to complex reflexion processes, which may initially seem more complicated than they really are (Broman et al. 2018). However, this approach not only triggers present and future meaningful learning, attitudes and values, but also offer moments that contemplate the nature of chemical thinking, its application and impact on daily lives, which should be one of the main objectives of chemistry teaching (Freire et al. 2019). Thus, thematic workshops in the university-school partnership may represent the possibility of establishing relations between practice and theory (Marcondes 2008) and serve as incentive for teacher education, because research into new investigative practices in chemistry teaching at schools is a kind of continuing education (Strippel & Sommer 2015).

Search for non-traditional methodologies in universities is often linked to teaching, research and extension projects (Alrajeh 2020). Thus, the academic environment can help propose curricular activities that deviate from traditional methodologies, as an incentive for teachers to insert new practices in their classes (Fullan 2015). The motivation for this study stems from an extension project that has been carried out at the Universidade Federal de Pelotas (UFPel), in Pelotas, RS, Brazil, entitled Transfere, whose objective is to mediate chemical knowledge between the university and the community. It focuses on chemistry education and seeks to promote interaction between the UFPel and public schools in Pelotas, a city in southern Brazil. Transfere is characterized by the diversity of its members' educational levels, since high school students, chemistry undergraduates, professors and schoolteachers work actively together from workshop planning to its implementation (Santos et al. 2020a).

Workshop themes are chosen by chemistry schoolteachers. Transfere organizes workshops to occur concurrently with regular chemistry classes at schools (Santos et al. 2020b; Lampe, Santos & Sangiogo 2020; Santos, Lampe, Silva 2020). The term "workshop" is noteworthy as a way of organizing planned activities and building knowledge, with emphasis on action, but without losing the theoretical basis (Paviani and Fontana 2009). Therefore, concerning university-school interaction, this paper highlights activities carried out in workshops which have already resulted in the production of an undergraduate thesis in chemistry (Preto 2016). More specifically, in this paper, implementation of the workshop "Coarse salt bath and the study of solutions" is analyzed. It is based on theoretical and methodological moments entitled "Three Pedagogical Moments (3 PMs)" (Delizoivov et al. 2002) in order to seek understanding of their effects on activities which were planned and implemented by Transfere.

Bath salts in Brazil are made from crystalline granules of sodium chloride, known as "coarse salt". They are common in popular culture in detoxifying baths that aim at renewing energy on physical and spiritual levels. The workshop on this theme was used for the study of chemical solutions in three groups of sophomores. This workshop, as well as other workshops and didatic productions developed by Transfere, is available in the website (in Brazilian Portuguese) *http://projetotransfere.wixsite.com/projetotransfere* (Projeto Transfere). The use of digital platforms can become a tool for sharing knowledge between the community and researchers, as well as in the study presented by Kermish-Allen et al. (2019).

When workshops that involve mediation between everyday knowledge and knowledge of Science are developed, they are considered didactic mediation processes which may result in new learning associated with experiential situations organized in 3 PMs (Delizoivov et al. 2002; Lopes 1999; Preto 2016). It occurs because the 3 PMs methodology seek to promote teaching and

learning processes which lead to problematization of concepts and application of knowledge under study.

The 1st PM is Initial Problematization, which introduces situations that are connected to the theme and known by students in their daily lives. Students are challenged to participate and answer questions about the subject. The activity advisor's role is to discuss the theme and cast doubts on the subject, but s/he does not have to answer questions and give explanations, so that students should feel the need to search for knowledge.

The 2nd PM is Knowledge Organization, which means the systematic study of the topic in order to better understand it and other significant situations. The 3rd PM is Knowledge Application, in which students are capable of analyzing and interpreting certain situations, such as those introduced in the 1st PM and other everyday situations related to the activity. In all 3 PMs, the activity advisor uses problematization and dialogicity in the mediation of new knowledge that aims at understanding and analyzing the theme. According to Cristiane Muenchen (2010), the methodology of 3 PMs began its development in a research group coordinated by Delizoicov and Angotti, in the Institute of Physics at the Universidade de São Paulo (USP), São Paulo, SP, Brazil, in the 1970's. The group discussed a proposal for Science teaching that aimed at understanding the physical world where students live. Development of the 3 PMs is supported by Paulo Freire (1974/2013), according Muenchen (2010), since he opposed to the banking concept of education, in which educators would make announcements and deposit contents on students, who would receive informations patiently to memorize.

Literature has recently described several studies that involve planning of workshops and didactic activities that use the theoretical-methodological approach of the 3 PMs (Pazinato and Braibante 2014); (Francisco et al. 2008); (Freitas Filho et al. 2013). It has enabled daily life and concepts developed in class to be associated, an objective which is one of the current challenges of chemistry teaching and has given rise to a lot of research, according to Pazinato and Braibante (2014). This reference has similarities with the workshop "Coarse salt bath and the study of solutions", which is the research focus of this study, since both proposals asked students to solve some questions in the first and third PMs. Besides, both studies were carried out in Brazilian public high schools.

The workshop proposed by Pazinato and Braibante (2014), whose theme was "Food", was developed with a class of juniors. It aimed to work on chemical structures found in food, such as proteins, carbohydrates and lipids, and their functions. According to the authors, the workshop resulted in students' active participation in all school interventions and enabled them to make hypotheses, observe results, predict responses, discuss with peers and better understand scientific knowledge. In their workshop, Francisco Jr., Ferreira and Hartwig et al. (2008) also emphasized the importance of experimentation as a constituent activity of the main aspects of Science teaching and learning processes. They used the ideas proposed by Delizoicov (1991) and Delizoicov et al. (2002) to develop the so-called problematized experimentation, which would be either a part of at least one of the 3 PMs or a part of all of them.

Another study that encompassed the 3 PMs was an interdisciplinary one conducted by Freitas Filho et al. (2013) in northern Brazil with three hundred high school students. When the authors defended the interdisciplinary aspect of the pedagogical activity, they stated that integration of chemistry with Physics and Biology may make students establish interdependent links among those sciences. In addition, an interdisciplinary activity can enable scientific knowledge to be acquired in a critical and reflective way, resulting in the elaboration of chemical concepts from students' real and close situations, the development of discussions and exchange of ideas about the theme under study and the search for troubleshooting information. Thus, based on their results, the authors demonstrated that the methodology they employed, with the insertion of different thematic approaches, made new learning easier. However, for teachers to develop the knowledge that is necessary for the activity, their preparation and qualification is essential, regardless of the curriculum structure that guides the activity (Overman et al. 2014).

The 3 PMs are not only used as guiding methodologies of activities that seek to promote teaching and learning processes of disciplinary concepts, but also have potential to guide continuing education processes of professionals in the field of Education, since they deal with thematic approaches that aim at achieving what the curriculum proposes, that is, to detach from propaedeutic teaching (Giacomini & Muenchen 2015). It is relevant because someone who has contact with a reproductive teaching process is likely to have a reproductive conception of learning. However, if the person has contact with a constructive teaching process, s/he is likely to have a constructivist learning character (Koballa et al. 2010). After the explicit analysis of references, the search for understanding the effects of 3 PMs on the planning and development of the workshop "Coarse salt bath and the study of solutions" is ratified, in order to qualify the focus of this study, as well as future projects that will be developed by Transfere. In this way, the objective of this research is to describe a study that focuses on the evaluation of 3 PMs with activities planned and performed in the workshop "Bath salt and the study of solutions", which was carried out with high school students in classes of chemistry.

MATERIAL AND METHODS

Participatory research (Lüdke and André 1986) means that researchers are also research subjects who contribute to the context with reports and memories in planning and implementation stages of workshops. Thus, in addition to planning and conducting a workshop entitled "Coarse salt bath and the study of solutions", in the 3 PMs methodology context, this study involves the analysis of students' responses to questionnaires, the analysis of oral manifestations that were registered in researchers' fieldnotes and the transcription of recorded audios. Workshop planning, development and evaluation was based on the interaction of subjects from different educational levels in a work group, composed of two professors, a schoolteacher, some college students and some school students.

The group met weekly to discuss school demands and the chemistry teacher's ones related to contents or topics that would be taught as workshops. All workshop activities took place at school, more precisely in the Science laboratory, library and computer room. Each workshop comprised a complex cycle of activities, as shown in Figure 1. The cycle may change and adapt, depending on needs imposed by each workshop and on results of its evaluations (Santos, Lampe, Sangiogo 2019). Six different workshops have been developed and implemented in high school classes since 2014, in order to contribute to students' learning and knowledge construction in chemistry contents which were highlighted by schoolteachers as complex and difficult to be understood by students.

Activities started (Figure 1) when students, under their teacher's supervision, chose the theme of the workshop (1) and reviewed its literature (2). To understand basic concepts related to the theme in question, various research sources, such as books, newspapers and websites, were used. Then, the didactic material was made (3), i. e., printed texts or booklets were produced and images and animations were presented. Materials produced for the workshop had to contain the theme, the initial problematization and the exploration of concepts that allow students to understand it. Subsequently, through literary research, the experiment or practical activity was defined to complement the theoretical theme under investigation (4). In the next step (5), all material – planned and made in the previous steps – was organized and questionnaires that would be distributed to students during the workshop, based on the 3 PMs, were defined. Then, the experimental activity was tested (6) with the intention of making necessary considerations and changes before workshop implementation in the school (7). It was dynamically and informally based on the 3 PMs; the 1st PM was carried out with the problematization of the theme and an initial questionnaire was given to the students, while the 2nd PM focused on the systematic study of the theme through didactic materials and the 3rd PM ended the activities with the application of knowledge through experimentation, followed by the final questionnaire that was answered by the students. Afterwards, results were evaluated (8) by

means of students' answers to the questionnaires and their oral participation in the workshop. Then, assessment of activities (9) was performed, so as to qualify future interventions. Finally, the last step (10) refers to the dissemination of results, didactic materials and presentations in local, regional and national events, as well as in the website *http://projetotransfere.wixsite.com/projetotransfere* (Projeto Transfere).

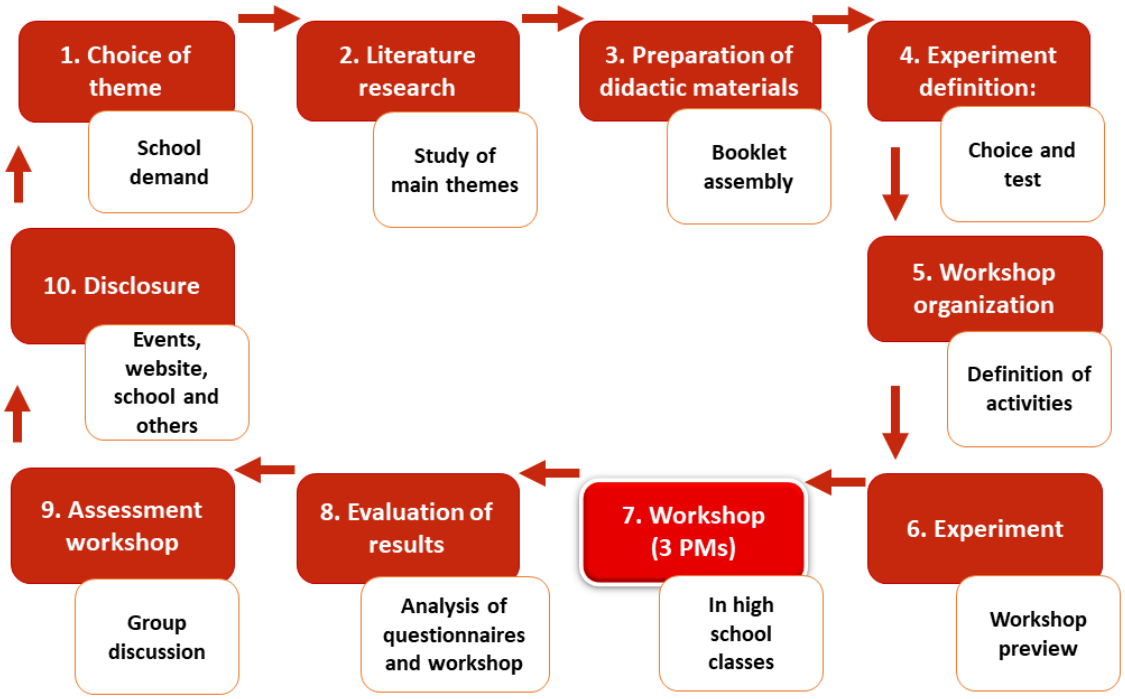

Figure. 1 Cycle that highlights workshop activities: (1) Planning; (2-6) Workshop viability; (7) Implementation and execution; (8) Evaluation of results; (9) Workshop evaluation; and (10) Dissemination and publication of results and didactic materials. Source: Authors (2021)

It is noteworthy that each workshop was planned to be carried out at the time that was made available by the school, in chemistry classes, that is, a 100-minute class. Thus, step (7) occurred in this time period. The other steps took place in weekly meetings at the school and at the university. This paper sought to analyze especially step (7) in the workshop "Coarse salt bath and the study of solutions". In this stage, initial problematization included reading an introductory text adapted from the internet, with the steps for the preparation of a coarse salt bath, followed by the projection of images of various types of solutions that are part of everyday life. Two questions of the initial questionnaire were analyzed. Question number 2: "What is the difference between shower water and coarse salt bath water?" Question number 3: "In chemistry, we have the study of solutions; do you know what a solution is?" Students were asked to write down the answers to the initial questions. In addition, in the three groups, most students participated orally during socialization and familiarization processes with the workshop theme. Then, throughout knowledge systematization, concepts were dialogically developed with the use of conversations and images of daily examples related to the solutions under study, followed by the study of the concept of the solution concentration. The difference between a water bath and a coarse salt bath was explained, as well as the presence of sodium chloride salt in water and its influence on human health. Afterwards, students received the printed material, a booklet with the theoretical content of the workshop, as well as the script of the experiments. For the application of knowledge, students were instructed to form small groups and each group was monitored by a high school student who is a member of Transfere. The activity consisted of two experiments; the first one had a demonstrative character while the second one had a participatory character.

In the first demonstrative experiment, three solutions of potassium permanganate salt ($KMnO_4$) were prepared at different concentrations to show their preparation and calculation. In the second experiment, the groups dissolved certain quantities of sodium chloride salt (NaCl) in a determined volume of water at different temperatures (cold, room temperature and boiling). In this case, the aims were to demonstrate the preparation of saturated and unsaturated solutions and to evaluate water solubility capacity at different temperatures. After the experiments, the final questionnarie was given to the students. Question number 3, which related concepts developed in the 3 PMs, was analyzed. It was question number 2 of the initial questionnaire: "What is the difference between shower water and coarse salt bath water?"

After the workshop, empirical materials that had been produced were gathered for analysis. Those materials were answers given by students to the questionnaires, oral manifestations that were recorded in fieldnotes, students' oral participations obtained from the transcription of the audio recorded during the intervention and oral and written impressions of Transfere members that participated in the whole process.

The research materials were analyzed using some ideas that underlie content analysis (Bardin 2011); (Moraes 1999), which not only seeks to describe and interpret the content of all kinds of documents and texts but also helps to reinterpret messages and achieve understanding of their meanings at a level that goes beyond common reading of representative situations of the object under investigation.

RESULTS

The empirical material under analysis consists of all materials that involve oral and written communication. When the workshop started, students were found to have some knowledge about the theme "coarse salt bath", which seemed to have arisen interest and curiosity, a fact that is consistent with the 1st PM of initial problematization. Question 2 of the initial questionnaire and some students' answers are described in Table 1.

Table 1. Answers to question 2 of the initial questionnaire. **Source:** Authors (2021)

Question	**What is the difference between shower water and coarse salt bath water?**
Answers	*"The shower water is not salty."* (Student A) *"There is no salt in the shower"* (Student B) *"The difference is that salt's bath water is prepared and shower water is not"* (Student C) *"The difference between them is that the shower water is sweet and the coarse salt's bath is salty"* (Student D) *"Salty water is a mixture"* (Student E) *"Water from shower is natural, but salty water is different because it changes the chemistry of water"* (Student F)

Thus, based on the content analysis (Bardin 2011); (Moraes 1999), meaning units were created from answers given to the question, followed by its category. Thus, the category "The possibility of understanding the difference between shower water and coarse salt bath water" (Table 2) was the result of the analysis of question 2. Chemistry themes linked to students' everyday facts are used for making the learning process easier. However, students' conceptual difficulties still seem to be quite considerable obstacles.

Table 2. Meaning units and categories. **Source:** Authors (2021)

Meanings units	*(...) it is not salty (...)* *(...) water from salt's bath is prepared and watter from shower is not (...)* *(...) water of shower is sweet, the coarse salt's bath is salty (...)* *(...) salty water is a mixture (...)*
Category	The possibility of understanding the difference between shower water and coarse salt bath water

Besides, in the 1st PM, when answering question 3 of the initial questionnaire – "In chemistry, we have the study of solutions; do you know what a solution is?" –, some students said they had already studied solutions or that they had heard something about solutions in chemistry classes, but none of them explained what solutions were. Some students cited examples of mixtures that, in their conception, would be solutions, such as "chocolate milk sold in cartons or the one prepared at home", "powdered juice dissolved in water", which can be a misperception of solutions. In the 2nd PM, called knowledge systematization, students showed surprise when they saw images of solutions, especially solid and gaseous examples, because they did not know these types of solutions. Students did not understand how commercially sold hydrated alcohol could be an example of a solution, either. Emphasizing concepts to lead to learning and understanding without imposing explanations was favored so that no false impression of learning would be given. However, students' oral manifestations showed evidence of the fact that the activities arose the desire to know more about the chemistry involved in the theme, such as answers registered in fieldnotes (Table 3).

Table 3. Oral manifestations expressed during the activities. **Source:** Authors (2021)

Oral Manifestations	*"What is there the alcohol for him to be a solution?"* (Student G)
	"Is milk a solution?" (Student H)
	"Is milk powder a solution?" (Student I)
	"In my job I should put water salted in the fryer content oil. Why?" (Student J)

After problematization (1st PM) and knowledge systematization (2nd PM), experiments were performed in the 3rd PM. During solution preparation with predetermined masses of sodium chloride (NaCl) and water at different temperatures, students came up with a discussion about sodium chloride as the solute and water as the solvent in a solution. This fact can be considered an attempt to associate workshop content with pratice. The workshop created a demand for knowledge related to everyday life, such as a student asking for his job routine. This question demanded the Transfere group to search for an answer and clarify students' thoughts. Thus, this dialogue, which was carried out with the use of the 3 PMs methodology, enabled high school students and undergraduates to acquire new knowledge.

Finally, comparison between some answers given to the initial questions and answers given to the final ones made it possible to notice students' progress towards conceptual coherence. Although students used chemical concepts to answer the questions, explanatory arguments did not accompany them. Some written and oral answers showed conceptual fragility, because there was no argument, a fact that could have been improved if there was more available time to study the theme, as a way to qualify the 2nd PM. Table 4 shows a comparison between answers given to questions 2 and 3 of the initial and final questionnaires, respectively, "What is the difference between shower water and coarse salt bath water?". This comparison showed that the three students chosen as representative examples answered differently after having studied the theme in the workshop based on the 3 PMs.

Students A and B responded the question, but they could not fully explain the chemical process. Student A was able to use the concept, but his answer was still incomplete. However, Student E managed to elaborate an answer that explained the question and advanced in the use of concepts, in relation to the initial part of the workshop. To corroborate, it is important to reflect on remarks of Echeverria (1996) regarding the fact that it is easy for students to use chemical terms, but that does not necessarily mean that they truly understand the facts. Therefore, it cannot be said that Student E really understood what he wrote. The same situation can apply to the other answers. Thus, answers given by students only enable to affirm that the workshop offered students the possibility of thinking about the theme of the activity in order to improve students' perceptions, which can result in learning signs, in agreement with the interrelationship between thought and language highlighted by Lev Vigotski (2008).

Table 4. Comparison of answers given before and after the 2nd PM to the question "What is the difference between shower water and coarse salt bath water?". **Source:** Authors (2021)

Question	What is the difference between shower water and coarse salt bath water?
Answers Initial Questionnaire	*"The shower water is not salty."* (Student A) *"There is not salt in the water from shower"* (Student B) *"Salty water is a mixture"* (Student E)
Answers Final Questionnaire	*"The salt's concentration is lower in the water from shower "* (Student A) *"The water of coarse salt´s bath is salty"* (Student B) *"The difference is that in the water from shower the salt's concentration is small and in the coarse salt bath the salt's concentration is high"* (Student E)

Many students' conceptions were found to be the fact that tap water contained nothing but water (only H_2O molecules), which raised many doubts about the solution concept. In addition, students themselves raised a demand that involved concepts of water purity and water types. such as drinking, distilled and mineral water. Although there was not enough time for all demands at the end of the workshop, Students A, B and E were able to understand that tap water may contain salts, such as chlorides, carbonates and fluorides, which are dissolved and have no visible color.

Discussions in the workshop were limited to 100-minute classes. The ideal situation would require more time to the 2nd PM, which is the moment devoted to theme studies and to problems posed in the 1st PM. Nevertheless, it is important to consider that activities carried out in this study sought to encourage reflection on known facts of students' daily lives, since, according to Echeverria (1996), quality of learning experiences may make concept formation easier to students. Regarding the experiment of NaCl dissolution in water, it may be stated that it acted as a facilitator of the understanding of factors, such as temperature and mass of solute, which influence solution preparation. Besides, the experiment was able to keep students interested and motivated throughout the activity.

The 3 PM methodology is a theoretical and methodological referential which guided planning and development of the intervention as an extra activity in high school classes. Activities arose curiosity and enabled students' interaction and oral and written participation throughout the process. In this teaching proposal, students could perceive that chemistry is part of their world, and that this science may lead to the development of more reflective thinking to overcome the superficial view of explanations of phenomena linked to chemistry.

Results of the workshop based on the 3 PMs should be contextualized in the Brazilian educational context and compared to the analysis carried out by the Program for International Student Assessment (PISA) in the Organization for Economic Cooperation and Development (OECD). The program aims at comparing evidences, found in several countries, based on 15-year-old students' performance at school (Inep 2018). Results show that, in 2018, 68.1% of 15-year-old Brazilian students did not reach the basic level in Mathematics, the minimum level to full exercise of citizenship. Concerning Sciences, it is 55%, while in reading, it is 50% (Inep, 2019). It should also be highlighted that state schools, such as the one under investigation, have lower percentages, i. e., below the national average. This increases the importance of the actions in this study, according the considerations made by. Scogin et al. (2018) that demonstrate small changes in science education must be made.

According to Joaquim Pinto, Teresa Neto and Jaime Silva (2019), who evaluated the PISA from 2000 to 2012, and to a literature review, five factors have influenced students' performance: the educational system; families' socioeconomic context, school characteristics, students' characteristics and the use of information and communication technologies. These factors have contributed to increase the difference in performance between OECD students and Brazilian ones. The authors also emphasize that "it is fundamental to investigate, publicize and discuss

factors that influence students' learning so that countries can take efficient and effective measures" (p. 54), such as studies of the 3 PMs in public schools in Pelotas, RS, Brazil.

CONCLUSION

The theoretical and methodological approach of the 3 PMs, which guided planning and development of the workshop "Coarse salt bath and the study of solutions", enabled problematization, dialogue and interaction, so that knowledge could be produced to boost students' learning. In the workshop, there were several instances of teaching and learning processes, which were mainly observed through students' motivation in the activities, their participation when they asked questions and even their answers given to questions and dialogues. This approach differs from traditional classes, since sometimes questions or doubts about students' daily lives are not considered by the latter, in addition to being an attempt to provide better learning conditions for high school students.

During the workshop, some progress was observed in answers given to questions, which was shown by the analysis and comparison between the initial and final moments of the workshop. However, it is known that time allocated by the school to the activity should be longer to further enhance teaching and learning processes proposed by the workshop. Longer workshop stages would allow for more in-depth discussions on the topic, as well as problematization that would ensure more dialogue between high school students and the Transfere group.

The use of the 3 PMs methodology contributed to teaching and learning processes, not only because it organized the sequence of activities, but also because it led to the understanding that different activities could be used during the pedagogical intervention without losing sight of the problematizing character of the referential, in order to generate reflection on the importance of chemistry themes whose discussion is based on daily life. Besides, the need to study the proposed theme for the workshop and the methodology of the 3 PMs was shown. As a result, Transfere members – high school students, schoolteachers, undergraduates and professors – improved and deepened their knowledge. Therefore, the 3 PMs methodology was found to enable considerable advances in the planning and development of the workshop, since it is a viable tool which brings positive effects to teaching and learning processes. In this way, the Transfere Project maintains its activities by developing thematic workshops on different topics relating chemistry to everyday life, aiming for future moments to expand research as well as the dissemination of the potential of 3PMs for teaching and learning processes, especially regarding the area of Sciences.

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REFERENCES

Alrajeh, T. (2020). The value and use of project-based learning in teacher preparation programs. *Cypriot Journal of Educational Sciences*, 15(5), 989 - 1010. https://doi.org/10.18844/cjes.v15i5.5135.

Broman, K., Berrnholt, S., & Parchmann, I. (2018). Using model-based scaffolds to support students solving context-based chemistry problems. *International Journal of Science Education*, *40*(10), 1176-1197. http://dx.doi.org/10.1080/09500693.2018.1470350.

Bardin, L. (2011). *Análise de conteúdo* [Content analysis] (70th ed.). Lisboa: Edições.

Delizoicov, D. (1991). *Conhecimento, tensões e transições.* [Knowledge, tensions and transitions] [Doctoral thesis University of São Paulo]. University of São Paulo Theses, Dissertations, Undergraduate Texts Archive. https://repositorio.ufsc.br/xmlui/bitstream/handle/123456789/75757/82794.pdf?sequence=1&isAllowed=y. Retrieved 06 August 2020.

Delizoicov, D., Angotti, J. A. P., & Pernambuco, M. M. (2002). *Ensino de ciências: Fundamentos e Métodos.* [Science Teaching: Fundamentals and Methods] (5th ed.).Cortez.

Echeverria, A. R. (1996). Como os estudantes concebem a formação de soluções. [How students conceive of solution formation] *Química Nova na Escola, 3*, 15-18. http://qnesc.sbq.org.br/online/qnesc03/aluno.pdf. Retrieved 06 August 2020.

Francisco, W., Ferreira, L., & Hartwig, D. (2008). Experimentação problematizadora: fundamentos teóricos e práticos para aplicação em salas de aula de ciências. [Problematic experimentation: theoretical and practical foundations for application in science classrooms] *Química Nova na Escola*, *30*(1), 34-41. http://qnesc.sbq.org.br/online/qnesc30/07-PEQ-4708.pdf. Retrieved August 06, 2020.

Freire, M., Talanquer, V., & Amaral, E. (2019) .Conceptual profile of chemistry: a framework for enriching thinking and action in chemistry education. *International Journal of Science Education*, *41*, 674-692. http://dx.doi.org/10.1080/09500693.2019.1578001.

Freire, P. (2013). *Pedagogia do Oprimido*. [Pedagogy of the Oppressed]. (67th rev. ed.). Rio de Janeiro: Paz e Terra. (Original work published 1974).

Freitas Filho, J. R., Almeida, M. A. V., Pina, M. S. L., Reis Filho, A. F., Oliveira, M. G., Arruda, A. M., Dantas, V. A., & Souza, M. V. J. (2013); Relato de uma experiência pedagógica interdisciplinar: Experimentação usando como contexto o rio Capibaribe. [Report of an interdisciplinary pedagogical experience: Experimentation using the Capibaribe River as context] *Química Nova na Escola, 35*(4), 247-254. http://qnesc.sbq.org.br/online/qnesc35_4/06-RSA-50-11.pdf. Retrieved August 06, 2020.

Fullan, M. (2015). *The new meaning of educational change*. (5th rev. ed.). New York: Teachers College Press. (Original work published 1982).

Giacomini, A., & Muenchen, C. (2015). Os três momentos pedagógicos como organizadores de um processo formativo: algumas reflexões. [The three pedagogical moments as organizers of a formative process: some reflections.] *Revista Brasileira de Pesquisa em Educação em Ciências*, *15*(2), 339-355. https://periodicos.ufmg.br/index.php/rbpec/article/view/4317/2882. Retrieved August 06, 2020.

Inep, Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (2018). *Programa Internacional de Avaliação de Estudantes* [Program for International Student Assessment] (PISA). Ministério da Educação e Cultura (MEC), Secretaria de Educação Básica. http://inep.gov.br/web/guest/pisa. Retrieved 06 August, 2020.

Inep, Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira. (2019). Pisa 2018 revela baixo desempenho escolar em leitura, matemática e ciências no Brasil [Pisa 2018 results show low academiv performance in reading, mathematics and science in Brazil.] *Programa Internacional de Avaliação de Estudantes* (PISA). Ministério da Educação e Cultura (MEC), Secretaria de Educação Básica. http://portal.inep.gov.br/artigo/-/asset_publisher/B4AQV9zFY7Bv/content/pisa-2018-revela-baixo-desempenho-escolar-em-leitura-matematica-e-ciencias-no-brasil/21206. Retrieved 06 August 2020.

Kermish-Allen, R., Peterman, K., & Bevc, C. (2019). A utilidade dos projetos de ciência cidadã em escolas K-5: medidas de envolvimento da comunidade e impactos nos alunos. *Cultural Studies of Science Education*, *14*, 627–641. https://doi.org/10.1007/s11422-017-9830-4.

Koballa, T. Jr., Graber, W., Coleman, D. C., & Kemp, A. C. (2010). Prospective gymnasium teachers' conceptions of chemistry learning and teaching. *International Journal of Science Education, 22*, 209-224. http://dx.doi.org/10.1080/095006900289967.

Lampe, L., Santos, A. J. R. W. A., & Sangiogo, F. A. (2020). Elementos da tabela periódica e modelo de Bohr com base na abordagem dos Três Momentos Pedagógicos. [Elements of the periodic table and Bohr model based on the Three Pedagogical Moments approach.] In: Desafios da educação brasileira: impactos e perspectivas [Challenges of Brazilian education: impacts and

perspectives] Org. Frederico Celestino Barbosa, Piracanjuba-GO: Editora Conhecimento Livre, 2020. https://docplayer.com.br/188848592-Frederico-celestino-barbosa.html.

Lopes, A. (1999); *Conhecimento escolar: ciência e cotidiano*. [School knowledge: science and daily life] (1th rev. ed.). UERJ.

Lüdke, M., & André, M. E. D. A. (1986). *Pesquisa em educação: abordagens qualitativas*. [Education research: qualitative approaches] (1th rev. ed.). São Paulo: EPU.

Marcondes, M. E. R. (2008). Proposições metodológicas para o ensino de química: oficinas temáticas para a aprendizagem da ciência e o desenvolvimento da cidadania. [Methodological propositions for chemistry teaching: thematic workshops for science learning and citizenship development] *Em Extensão*, *7*, 67-77. https://www.sumarios.org/artigo/proposi%C3%A7%C3%B5es-metodol%C3%B3gicas-para-o-ensino-de-qu%C3%ADmica-oficinas-tem%C3%A1ticas-para-aprendizagem-da. Retrieved August 06, 2020.

Moraes, R. (1999). Análise de conteúdo. [Content analysis] *Educação, 22*(37), 7-32. http://cliente.argo.com.br/~mgos/analise_de_conteudo_moraes.html. Retrieved August 10, 2021.

Muenchen, C. (2010). *A disseminação dos três momentos pedagógicos: um estudo sobre práticas docentes na região de Santa Maria/RS*. [The dissemination of the three pedagogical moments: a study about teaching practices in the Santa Maria/RS region] [Doctoral thesis Universidade Federal de Santa Catarina]. University Federal of Santa Catarina Theses, Dissertations, Undergraduate Texts Archive. http://repositorio.ufsc.br/xmlui/handle/123456789/93822. Retrieved August 06, 2020.

Overman, M.; Vermunt, J. D.; Meijer, P. C.; Bulte, A. M. W. & Brekelmans, M. (2014); Students' Perceptions of teaching in context-based and traditional chemistry classrooms: comparing content, learning activities, and interpersonal perspectives. *International Journal of Science Education*, *36*, 1871-1901. http://dx.doi.org/10.1080/09500693.2013.880004.

Paiva, J. C., Morais, C., Rosa M. P. A., Moreira, L., & Eichler, M. L. (2016). Desenvolvimento profissional e cooperação internacional para professores de química: avaliação da intenção de mudança pedagógica após formação continuada no Porto, Portugal. [Professional development and international cooperation for chemistry teachers: evaluation of pedagogical change intention after continuing education in Porto, Portugal.] *Química Nova*, *40*(1), 105-112. http://dx.doi.org/10.21577/0100-4042.20160179.

Paviani, N. M. S., & Fontana, N. M. (2009). Oficina pedagógica: relato de uma experiência. [Pedagogical workshop: report of an experience.] *Revista Conjectura*, *14*(2), 77-89. http://abenfisio.com.br/wp-content/uploads/2016/05/Oficinas-Pedag%C3%B3gicas.pdf. Retrieved August 06, 2020.

Pazinato, M., & Braibante, M. (2014). Oficina temática composição química dos alimentos: uma possibilidade para o ensino de química. [Thematic workshop chemical composition of food: a possibility for chemistry teaching.] *Química Nova na Escola*, *36*(4), 289-296. http://dx.doi.org/10.5935/0104-8899.20140035.

Pinto, J., Neto, T. B., & Silva, J. C. (2011). Fatores influenciadores do desempenho de estudantes portugueses, singapurenses, holandeses, espanhóis e brasileiros em Literacia Matemática no PISA: Revisão Integrativa. [Factors that influencie the Portuguese, Singaporean, Dutch, Spanish and Brazilian students performance in Mathematical Literacy at PISA: Integrative Review.] *Revista de Estudios y Experiencias en Educación*, *18*(37), 41-60. https://doi.org/10.21703/rexe.20191837dapiedade7.

Preto, C. R. (2016). *O estudo e viabilidade dos Três Momentos Pedagógicos na implementação de oficinas em aulas de química do ensino médio*. [The study and feasibility of the Three Pedagogical Moments in the implementation of workshops in high school chemistry classes] [Undergraduate Texts. Universidade Federal de Pelotas]. University Federal of Pelotas Theses, Dissertations, Undergraduate Texts Archive. https://wp.ufpel.edu.br/licenciaturaquimica/tccs/. Retrieved August 06, 2020.

Projeto Transfere. [Transfere Project]. https://projetotransfere.wixsite.com/projetotransfere. Retrieved August 06, 2021.

Rushton, G.; Dewar, A.; Ray, H. E.; Criswell, B. A. & Shah, A. (2016). Setting a Standard for chemistry Education in the Next Generation: A Retrosynthetic Analysis, *ACS central science*, *2*(11), 825-833, 2016. http://dx.doi.org/10.1021/acscentsci.6b00216.

Santos, A. J. R. W. A.; Sangiogo, F. A.; Paula, C. B.; Lampe, L.; Moreira, L. L. & Silva, V. S. (2020a). Mediação de conhecimentos de química associados ao cotidiano através das ações de extensão do projeto Transfere. [Mediation of chemistry knowledge associated with everyday life through the extension actions of the Transfere project] In: A extensão universitária nos 50 anos da UFPel [The university extension in the 50 years of UFPel]. Org. Francisca Ferreira Michelon, Ana da Rosa Bandeira. Pelotas : UFPel. PREC; Ed. da UFPel, p. 781-796. http://guaiaca.ufpel.edu.br/handle/prefix/5671.

Santos, A. J. R. W. A.; Lampe, L.; Silva, V. S.; Moreira, L. L. & Paula, C. B. (2020b). Mediação de experiências e aprendizados associados à cultura em química em escolas de ensino médio [Mediation of experiences and learning associated with culture in chemistry in high schools] *Expressa Extensão*, *25*(3), p. 20-31. https://doi.org/10.15210/ee.v25i3.17991.

Santos, A. J. R. W. A.; Lampe, L. & Sangiogo, F. A. (2019). O aprimoramento de conhecimentos populares por meio de oficina temática envolvendo a química do cotidiano. [The improvement of popular knowledge through thematic workshop involving daily chemistry] *Expressa extensão*, *24*(1), 141-152. http://dx.doi.org/10.15210/ee.v24i1.

Santos, A. J. R. W. A.; Lampe, L. & Silva, V. S. (2020). A química dos detergentes - proposta de estudo teórico e prático a estudantes de ensino médio [Detergent chemistry - proposal for theoretical and practical study for high school students]. In: Coletânea Educação 4.0: tecnologias educacionais [Education 4.0 Collection: Educational Technologies]. Org. Patrício Moreira de Araújo Filho, Raimundo Luna Neres, Ernane Rosa Martins e Raimundo José Barbosa Brandão. São Luís: Editora Pascal, vol. 3, p. 122-133. https://doi.org/10.29327/523546.

Scogin, S.C., Cavlazoglu, B., LeBlanc, J., & Stuessy, C. L. (2018). Inspiring science achievement: a mixed methods examination of the practices and characteristics of successful science programs in diverse high schools. *Cultural Studies of Science Education, 13*, 649–670. https://doi.org/10.1007/s11422-016-9796-7.

Strippel, C. G., & Sommer, K. (2015). Teaching nature of scientific inquiry in chemistry: how do German chemistry teachers use labwork to teach NOSI? *International Journal of Science Education*, *37*, 2965-2986. https://doi.org/10.1080/09500693.2015.1119330.

Teixeira-Dias, J. J. C., Jesus, H. P., Souza, F. N., & Watts, M. (2005). Teaching for quality learning in chemistry. *International Journal of Science Education*, *27*, 1123-1137. http://dx.doi.org/10.1080/09500690500102813.

Vigotski, L. S. (2008). *Pensamento e Linguagem*. [Thought and Language] (4th rev. ed.). São Paulo: Martins Fontes. (Original work published 1934).