

Teacher training with a focus on research-based teaching: reports of pedagogical practice

ARTICLE

Isabela dos Santos Carvalhoⁱ

Universidade Federal do Pará, Belém, PA, Brasil

João Manoel da Silva Malheiroⁱⁱ

Universidade Federal do Pará, Castanhal, PA, Brasil

Márcia Cristina Palheta Albuquerqueⁱⁱⁱ

Universidade Federal do Pará, Belém, PA, Brasil

Deyse Danielle Souza da Costa^{iv}

Universidade Federal do Pará, Belém, PA, Brasil

Abstract

The present work aims to discuss pedagogical actions related to teacher training, focusing on the didactic approach of Research-Based Teaching based on Carvalho (2013) and Malheiro (2016), using scientific content such as the surface tension of water. This is an experience report on two workshops entitled Teacher training with a focus on Research-Based Teaching. The methodology used is a qualitative approach, with a descriptive nature. The workshops were organized in three moments: 1) Reflection on the role of the teacher and their commitments to basic education; 2) Discussion about the Research-Based Teaching approach and strategies used in its application; 3) Practical activity based on the steps of an Investigative Teaching Sequence. The results show the importance of holding workshops, as well as the impact factor and receptivity of the participants, therefore teaching practices based on Research-Based Teaching are of social and professional relevance in the area.

Keywords: Research-Based Teaching. Teacher Training. Scientific Content. Teaching Practices. Investigative Teaching Sequence.

FormAÇÃO de professores com foco no ensino por investigação: relatos de prática pedagógica

Resumo

Este trabalho objetiva discutir as ações pedagógicas relacionadas à formação de professores, focando na abordagem didática do Ensino por Investigação com base em Carvalho (2013) e Malheiro (2016), a partir de conteúdos como a tensão superficial da água. Trata-se de um relato de experiência sobre a realização de duas oficinas intituladas FormAÇÃO de professores com foco no Ensino por Investigação. A metodologia é de abordagem qualitativa, com natureza descritiva. As oficinas foram organizadas em três momentos: 1) Reflexão sobre o papel do professor e seus compromissos com o ensino básico; 2) Discussão sobre a abordagem do Ensino por Investigação e estratégias utilizadas na sua aplicação; 3) Atividade prática a partir das etapas de uma Sequência de Ensino Investigativa. Os resultados apresentam a importância da realização de oficinas, assim como o

fator de impacto e a receptividade dos participantes, logo as práticas docentes baseadas no Ensino por Investigação são de relevância social e profissional na área.

Palavras-chave: Ensino por Investigação. Formação de professores. Conteúdos Científicos. Práticas docentes. Sequência de Ensino Investigativa.

1 Introduction

2

We live in a time full of change, in which society is constantly developing and schools are transforming. These changes are accompanied by training needs, as teaching professionals increasingly need to rethink their practices in order to face the constant challenges of the job. In addition to social influences, the ways of teaching corresponding to curricular subjects are greatly influenced by what is being researched at universities and research centers (Carvalho *et al.*, 2017).

In this sense, we highlight the importance of discussions in research groups, specifically the Grupo de Estudo, Pesquisa e Extensão – FormAÇÃO de Professores de Ciências. This group holds discussions and debates related to teacher training, teaching knowledge and methodologies that can be used by education professionals in the classroom (Malheiro, 2016).

In addition, we highlight the project approved by the Comitê de Ética em Pesquisa: Os Clubes de Ciências e os Processos de Ensino e Aprendizagem das Ciências na Educação Básica. This project aims to take training workshops to different cities and communities in the Amazon region, specifically in the state of Pará. We hope that the participants (basic education teachers and students from various undergraduate programs) will be able to reflect on the challenges of being a teacher in these times of change and “disposable” knowledge (Malheiro, 2009), especially those related to Research-Based Teaching.

Research-Based Teaching of science is widely discussed in international and national literature, with the main reference in the Brazilian context being professor and researcher Ana Maria Pessoa de Carvalho. When we talk about Research-Based

Teaching, we are dealing with differentiated teaching strategies that are increasingly being used in the classroom. From this point of view, we can consider various strategies that contemplate the investigative character, as long as the fundamental principles related to investigative teaching are followed (Lima *et al.*, 2008).

Among the main needs of the 21st century are those related to the expected profile of the student. For this reason, there has been much discussion about adopting active methodologies or student-centered strategies. Research-Based Teaching, therefore, enables the development of autonomy and the ability to make decisions, as well as evaluate and solve problems, appropriating concepts and theories from the natural sciences (Lima *et al.*, 2008).

Another important issue is that there is not just one professional profile. When they come into contact with basic education, teachers' backgrounds diversify in various areas of knowledge and life experiences. In some places, especially in certain regions of northern Brazil, there is a need for contact with different methodological strategies. This is because education professionals' classes are often limited to more traditional teaching methods, such as those linked to memorization and with little student participation (Malheiro; Teixeira, 2022).

With this in mind, our aim is to present a report on the didactic-pedagogical actions that were carried out for education teachers and students from various undergraduate programs, through the FormAÇÃO de professores com foco no Ensino por Investigação workshops. These workshops were structured around three specific moments: reflection on the role of the teacher and their responsibilities in basic education; discussion on the methodological approach of Research-Based Teaching and the diverse strategies used in its application; and practical activities focused on Research-Based Teaching, based on the stages of an Investigative Teaching Sequence (Carvalho *et al.*, 2009).

The workshops were held in partnership with the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq). On some occasions, they were supported by the State/Municipal Education Departments of some localities. In general, the workshops were given by the project's general coordinator and master's and/or doctoral

students from the Programa de Pós-Graduação em Educação em Ciências e Matemática da Universidade Federal do Pará (PPGECM/UFGPA).

The main objective of these workshops was to discuss teaching practices and how Research-Based Teaching can be implemented in public primary schools, even those that don't have laboratories, as is the case in most schools in northern Brazil. We hope that the teachers from the various areas of knowledge who took part in the workshops will be able to rethink their teaching practices, with the aim of gradually including the Research-Based Teaching approach in their classes.

1.1 Research-Based Teaching and Investigative Teaching Sequences

In the literature, Research-Based Teaching is referred to in different ways, such as the term “Inquiry”, teaching by discovery, inductive teaching, problem solving, learning by questioning, etc. (Zômpero; Laburú, 2011). The discussion goes beyond its definition, as there is no consensus on it, but rather different approaches by researchers who intend to discuss the subject.

Since its inception, research teaching has been linked to the image of a laboratory and the scientific method. Gil Pérez and Castro (1996) argue about the intended laboratory practice when involving research, pointing out fundamental aspects of scientific research. Some of these aspects include: implementing open situations; encouraging student reflection; providing analysis of qualitative data; proposing hypotheses; planning activities; proposing analysis of results; reviewing results and proposing implications in the field of Ciência, Tecnologia e Sociedade (CTS).

From a theoretical point of view, Research-Based Teaching is configured as a didactic approach, which can bring together various strategies, as long as it is aimed at teaching in which student participation is not restricted to a passive form (Sasseron, 2018). Currently, research is used in teaching to develop cognitive skills in students (Coelho; Almeida; Malheiro, 2019), provide contact with the performance of procedures and the ability to argue (Zômpero; Laburú, 2011).

Azevedo (2004) states that the aim of Research-Based Teaching is to enable students to debate, think, justify their ideas, understand concepts and apply their knowledge in new situations. Whether practical or theoretical, investigative activities are linked to social issues, different types of learning and the possibility of doing science (Coelho; Malheiro, 2019).

Malheiro (2016) reinforces the role of experimental activities in science teaching, emphasizing the different existing classifications related to experimental procedures and giving an overview of the different types of experiments and laboratory practices. The author provides a theoretical framework based on investigative experimentation and the perspective of Investigative Teaching Sequences (ITS).

ITS can be defined as sequences of activities covering a topic in the school program in which each of the activities is planned from the point of view of the material and didactic interactions (Carvalho, 2013, p. 9). The role of ITS is to make it possible to organize investigative activities of any kind, to be applied in the classroom or outside it, in non-formal spaces.

Carvalho *et al.* (2009) propose dividing ITS into seven stages, which they consider important to carry out during Research-Based Teaching. These stages are shown in table 1.

Table 1 – Stages of investigative experimentation

Stages	Description
1. The teacher proposes a problem	The teacher poses a problem (which can be experimental or not) to the students, who are divided into groups of 4 to 5 members. The problem can be a question, an excerpt from a song or poem, a movie, etc. The important thing at this point is to be comprehensible to the students and to distribute the materials needed to solve the problem.
2. Acting on objects to see how they react	In an experimental activity, this stage is when the students come into contact with the available materials, observing and manipulating them. The teacher should go through the groups to see if the initial problem has been understood and also check that everyone is having the opportunity to handle the material.
3. Acting on objects to obtain desired effect	This is the moment when students will really start to act and test hypotheses, handling them intensively with trial and error. The teacher's role is to inquire without giving answers, going around the group to question what the students are doing and how they are doing it.

4. Becoming aware of how the effect was produced	Once they have solved the problem, the material should be collected by the teacher. At this point, the students are organized into semicircles or whatever arrangement they are in so that they can start a discussion about what was done to solve the problem.
5. Giving causal explanations	At this point, the teacher asks questions like “why?” and “how did they make it work?”. The students are expected to express their causal explanations. The students should clarify “why it worked”. Following on from this, it is possible to expand the students’ vocabulary, enabling them to understand the scientific knowledge involved in solving the problem. The teacher’s role is important in mediating this correctly.
6. Writing and drawing	This stage is linked to the individual systematization process, in which the teacher asks the students to write or draw about the experience. It’s important that the students are free to use their creativity and write down what caught their attention, what they learned during the experiment, etc.
7. Relating activity and everyday life	At this point, the teacher can give practical examples that are close to the student’s everyday life, showing that what has been seen in the experiment is not just about manipulating materials, but that there are concepts involved in the phenomena observed, enabling them to get closer to the world around them.

Source: Adapted from Carvalho *et al.* (2009).

1.2 Continuing teacher training with a focus on investigative activities

Nowadays, we recognize that the challenge to be faced when designing teacher training activities is to select activities that meet specific objectives, such as: developing and reframing content and broadening the methodological repertoire (Carvalho *et al.*, 2017). In this sense, there has been a lot of discussion about the profile of education professionals in relation to their teaching practices, especially when it comes to continuing education.

When we think of teacher training with a focus on Research-Based Teaching, we are referring to a profile of professional who plays a role in guiding or directing activities. In this context, the teacher can propose and discuss questions, contribute to the planning of the investigation, guide the gathering of evidence and the explanations that emerge during the activity, while also enabling students to argue and systematize knowledge (Rocha; Altarugio; Malheiro, 2018).

Barbosa, Rocha and Malheiro (2019) discuss the role of the teacher-monitor and the characteristics of their questions during the mediation of investigative activities. The term “teacher-monitor” is used for volunteers at the Clube de Ciências Prof. Dr. Cristovam

W. P. Diniz¹. The authors consider that questioning during problem posing and the problem-solving process contributes significantly to learning and scientific conceptions in the context of the mentioned club. In this sense, teachers in training or working in basic education, when they come into contact with the research teaching proposal, can be considered as a teacher-monitor, that is, a mediator of knowledge and a questioner, no longer with a centralized image of the holder of all knowledge.

2 Methodology

This study is based on research with a qualitative approach (Flick, 2009), since it considers a dynamic relationship between the real world, the subject and its aspects that the author deems important, such as: appropriability of methods and theories, perspective of the participants and their diversity, reflexivity of the researcher, variety of approaches and methods implemented to carry out the research.

The study is descriptive in nature, as it aims to describe the characteristics of a given population or phenomenon, or to establish relationships between variables (Gil, 2002). We used video and audio recordings of moments of interaction between the lecturers and the teachers to gather information about the workshop participants. In addition, some post-application testimonies will be taken into account. It is important to note that the study has been approved by the ethics committee for research with human beings, as a way of preserving the identity of the participants, whose real names will not be mentioned, opting instead to use fictitious names.

The first workshop considered took place in Marapanim, located in the northeast of the state of Pará. The town has a university center that includes some degree courses linked to the Universidade Federal do Pará (UFPA) and the Universidade Federal Rural da

¹ Environment of actions developed related to investigative experimentation, scientific initiation for children and adolescents and initial and continuing teacher training with a focus on Research-Based Teaching, in particular the use of ITS (Carvalho; Queiroz; Malheiro, 2023).

Amazônia (UFRA). The workshop was publicized on social media and made available, free of charge, to the students of the center, with an average of 36 attendees.

The second workshop was held in São Caetano de Odivelas, also located in the northeast of Pará. This time, the workshop was held at the EMEF Dep. Nilson Célio Sampaio and was made available free of charge to professionals from the municipality's basic school system who were interested in the topic. The activity was attended by 28 participants from various fields of knowledge.

Both workshops featured a lecturer from the Universidade Federal do Pará (*Campus Castanhal*) and master's and doctoral researchers linked to the Pós-Graduação em Educação em Ciências e Matemáticas (PPGECM-UFPA) as speakers.

Table 2 shows the moments of the workshop and how the division between theory and practice was made to address the main points related to Research-Based Teaching.

Table 2 – Moments of the teacher training workshop

Moments	Actions taken
1	Reflection on the role of teachers and their contributions to basic education.
2	Discussion on the Research-Based Teaching approach and strategies used in its application.
3	Practical activity based on the stages of an Investigative Teaching Sequence.

Source: Authors (2024).

In the first moment, a general reflection was made on the role of the teacher, in an interactive and dynamic way, encouraging constant interaction between the participants using videos, songs, poems, illustrative images and optical illusions to awaken people's attention, concentration and perception, but always trying to reflect on the way they are used to perceiving other people and problematic situations.

The second moment is reserved for the presentation of the epistemological references related to Research-Based Teaching and the strategies used by various researchers in their practices in the different areas in which they work. At this point, the importance of Science Clubs is highlighted, explaining their contribution to children and

adolescents who regularly attend the activities that take place in these non-formal educational spaces.

The third moment involves the presentation of a concrete challenge that requires workshop participants to set up an experiment and carry out procedures to solve the problem. The aim of this moment was to make the teachers experience the stages of an ITS in practice. The problematization is based on the literary poem “O menino que carregava água na peneira”, by Manoel de Barros², with the following problem question being posed: using the materials available, how can the glass be turned upside down without the water falling out? The teacher would then ask whether, as in the poem, it would be possible to carry water in the sieve, asking the students based on the problem posed.

With this experiment, the students would see how the phenomenon of surface tension of water occurs, which would make it possible to actually load water into the “sieve”, using the materials provided, such as: buckets, cups, pieces of tulle (large enough to cover the mouth of the cup), square pieces of EVA, elastic bands and toothpicks. The participants split into teams and began to experience the stages of the investigative experiment. Only the writing and drawing stage was not carried out, due to time constraints.

3 Results and Discussion

Based on the previous point, we will discuss the moments and experiences lived in the teacher training workshops focusing on Research-Based Teaching.

In Marapanim, the teacher began the first moment with a reflection on the role of the teacher and their contributions to basic education, given that the audience was made up of undergraduates from the university center, mainly from the Pedagogy course. This reflection was well received by the participants, who interacted and shared many of their experiences and difficulties. This first moment was motivational. One of the teacher's main

² BARROS, M. O menino que carregava água na peneira. **Poetriz** (Blog). Disponível em: <https://poetriz.wordpress.com/?s=o+menino+que+carregava+%C3%A1gua+na+peneira>. Acesso em: 2 fev. 2024.

questions to those present was: what is your work? If you didn't exist, what would you be missed for?³

With regard to these reflective moments, Oliveira and Serrazina (2002) point out that reflection is associated with the way we deal with problems in professional practice. In order to accept the state of uncertainty, professionals become open to new experiences and paths, building and implementing solutions. Thus, the exchange between the lecturer and the participants contributes significantly to the construction or reconstruction of professional profiles. As Freire (1996, p. 43-44) states, “in the ongoing training of teachers, the fundamental moment is that of critical reflection on practice. It is by thinking critically about today's or yesterday's practice that the next practice can be improved”.

The second part of the workshop was devoted to discussing the theoretical and methodological basis of Research-Based Teaching, focusing on the ITS stages. At this point, one of the authors of this article explained the didactic approach, introducing the participants to the main theoretical references and books used as a basis for the research carried out by the Grupo de Formação de Professores de Ciências. It is worth noting that the work carried out at the Clube de Ciências Prof. Dr. Cristovam W. P. Diniz is also presented, as well as other actions that focus on Research-Based Teaching.

Contact with investigative practices encourages education professionals to get involved with investigative experimentation and to take a leading role in it. Throughout the workshop, the teacher focuses on the idea that many experiments can be done with alternative and/or low-cost materials, showing these professionals that laboratories are not always necessary for scientific practices and investigations, since many schools do not have science laboratories.

Thus, in addition to the motivational issue, the teacher presents dynamics that instigate the participants to understand the different ways of proposing problematizations. Some of these dynamics involve the use of sealed boxes with an object inside. When they are distributed, the teacher asks them to investigate and hypothesize about what is inside

³ The motivational questions were based on the book *Viver em paz para morrer em paz*, by Mário Sérgio Cortella.

each box, stimulating the use of the five senses (smell, taste, touch, hearing, sight) to solve the problem. Another dynamic takes place using song lyrics, excerpts from movie scenes and video resources. Thus, the teacher training workshop aims to do much more than present research teaching, but to enable participants to experiment with different strategies for problematizing with their students, without the need for laboratories.

In the third moment, we have investigative experimentation as a strategy to be experienced by the workshop participants, who test their hypotheses following the ITS stages, starting from the initial problematization.

Figure 1 – Investigative experiment in the third moment



Source: Authors (2024).

The mediators of the experiment have a fundamental role, which consists of problematizing, asking constant questions, without providing the answers, to the participants. Bachelard (1996, p. 18) proposes that “in the first place, one must know how to formulate problems [...] it is precisely this sense of the problem that characterizes the true scientific spirit. For the scientific spirit, all knowledge is an answer to a question”. In his words, we see how fundamental the use of problems is to the construction of scientific knowledge. This strategy emphasizes the need to question, explore and investigate in order to achieve a deeper and more meaningful understanding of the world around us.

This approach was well received and recognized by many of those present as a strategy to guide the student's understanding of the problems, which can make a difference

in the participants' classes, because when the answers are not given directly, the students are guided to construct their knowledge, often making it more meaningful and easier to understand.

In relation to the questions asked by the teachers, the research by Barbosa, Rocha and Malheiro (2019) shows that, during problematization, the questions that arose were related to focus and attention, with questions centered on the subject, the data, the problematization, etc. When solving the problem, the questions are mainly aimed at speculation and focus and attention. When it comes to systematizing knowledge, the questions asked by the teachers are person-centred questions, as well as focus and attention, process-centred and problematization questions, contributing to investigative dialogical interactions.

The questions, even if they are not the focus of this work, enhance the investigative process and the actions that can be taken by the participants in an attempt to solve the problem. When asked appropriately, questions guide and help develop skills and competencies.

In this workshop, we had a report from Laura, who said the following about these formative moments:

I learned how to guide and instruct on research instruments all the way through, which made learning easier. You offer expert guidance, clarify doubts, provide many practical examples of research to be worked on and created in a collaborative environment aimed at stimulating the exchange of knowledge between participants. I can say that the research approach will help students to develop research strategies and critically analyze the results of an objective.

Regarding the workshop in general, the same participant said:

The workshop was great, it will give me the opportunity to improve my research and analysis skills in my work with my students. The teachers were excellent, they showed that we can provide a deeper understanding of research techniques and promote an exchange of ideas between participants and safety in the experiment.

Based on the information, we see that she uses terms such as “expert guidance” and “practical examples of research”, thus recognizing positive aspects of the workshop,

such as the guidance and theoretical background offered to professionals and the moment of interaction with investigative experimentation. With their positioning, we realize that the actions of the ministers encompassed the following expected objectives: deepening, because they involved the participants in understanding theoretical and methodological issues; reframing content, because, from this contact with investigative activities, professionals can reformulate their classes when necessary, oriented to promote a more active participation of the student during this journey, not leaving aside the specific contents of the school menu.

In addition to expanding the methodological repertoire, which is related to the understanding that Research-Based Teaching, for some authors, is defined as a didactic approach that offers a range of methodological strategies and procedures, in which the essential thing is the problematization and the investigative openness given to students to propose and test hypotheses, ideas, etc. (Carvalho *et al.*, 2017).

3.1 Formação de professores com foco no Ensino por Investigação workshop in São Caetano de Odivelas

A second workshop for basic education professionals took place on January 27, 2024, in São Caetano de Odivelas, in northeastern Pará. In the first moment, as happened in Marapanim, there is a reflection on teaching practices and the role of the teacher.

The second moment, as in the Marapanim workshop presented earlier, included theoretical explanations of the investigative activities, with the possibility of disseminating the strategies used to basic education students who have the opportunity to experience the actions developed at the Science Club.

Figure 2 – Second part of the workshop in São Caetano de Odivelas (PA)



Source: Authors (2024).

One of the participants, identified as Mariana, said the following about her experience:

The workshop was interesting for me, even though I had already had contact with experiences in my undergraduate degree in Ciências Naturais, in which I had subjects in physics, chemistry, etc. I was interested because the teacher explained in a way that I fully understood, using the methodologies and passing on the themes with enthusiasm and optimism at the time of the workshop.

With regard to teaching practices, the participant says: “I love teaching with different methodologies, to make the student understand the subjects better. I use experiments in my classes”.

We can see how the workshop provided the participant with a reflection, linked to a recovery of the contact with experimental activities throughout her education, which shows that practices should be constantly used in the classroom. This is in line with Freire's (1996) proposition in which teacher training is seen as a fundamental moment of critical reflection on their practice. In this way, we realized that even though the participant had had contact with methodologies other than the conventional ones, she expressed her enthusiasm in a reflective moment about her actions, as well as having had contact with the theoretical basis.

4 Conclusions

In this paper, we present a record of some of the moments we experienced while participating in workshops focused on research teaching for teachers and future teachers of basic education. We reiterate the importance of providing meetings that contribute to the teacher's teaching practice, presenting different ways of teaching, through activities that allow the student to be the protagonist of their learning.

Based on some of the reports and especially on the engagement seen during the activities, we consider it essential to continue and publicize the actions carried out, especially those aimed at bringing knowledge and exchanging experiences to cities further away from the metropolitan region.

When it came to reflecting on the role of teachers and their contributions to basic education, we had contact with two different profiles of participants. Some were in the process of training, i.e. undergraduates on the Pedagogy course linked to the Marapanim university center. The second profile was of professionals from the public school system in the city of São Caetano de Odivelas, from different areas of knowledge, but engaged in learning more about science teaching and research activities. It's worth noting that each of the profiles brings their own life and classroom experiences, and can reframe their practices and improve their methodology through the reflections that have been suggested about their professional role in society.

With regard to the discussion on the Research-Based Teaching approach and the strategies used in its application, it is worth highlighting that it was important to situate the participants in relevant research on the subject of Research-Based Teaching, investigative experimentation and ITS, so that they can be given the necessary theoretical support for studies and practical actions based on scientific investigation.

It was also a time for scientific dissemination, as much has been produced in the area, including work from the northern region of Brazil itself.

Finally, the moment of practical activity based on the stages of an Investigative Teaching Sequence was intended to present ITS in a practical way, this being one of the

most important moments in which theory and practice can be united. It all started with a problematization, a questioning. From there, attempts were made, hypotheses raised and tested in search of a solution to a problem. Those present experienced the process so that they would be able to reproduce it with their students in the future.

We would point out that this study corroborates what has been discussed in the literature on science education in the context of teacher training, showing in practice how workshops are developed for professionals outside the metropolitan region of the city. One of the objectives, intrinsically related to the development of teaching practices, is the possible creation of science clubs in each location, with a focus on research teaching by teachers. We see this as a challenge, as setting up and maintaining them requires a willingness on the part of the teacher and basic infrastructure. As we have seen, science clubs are formative spaces for the development and dissemination of science, so teacher training workshops could arouse interest in founding these non-formal teaching spaces, as well as contributing to a more formative and interactive basic education for students.

References

AZEVEDO, Maria Cristina P. Stella. Ensino por investigação: problematizando as atividades em sala de aula. *In*: CARVALHO, Anna Maria Pessoa de. **Ensino de ciências: unindo a pesquisa e a prática**. São Paulo: Pioneira Thomson Learning, v. 3, p. 19-33, 2004.

BACHELARD, Gaston. **A formação do espírito científico: contribuição para uma psicanálise do conhecimento**. Tradução Esteia dos Santos Abreu. 1. Ed. Rio de Janeiro: Contraponto, 1996.

BARBOSA, Daisy Flávia Souza; ROCHA, Carlos José Trindade da; MALHEIRO, João Manoel da Silva. As perguntas do professor monitor na experimentação investigativa em um Clube de Ciências: Classificações e organização. **Research, Society and Development**, v. 8, n. 4, p. 12, 2019. Disponível em: <https://dialnet.unirioja.es/servlet/articulo?codigo=7164698>. Acesso em: 31 jan. 2024.

CARVALHO, Anna Maria Pessoa de. (Org.). **Formação continuada de professores: uma releitura das áreas de conteúdo**. 2. Ed. São Paulo: Cengage Learning, 2017.

CARVALHO, Anna Maria Pessoa de. (Org.). **Ensino de Ciências por investigação:** condições para implementação em sala de aula. 1. Ed. São Paulo: Cengage Learning, 2013.

CARVALHO, Anna Maria Pessoa de (Org). **Ciências no ensino fundamental:** o conhecimento científico. 2. Ed. São Paulo: Scipione, 2009.

COELHO, Antônia Ediele de Freitas; ALMEIDA, Willa Nayana Corrêa; MALHEIRO, João Manoel da Silva. Desenvolvimento de habilidades cognitivas e ensino de matemática em um Clube de Ciências da Amazônia. **Amazônia: Revista de Educação em Ciências e Matemáticas**, v. 15, n. 33, p. 37-55, 2019. Disponível em: <https://dialnet.unirioja.es/servlet/articulo?codigo=7004329>. Acesso em: 31 de jan. 2024.

FLICK, Uwe. **Introdução à pesquisa qualitativa.** Tradução: Joice Elias Costa. 3. Ed. Porto Alegre: Artmed editora, 2008. 405p.

FREIRE, Paulo. **Pedagogia da autonomia:** saberes necessários à prática educativa. São Paulo: Paz e Terra, 1996

GIL, Antonio Carlos. **Como elaborar projetos de pesquisa.** 4. ed. São Paulo: Atlas, 2009. 176p.

GIL PEREZ, Daniel; VALDÉS CASTRO, Pablo. La orientación de las prácticas de laboratorio como investigación: un ejemplo ilustrativo. **Enseñanza de las Ciencias**, v. 14, n. 2, p.0155-163, 1996. Disponível em: <https://raco.cat/index.php/Ensenanza/article/view/21444>. Acesso em: 02 de fev. 2024.

LIMA, Maria Emília Caixeta de Castro (Org). **Ensino de Ciências por Investigação-ENCI-** 1. Ed. Belo Horizonte: UFMG/FaE/CECIMIG, 2008.

MALHEIRO, João Manoel da Silva; TEIXEIRA, O. P. B. Estratégias de Ensino e Aprendizagem com base na Resolução de Problemas em um Curso de Extensão. *In:* NARDI, R.; BASTOS, F. **Interfaces entre a Produção Acadêmica em Ensino de Ciências e os Saberes e Práticas Docentes em diferentes níveis, modalidades de ensino e espaços educativos.** São Paulo (SP): Livraria da Física, 2022.

MALHEIRO, João Manoel da Silva. Atividades experimentais no ensino de ciências: limites e possibilidades. **Actio: docência em ciências**, v. 1, n. 1, p. 108-127, 2016. Disponível em: <https://revistas.utfpr.edu.br/actio/article/view/4796>. Acesso em: 02 de fev. 2024.

MALHEIRO, João Manoel da Silva. **A resolução de problemas por intermédio de atividades experimentais investigativas relacionadas à biologia:** uma análise das ações vivenciadas em um curso de férias em Oriximiná (PA). Tese (Doutorado)- Universidade Estadual Paulista, Faculdade de Ciências, São Paulo, 2009. Disponível em:

<https://repositorio.unesp.br/items/4fce641a-c08f-4144-8148-3c7c727ce660>. Acesso em: 06 de fev. 2024.

OLIVEIRA, Isolina; SERRAZINA, Lurdes. A reflexão e o professor como investigador. **Reflectir e investigar sobre a prática profissional**, v. 29, n. 29-42, 2002. Disponível em: https://www.researchgate.net/publication/260942853_A_reflexao_e_o_professor_como_investigador. Acesso em: 15 de fev. 2024.

ROCHA, Carlos José Trindade da; ALTARUGIO, Maisa Helena; MALHEIRO, João Manoel da Silva. Formação de professores e o ensino investigativo na química: reflexões e estratégias. **Research, Society and Development**, v. 7, n. 5, p. e1275317, 2018. Disponível em: <https://www.redalyc.org/journal/5606/560659012012/560659012012.pdf>. Acesso em: 06 de fev. 2024.

SASSERON, Lúcia Helena. **Ensino por investigação**: pressupostos e práticas. (Apostila de Licenciatura em Ciências USP/Univesp. Módulo 7. Capítulo 12. p. 116-124), São Paulo, 2018. Disponível em: https://midia.atp.usp.br/plc/plc0704/impressos/plc0704_12.pdf. Acesso em: 05 fev. 2024.

ZÔMPERO, Andreia Freitas; LABURÚ, Carlos Eduardo. Atividades investigativas no ensino de ciências: aspectos históricos e diferentes abordagens. **Ensaio: pesquisa em Educação em Ciências**, v. 13, p. 67-80, 2011. Disponível em: <https://www.scielo.br/j/epec/a/LQnxWqSrmzNsrRzHh3KJYbQ/?la>. Acesso em: 05 fev. 2024.

Acknowledgements

To CNPq, for awarding a productivity grant to the second author. To CAPES, for awarding research grants to the first and third authors.

¹Isabela dos Santos Carvalho, ORCID: <https://orcid.org/0009-0009-5451-6428>

Universidade Federal do Pará (UFPA)

Licenciada em Física pela Universidade Federal do Pará. Mestranda em Educação em Ciências e Matemáticas (PPGECM) do Instituto de Educação Matemática e Científica (IEMCI-UFPA).

Authorship contribution: Writing the scientific paper.

Lattes: <http://lattes.cnpq.br/3308441809416812>

E-mail: isabelacarvalho194@gmail.com

ii João Manoel da Silva Malheiro, ORCID: <https://orcid.org/0000-0002-2495-7806>

Universidade Federal do Pará (UFPA)

Licenciado em Ciências Biológicas pela Universidade Federal do Pará. Mestre em Educação em Ciências e Matemáticas (UFPA). Doutor em Educação para a Ciência (UNESP/Bauru). Professor Associado IV na Universidade Federal do Pará. Professor do Programa de Pós-Graduação em Educação em Ciências e Matemáticas (PPGECM) e do Programa de Pós-Graduação em Docência em Educação em Ciências e Matemáticas (PPGDOC) e da Faculdade de Pedagogia (*Campus Castanhal*).
Authorship contribution: Review and guidance.

Lattes: <http://lattes.cnpq.br/7502225344402729>

E-mail: joaomalheiro@ufpa.br

iii Márcia Cristina Palheta Albuquerque, ORCID: <https://orcid.org/0000-0003-4899-3067>

Universidade Federal do Pará (UFPA)

Licenciada em Física pela Universidade Federal do Pará. Mestre em Docência em Educação em Ciências e Matemáticas. Doutoranda em Educação em Ciências e Matemáticas (PPGDOC) do Instituto de Educação Matemática e Científica (IEMCI-UFPA).

Authorship contribution: Proofreading and editing.

Lattes: <http://lattes.cnpq.br/0982797512622985>

E-mail: mcppalhetaalbuquerque@gmail.com

iv Deyse Danielle Souza da Costa, ORCID: <https://orcid.org/0000-0003-3298-5759>

Universidade Federal do Pará (UFPA)

Licenciada em Pedagogia pela Universidade Federal do Pará. Mestre em Políticas Públicas Educacionais pelo Programa de Pós-Graduação da Universidade Federal do Pará – PPGED/UFPA. Doutoranda em Educação em Ciências e Matemáticas do Instituto de Educação Matemática e Científica (IEMCI-UFPA).

Authorship contribution: Proofreading and editing.

Lattes: <http://lattes.cnpq.br/1288399414203804>

E-mail: daysecosta13@gmail.com

Responsible publisher: Genifer Andrade.

Ad hoc experts: Mirelle Araújo da Silva e Andrecksia Viana Oliveira Sampaio.

How to cite this article (ABNT):

CARVALHO, Isabela dos Santos *et al.* FormAÇÃO de professores com foco no ensino por investigação: relatos de prática pedagógica. **Rev. Pemo**, Fortaleza, v. 6, e13701, 2024. Disponível em: <https://revistas.uece.br/index.php/revpemo/article/view/13701>

Received on August 6, 2024.

Accepted on October 15, 2024.

Published on December 9, 2024.