http://doi.org/10.14393/ER-v31e2024-46

# Interdisciplinary didactic workshops and co-teaching: analysis of a co-training proposal for science teachers[1]

*Leíce Germana da Silva Barbosa*[2]
*Thiago Araújo da Silveira* [3]
*Francisca Suene Alcântara Siqueira* [4]

**ABSTRACT**

This study aims to analyze the co-planning of Interdisciplinary Didactic Workshops carried out in a co-training process, identifying elements of co-teaching in this proposal. The research was developed in the context of the Interdisciplinary Didactic Workshops discipline of the Chemistry Degree Course at a public university in the state of Pernambuco and involved Chemistry undergraduates, basic education teachers and the teacher who is responsible for the discipline. The data were obtained through focus groups and document analysis. The results show that the planning and evaluation of Interdisciplinary Didactic Workshops, as a space-time for co-teaching, point to a training of science teachers that occurs in a collective and dynamic manner, in a perspective in which the relationship between theory and practice becomes unavoidable, expanding the possibilities of the subjects to "be more", encouraging the interpretation and intervention in social practices, and promoting openness to differences through co-responsibility.

[1] Ensglish version by Espanglish Traduções. *E-mail*: atendimento@espanglish.com.br.

[2]Master. Federal Rural University of Pernambuco, Pernambuco, Brazil. Orcid: https://orcid.org/0009-0002-5379-2497 . *E-mail*: leicegermana@gmail.com.

[3] PhD. Federal Rural University of Pernambuco, Pernambuco, Brazil. Orcid: https://orcid.org/0000-0003-1476-5824 . *E-mail*: thiago.silveira@ufrpe.br.

[4] Master. Federal Rural University of Pernambuco, Pernambuco, Brazil. Orcid: https://orcid.org/0009-0001-8033-8487 . *E-mail*: francisca.suene@ufrpe.br.

**KEYWORDS:** Interdisciplinary didactic workshops. Co-teaching. Teacher training.

*Oficinas didáticas interdisciplinares e co-ensino: análise de uma proposta co-formativa de professores de ciências*

**RESUMO**

O presente trabalho objetiva analisar os co-planejamentos de Oficinas Didáticas Interdisciplinares (ODI) realizados em um processo co-formativo, identificando elementos da co-docência nessa proposta. A pesquisa foi desenvolvida no contexto da disciplina Oficinas Didáticas Interdisciplinares do Curso de Licenciatura em Química de uma universidade pública no Estado de Pernambuco e envolveu licenciandos em Química, professores da educação básica e o professor formador da disciplina. Os dados foram obtidos por meio de grupos focais e análise de documentos. Os resultados evidenciam que o planejamento e a avaliação de Oficinas Didáticas Interdisciplinares, como espaço-tempo para a co-docência, apontam para uma formação de professores de ciências que ocorre de maneira coletiva e dinâmica, numa perspectiva em que a relação entre teoria e prática se torna incontornável, ampliando as possibilidades dos sujeitos de "serem mais", incentivando a interpretação e intervenção nas práticas sociais, e promovendo a abertura às diferenças por meio da corresponsabilidade.

**PALAVRAS-CHAVE:** Oficinas didáticas interdisciplinares. Co-docência. Formação de professores.

*Talleres didácticos interdisciplinarios y coenseñanza: análisis de una propuesta de coformación para profesores de ciencias*

**RESUMEN**

Este trabajo objetivo analiza la coplanificación de Talleres Didácticos Interdisciplinarios realizados en un proceso de coformación, identificando elementos de coenseñanza en esta propuesta. Esta investigación se desarrolló en el contexto de la disciplina Talleres Didácticos Interdisciplinarios de la Licenciatura en Química de una Universidad Pública del Estado de Pernambuco e involucra a graduados en química,

profesores de educación básica y formadores de docentes de la materia. Obtuvimos datos a través de grupos focales y documentos analizados. Los resultados muestran que la planificación y evaluación de Talleres Didácticos Interdisciplinarios como espacio temporal de coenseñanza, apunta a una formación de profesores de ciencias que se desarrolla de manera colectiva y dinámica, en una perspectiva en la que la relación entre teoría y práctica, la ampliación de las posibilidades de los sujetos para "ser más", el fomento de la interpretación y la intervención en las prácticas sociales y la apertura las diferencias a través de la corresponsabilidad.

**PALABRAS CLAVE:** Talleres didácticos interdisciplinarios. Coenseñanza. Formación docente.

* * *

## Introduction

This article discusses the co-formative process involving science teachers in initial training and teachers in continuous training, who were involved in the co-planning of Interdisciplinary Didactic Workshops (IDW). In addition to these aspects, reflections are presented on co-teaching, a formative model of interaction between basic education schools and universities, aimed at establishing horizontal collaboration between the social players in these institutions (Washut-Heck et al., 2008).

The aspects analyzed in this study are part of the co-planning undertaken by teachers in initial and continuing training, whose activities were organized based on the building blocks of Interdisciplinary Didactic Workshops (IDW), a didactic proposal that considers people to be at the center of the teaching and learning process, involving them in collaborative knowledge construction through problem situations, turning the learning space into a place for investigation, research, construction and creativity.

Based on the interdisciplinary, hermeneutic, dialectical, dialogical and complex nature of IDW, the latter could be configured as a space-time for

training in which teachers from different areas can work on the basis of a common and critical proposal, which articulates culture and science in favor of more holistic learning based on social context and practice (Silveira, 2020). In spaces where Interdisciplinary Didactic Workshops (IDW) are used, people with different backgrounds and cultures meet, mediated by dialogue and practice in search of learning and autonomy. Therefore, in this paper we present the co-planning of IDWs developed by undergraduates, basic education teachers and the teacher trainer, who worked collaboratively through Working Groups (WGs).

In this regard, aspects of Interdisciplinary Didactic Workshops (IDW) and co-teaching are discussed as proposals for teacher training, seeking to alter the dichotomous relationship between theory and practice and promote interaction between three spaces - professional, university and school - and thus develop the transformative potential of teacher training.

Therefore, the purpose of this article is to analyze the co-planning of Interdisciplinary Didactic Workshops (IDW) undertaken in a co-formative process, identifying elements of co-teaching in this proposal.

## Co-Teaching

The concept of co-teaching involves two or more teachers who teach and learn together in an activity in which they all share responsibility for planning, teaching and assessing (Tobin, 2006; Murphy & Beggs, 2006). Corroborating these ideas, Murphy et al. (2015) emphasize that co-teaching "*occurs when teachers share responsibility for all aspects of student learning during a period of instruction [e.g., a lesson or curriculum unit], including planning, teaching, and assessment*" (Murphy et al., 2015, p. 281).

The concept of co-teaching emerged as a model for teaching undergraduates on teacher training courses (Gallo-Fox & Scantlebury, 2016). From this perspective, co-teaching aims to train teachers in a collaborative

manner, involving trainee teachers, basic education and higher education teachers and university researchers in the construction of the work processes associated with teaching. This model offers future teachers authentic and guided opportunities during their training experience (Washut-Heck et al., 2008).

It is worth emphasizing that the concept of co-teaching presented here extends beyond the triad of teachers in training, basic education teachers and university professors/trainers. Rather, it is a formative and dialogical process between future teachers (undergraduates) and experienced teachers (from the university and the school) that involves co-planning and co-teaching.

In this manner, it is important to emphasize that co-teaching conceives learning and teaching as a socio-cultural activity, in which hierarchical structures are broken down through a collaborative environment, where co-teachers - experienced teachers (from university and school) and future teachers (undergraduates) - are mutual partners who share responsibilities in the teaching and learning process (Roth & Tobin, 2005; 2006).

Through such a new praxis, teachers and future teachers broaden their knowledge of what teaching entails, sharing new understandings and exploring frontiers through this collective practice. According to Scantlebury et al. (2007), this process requires clear communication regarding collectively generated practice, a mutual sense of respect for contributions during co-planning and in the development of practice, alongside a shared sense of co-responsibility in order to meet the needs of students.

The process of co-planning requires the willingness of co-teachers to share ideas and reflect on past, present and future experiences for collective development. This leads to the co-generation of educational proposals, known as co-generative dialogues (Silva et al., 2022).

As a characteristic of dialogic action, Freire (1996) highlights that collaboration involves communication and is based on dialogue. According to the theory of dialogic action, adherence to ideas is sought, without imposing,

manipulating or simplifying. In this understanding, co-generative dialogues are essential for co-teaching, providing a space to share ideas and experiences with the aim of improving teaching and learning. These value mutual listening, promoting a horizontal approach to the co-teaching process and allowing for different perspectives on teaching and learning experiences (Scantlebury et al., 2008).

A collaborative approach to teacher training is proposed by Imbernón (2023), understood here as co-education, with a focus on commitment and collective responsibility to transform the educational institution into an environment of continuous learning. This co-education requires constant dialogue, debate, consensus-seeking and conflict mediation to boost organizational, personal and collective development.

According to this understanding, Scantlebury et al. (2008) argue that shared responsibility and respect between co-teachers are essential elements that enable a co-formative process. These are the manner in which co-teaching promotes a democratic approach to (initial and continuing) teacher education and fosters opportunities for future teachers to develop in an interactive environment (Murphy & Beggs, 2010, p. 33).

Co-teaching enables teachers to collaborate in the development of activities and the mediation of students' learning needs. Co-planning is fundamental, allowing teachers to share ideas, resources and organize activities (Gallo-Fox & Scantlebury, 2016). This process involves both new and experienced teachers discussing teaching, assessment and curriculum strategies.

However, it should be noted that during co-planning meetings, teachers indicate and resolve differences, establishing an agreed reality on how learning environments and teaching strategies could be used and improved, promoting collaboration between educators and enriching their teaching practices.

This implies directing co-training towards a process that encourages reflection through participation, incorporating elements such as personal contribution, flexibility, motivation, shared objectives, transparent guidelines, coordination and self-evaluation. This co-training process is based on a methodology centered on actual situations, which involves exchanges, debates, readings, group work, critical incidents and challenging situations, thereby demanding a critical and unconventional stance in training, including the analysis of the ideological and attitudinal bases underlying teaching practice (Imbernón, 2023).

## Interdisciplinary Didactic Workshops (IDW)

The definition of what workshops are is quite polysemic. In the simplest terms, workshops are defined as activities that involve something practical. On the other hand, Vieira and Volquind (2002) see this proposal in a more complex manner, stating that, in order to achieve its didactic objective, the workshop must allow theory to be reflected on through practice, requiring an interdisciplinary relationship.

According to Albuquerque, Mayer and Bastos (2009), in addition to a practical task, workshops should have an interdisciplinary approach as their main axis, as these workshops enable the establishment of a relationship between theory and practice, allow the application of theoretical principles and laws to everyday situations and favor the articulation of knowledge, enabling the development of more critical and problematizing learning.

When workshops are used as a pedagogical process, the aim is to develop skills in students such as: collective search for solutions, stimulating creativity; emotional development and adaptations to everyday situations; valuing the contribution of each individual; improving aspects of speech and communication; and the relationship between theory and practice, as well as experience with consciousness (Mirabent Perozzo, 1990, p. 68).

For the workshops, Vieira and Volquind (2002) argue that the realities studied articulate three instances in the teaching and learning process: thinking, acting and feeling, considering that human beings need to be active in their learning process and that they don't just learn based on cognitive, logical and/or exclusively rational issues. Human beings are holistic and, therefore, learning must also be.

The teaching process in Interdisciplinary Didactic Workshops is organized around a problem-situation, which is an open question or case whose resolution requires practical and theoretical input from two or more disciplines. Through this resolution process, content is explored in an articulated manner, while developing group work skills, contingency management, questioning, and problem solving based on research, action and reflection (Silveira, 2020).

Furthermore, Silveira (2020) highlights the capacity of Interdisciplinary Didactic Workshops to work with hermeneutics, dialectics, dialogicity and complexity. Hermeneutics allows individual constructs to interact in order to understand and expand reality, seeking solutions. Dialectics reveals the conflictive and non-conformist nature of reality, allowing for ruptures. Dialogicity involves reflective encounters to solve problems, learn and question. Lastly, complexity encompasses the unity and multiplicity of reality, exploring the unpredictable, the interconnection between sciences and cultures, and the integration of knowledge and feelings.

With these fundamentals in mind, a question arises: how to create an IDW?

As Silveira (2020) argues, the ideal context for developing an IDW is one that provides teachers with greater flexibility, autonomy and creative potential, preventing the creative process from being locked into any established methodology. In this respect, teachers should choose the resources, strategies and contexts that best suit their classes, infrastructure

and teaching style. However, some elements can be identified that characterize the steps of this didactic proposal:

- **Organization of the Working Group**: Interdisciplinary in nature, the development of an IDW requires a collaborative process between teachers, i.e. the creation of a group responsible for planning, implementing and assessing the proposal. The group may comprise two or more teachers from different disciplines and include the participation of students, which could lead to a new manner of communication between teachers and students, where each contributes with their experience (Vieira & Volquind, 2020, p.17).
    - **Preparation of the problem situation and objectives**: The starting point to plan an IDW is the design of the problem situation and its objectives. The problem situation is an open and questioning problem context, in which knowledge from two or more disciplines will be gathered to solve the problem. Solving the problem situation should allow for flexible, differentiated and creative responses from the students, promoting greater reflection from different perspectives.
    - **Selection of teaching strategies**: The selection of teaching strategies for an IDW needs to be aligned with the objectives of the proposal. These strategies are not limited to a specific methodology, allowing teachers to select the one that best suits their needs. Strategies should value practical work, promote dialogue and discussion of controversial issues, work in the hermeneutic circle, focus on teamwork and value student autonomy.
- **Learning assessment and self-assessment**: In IDW, the assessment occurs throughout the application process and is therefore formative. This assessment allows both teachers and students to observe the knowledge acquired and the decisions made during the workshop. Self-assessment allows students to reflect on their development and identify what they have already learned and what they still need to learn.

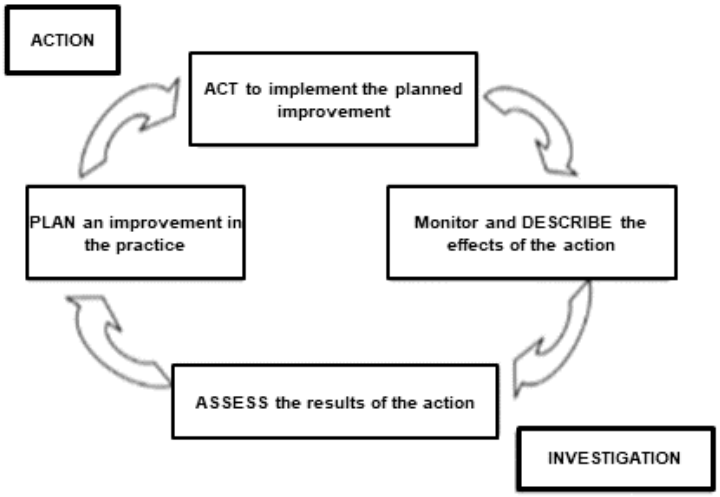
## Methodological Approach

The present research is qualitative in nature, allowing to focus on the complex reality of science teacher training. In this sense, the present research focuses on the process of developing the co-planning of Interdisciplinary Didactic Workshops (IDW), approaching the context in a dialogical, horizontal and ethical manner, involving all participants in the search for expanding knowledge and transforming teaching practices through actions and reflections.

Action Research is the type of research that best represents the present article. Action Research allows teachers to become involved in the process of investigating, analyzing and implementing changes in professional practices. According to Engel (2000), teachers must transform their classrooms into objects of research, rather than being mere consumers of research conducted by others.

A four phase cycle (figure 1) is proposed by Tripp (2005) for the development of action research and emphasizes continuous reflection as essential to the process, affecting the planning, implementation and assessment of the results achieved. Different approaches in each phase may yield different results, communicated in different manners to different audiences (Tripp, 2005).

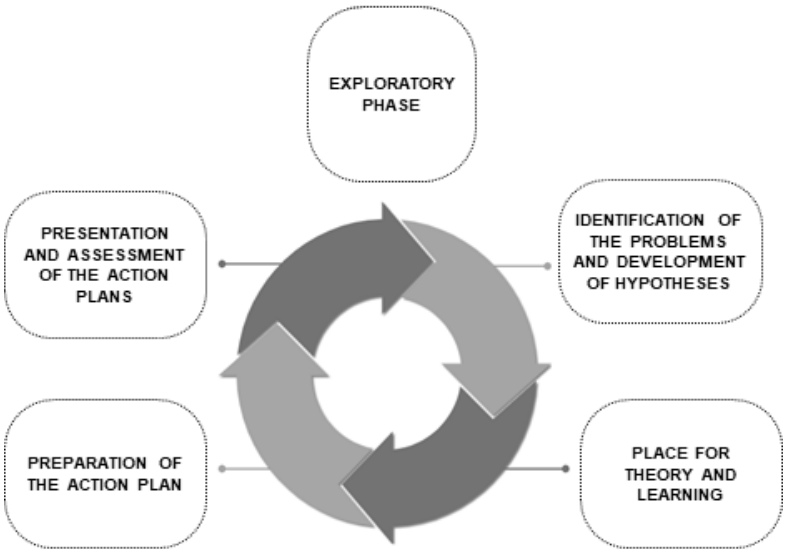
**FIGURE 1**: Action-Research Cycle proposed by Tripp (2005)




**Source**: Tripp (2005)

The present research has not followed a linear, predetermined flow. The social players acted interactively, reflecting on practice and proposing solutions to the problems identified in the construction of the IDWs. The action research was developed based on the phases proposed by Thiollent (2011) and in the cycle proposed by Tripp (2005), as illustrated in the figure below.

**FIGURE 2**: Action-Research Cycle




**Source**: Prepared by the authors

Over the course of this article, details will be provided on the phases of the research, in parallel with the description of the stages of the Interdisciplinary Didactic Workshops (IDWs), once an analogous relationship has been observed between the epistemological and methodological perspectives of action research (Thiollent, 2011) and the process of co-construction of the IDWs.

1. **Exploratory Phase**: The exploratory phase of action research commenced with an analysis of the current situation, observing the context, practices and scenario of the participants (Tripp, 2005). Thus, the co-planning of the Interdisciplinary Didactic Workshops (IDWs) occurred in the optional subject "Interdisciplinary Didactic Workshops", aimed at chemistry undergraduates at a public university in the State of Pernambuco, with a total workload of 60 hours. The course integrates theory and practice in science teaching, based on theoretical assumptions such as Dialogicity by Freire, Hermeneutics, Dialectics and Complexity. And, the objective is to develop Interdisciplinary Didactic Workshops based on these theoretical assumptions for application in the municipality's primary schools. Note that this research was conducted in a challenging context, affected by the global health crisis, the COVID-19 pandemic. The subject was taught remotely during the exceptional school term (PLE) of 2020, and the use of digital technologies such as Google Meet, Google Classroom and Telegram enabled synchronous and asynchronous activities to be performed. The social players, referred to here as co-teachers, involved in this curricular component were a teacher trainer, responsible for the subject and with a PhD in Science Teaching; three teacher tutors, with degrees in Biological Sciences, Physics and Mathematics, all working in basic education; and sixteen undergraduate chemistry students.

2. **Identification of problems and development of hypotheses**: The co-teachers initiated discussions on learning through practice, identifying gaps in the teaching and learning process concerning the relationship between theory and practice of school science content. Moreover, they recognized the need to break with the fragmented approach to studying scientific content using traditional teaching methods, seeking interdisciplinary pedagogical proposals that overcome the dichotomy between theory and practice. The activity corroborates the activities of Action Research, as the co-teachers mobilized to solve the problem, beginning to study the Theoretical and Methodological Foundations for Interdisciplinary Didactic Workshops (IDWs) and the co-construction of an IDW Plan.
3. **Theory and Learning**: Within the workshops, there is a connected relationship between theory and practice. Accordingly, thematic modules were organized with the aim of studying the theoretical and methodological foundations for Interdisciplinary Didactic Workshops (IDW), and study, research and work groups were organized with the aim of encouraging reflection and discussing ways of co-constructing an IDW Plan. This phase corroborates the activities of action research, when Thiollent (2011) states that problems are interpreted from a theoretical and practical perspective, thereby taking advantage of the learning capacity and enriching learning according to the demands of the action around which the research is being conducted.
4. **Preparation and Presentation of IDW Plans**: Considering the interdisciplinary and dialogue-based approach of IDW, the IDW Plans were developed in a collaborative fashion through working groups comprised by co-teachers from different disciplines. This proposal corroborates action research, which is participatory in nature, as researchers and participants who are representative of the situation or problem are involved in a cooperative or collaborative manner

(Thiollent, 2011; Tripp, 2005). After preparing the plans, the working groups presented their co-constructions of the IDW Plans in a synchronous meeting. The presentation was recorded and everyone involved participated.

Note that the research data was collected during the preparation and presentation of the IDW Plans. Therefore, in order to accomplish the objective proposed by this research, more than one data collection technique was employed. In this regard, the focus groups were held during the action plan preparation phase, during the mentoring sessions for the co-construction of the IDW Plans. The document analysis of this work was based on the Interdisciplinary Didactic Workshops (IDW) Plans prepared by the co-teachers.

Data analysis was conducted using the Hermeneutic-Dialectic Approach. The combination of hermeneutics and dialectics leads the interpreter to attempt to understand the "text", the "speech", the "testimony" as the result of a social and knowledge process, both the result of multiple determinations, but with a specific meaning.

Consequently, the stages of this data analysis process, summarized by Oliveira (2001; 2013), will be followed: a) Level of Fundamental Determinations: understanding the socio-historical context of the social players in the research as a theoretical basis; b) Level of Encounter with Empirical Facts: analysis of the events that emerged during the investigation, involving a comprehensive exploration of reality; c) Organization and Systematization of Data in Blocks of Analysis and Identification of Categories: grouping of theoretical and empirical data, arrangement in categories and synthesis of the grouped data.

Accordingly, data analysis was conducted by transcribing audios of tutoring sessions, analyzing Telegram conversations and assessing IDW Plans.

Considering that the objective of this article is to analyze the co-planning of Interdisciplinary Didactic Workshops (IDW) conducted in a co-formative process, identifying elements of co-teaching in this proposal, the discussions are organized in the theoretical category "co-teaching as a co-formative and dialogical process". It is important to emphasize that, in this theoretical category, empirical categories were also found: dialogue in teacher training and the relationship established between social players. These categories provide relevant reflections regarding the scope of this research.

## Data Discussion

The comments given by the co-teachers reveal that the preparation, implementation and assessment of an IDW consists of a process to share ideas, debate and ask questions, since the objectives and results will be obtained collectively. As can be seen from the following conversations in the Working Group:

**Table 1**: Co-teacher Dialogue

| Co-teachers | Comments / Conversation |
|---|---|
| Fabrício | We had the idea of working on the context of the pandemic. |
| Lia | Yeah, that's it! How mixing cleaning products with rubbing alcohol can be harmful. |
| Raquel Reis | On the use and dangers of cleaning products in the fight against Covid-19. |
| Fabrício | Regarding mixtures of cleaning products with the aim of exterminating the virus, this could end up resulting in a domestic accident, as well as adulterated products sold in supermarkets. |
| Raquel Reis | The COVID-19 Pandemic has made Brazilians more accustomed to cleaning and disinfecting their homes. However, some people tend to mix different cleaning products, which is not recommended as this can cause dangerous chemical reactions. |

| | |
|---|---|
| Black Alien | Well, I believe that Luedji can also intervene in biological matters. |
| Fabrício | Great! This way we can work on the biology of viruses and bacteria, especially the Covid-19 virus. |
| Luedji | (...) biology would not only be involved in the damage that these mixtures cause to health, but we could also explore the structure of the virus and how these products eliminate the coronavirus or not. I can also see mathematics within this context, as we can bring in the question of the growth (in graphs) of intoxication by these mixtures during the pandemic. |

**Source**: Research data

The comments above present the initial discussion of the Working Group to co-construct the IDW Plan and demonstrate how some of the interactions occurred on the Telegram app. It can be seen that the co-education process was based on dialogue in all possible directions between students-students, students-tutors and students-teacher.

Within this context, the empirical category "Dialogicity in teacher training" deserves special mention. These co-generative dialogues illustrate how the group creation process develops and how dialogue drives the development of ideas, increasing the scientific and interdisciplinary repertoire of the participants and the proposals that will be presented in the IDWs. The dialogues provide several markers of interaction that reinforce an important theoretical category in Freire (1996), which is "true dialogue".

This type of dialogue emphasizes how important elements such as sharing, praxis, action-reflection and work are to the act of saying the word. In the construction of the IDWs expressed in these dialogues, an immense respect for the contribution and thought of the other can be noticed; we can see the mutual recognition, in equality, of the condition of pronouncing the world (Freire, 1996).

Without co-generative dialogues there is no co-teaching, rendering it impossible to exchange ideas to improve teaching and learning. The dialogues

value all opinions equally and emphasize the importance of listening in order to share perspectives on teaching and learning. This leads to a horizontal approach in co-teaching, allowing for a broad understanding of teaching and learning experiences (Scantlebury et al., 2008).

Furthermore, the initial dialogues of the Working Group present elements of co-teaching, which highlight that the co-generative process involved in the co-planning of the IDWs allowed for greater proximity between the co-teachers and the opportunity to discuss their disciplinary practices, as observed in the comments made by Luedji when discussing Biology. The co-generative dialogues observed and/or reported on Telegram, in the presentation videos and in the questionnaire demonstrate that the teachers are beginning to make progress in the use of sharing content with each other as a technique (Kariuki; Hopkins, 2010).

In accordance with Leite, Dolabella, Silva, Ferreira and Campos (2013), teacher training encompasses the complexity of social and cultural changes. These changes require a know-how that combines theory and practice in an ingenious and qualified manner. Accordingly, interdisciplinarity is an indispensable approach for teachers, considering that interdisciplinarity encompasses an epistemological perspective that unites the knowledge of disciplines and areas of knowledge, as a condition to create meaning and search for totality.

Freire (2020) argues that the knowledge under discussion in the classroom does not come into fruition in one theoretical time and one practical time, and that teachers should work on and reflect on their choices so that this dichotomy is not established in the development of the IDW. The intentionality described in Moment 1 and in the problem situation, as illustrated in Table 2, presents elements in the process of co-planning an IDW, highlighting the relationship between theory and practice.

**Table 2**: IDW Plans

| IDW PLAN - CHEMISTRY AND BIOLOGY AGAINST CORONAVIRUS |
|---|
| **Interdisciplinary Moment 1**: This stage focuses on discussing the importance of social distancing and isolation measures as a form of prevention. Furthermore, to use chess as a strategy to compare the overcrowding of hospitals, in case the measures are not followed, applying mathematical and biological concepts to draw a profile of the scale of contagion. |
| IDW PLAN - CHEMISTRY AND MATHEMATICS IN THE CIVIL CONSTRUCTION INDUSTRY |
| **Problem Situation:** Throughout the entire world, countless architectural projects of exuberant beauty can be seen: beautiful houses, churches, schools, businesses, etc., where architects use their creativity to create very different designs that take on different geometric shapes. These buildings are built using a variety of materials, not only to show off their beauty and exuberance, but also to ensure comfort and safety for the residents. Considering the city of Javé, in Pernambuco, what would be the best shape and material to use when building a residence, considering the climate and the population? |

**Source**: Research data

The proposal presented in Moment 1 of the IDW "Chemistry and Biology against Coronavirus" uses the analogy of chess to illustrate the risk of hospital overcrowding in case preventive measures against Covid-19 are not adopted, demonstrating the exponential growth in cases and how the contagion rate is influenced by biological factors. The IDW "Chemistry and Mathematics in the Civil Construction Industry" addresses the relationship between architecture, form, material, climate and the needs of the population.

In the two IDW plans, it can be observed that, based on the challenge of co-creation, the teachers thought about how to mobilize theory and procedures, while taking into consideration the suggestions of their peers, social needs and the knowledge required for the teaching and learning process.

Another aspect observed in the teacher training process involved in the co-planning of the IDWs above refers to the critical-social commitment demonstrated both in the interdisciplinary moment 1 of the IDW Plan "Chemistry and Biology against the Coronavirus", when addressing the pandemic issues of Covid-19, and also in the problem situation of the IDW "Chemistry and Mathematics in the Civil Construction Industry".

The expression of creativity is manifested in the conversations during the co-generative dialogues and in the IDW Plans, emerging as a significant element to be explored within the context of co-teaching.

The activity proposed in Table 3 presents creative elements when considering the geometric proportions of different floor formats compared to the chemical properties of the materials, by means of a real situation that allows analysis regarding the implications of changes in flooring on the functionality of the environment. The activity also encouraged students to think creatively when choosing the geometric shape of the flooring for each room. In addition, the flexibility offered by the opportunity to change formats in the event that something doesn't work demonstrates that the process is an opportunity to experiment, make mistakes and adjust - a creative approach also in the assessment aspect, as it enables the teacher to monitor the learning process of the student and interact with feedback on the construction of the students.

**Table 3**: Activity proposed in the IDW Plan

| IDW PLAN CHEMISTRY AND MATHEMATICS IN THE CIVIL CONSTRUCTION INDUSTRY |
|---|
| During this stage, the class should be divided into up to 5 groups, with the objective of researching flooring that can be applied indoors and outdoors, focusing on the most common, cheap and durable options, such as ceramic tiles, porcelain tiles, burnished cement finishing, flagstones and marble. After researching, each group will have to choose which flooring will be used in each room of the house. In order to make the activity more dynamic, tangram pieces with different geometric shapes will be used so that each group can put together a floor plan with geometric shapes, colors and different flooring models. After choosing the geometric shape for each room, the groups can request a printout of the floor (in the colors and shapes selected by the group) to stick on the tangram, allowing them to better visualize what is being created and assess whether it is feasible and possible to have a house with floors of different shapes, and what the implications of these changes would be for the functionality of the room. As the tangram offers the possibility of varied assembly, whenever students realize that something wouldn't work, they could change it to another geometric shape. |

**Source**: Research data

Regarding creativity, Chagas, Aspesi and Fleith (2005) state that there is a direct relationship between the promotion of creativity and the quality of the interactions established between subjects. As such, the co-teaching process, which involves planning the IDWs, allowed the teachers to interact in a dynamic, creative, integrated and interdisciplinary manner. In view of the above, another empirical category was found: "Relationships established between social players".

Whereas current trends emphasize the importance of collaboration and joint work between teachers, there is a persistent reality of educators isolating themselves in their classrooms, in an individualistic culture. In other words, the individual thinks and acts individually, being the center of all decisions. This can promote important reflections, but it also deprives teachers of the stimulus and support of teamwork, as well as the possibility of receiving necessary support in the process of professional development. And one of the ways to help break down individualism is ongoing teacher training (Garcia, 2010; Imbernón, 2022).

Based on this understanding, strengthening teacher training mechanisms and practices that establish a collaborative process as a fundamental element for teacher training is essential, since this provides teachers with situations in which commitment, responsibility and reciprocity are necessary to perform their teaching work. As can be seen in the co-generative dialogues during co-planning and in the IDW Plans, bringing teachers into a collaborative context promotes greater communication between subjects, an increase in professional, pedagogical and human knowledge, as well as the creation of an atmosphere of openness to accepting criticism, self-regulation and creativity (Imbernón, 2010).

Elements of collaboration in the co-teaching process involving IDWs can be seen in the following comments:

**Table 4**: Comments from the co-teachers during the co-planning dialogues

| Co-teachers | Comments / Conversation |
|---|---|
| Luedji | We could start the problem with context, mentioning that a pandemic began in March of this year... |
| Mano Brown | We will be working with chemical reactions, but I want to see how this would work in the classroom. |
| **Co-teachers** | **Comments / Conversation** |
| Lia | I believe we could start as Luedji said |
| Gilberto Gil | let's add this here and we'll adjust it later |

**Source**: Research data

When analyzing the above comments, we have resorted to the study by Silva (2021) on co-teaching. In that study, the author emphasized that the use of the pronouns "we" and "us" together with verbs such as "start", "work", "add" denote collective action. As such, the comments indicate an openness to collaboration and dialogue, demonstrating that the construction of the plan is being influenced by multiple perspectives, and the decision to set aside time for adjustments, in a collective effort to guarantee the plan, indicates co-responsibility in finding solutions.

Co-teaching and co-generative dialogues require respect and co-responsibility between co-teachers (Scantleburya, 2007). Therefore, it is important to reiterate that IDWs are pedagogical strategies that involve collaboration between teachers from different subjects in order to create contextualized learning experiences. Thus, work involving IDWs aims to "promote changes in behavior through shared responsibility, interdisciplinary and globalizing group work" (Vieira & Volquind, 2002).

The willingness of the co-teachers to experience the Workshops at school is particularly noteworthy, as seen in the words of Teacher Tutor Mano Brown: "We will be working with chemical reactions, but I want to see how this would work in the classroom." This evidences an interest in working

together with other teachers. The desire to observe how the work takes place with peers indicates a willingness to experience co-teaching.

Co-teaching is the joint action within the classroom, just as co-planning is a process within co-teaching. However, it should be noted that, due to social isolation during the Covid-19 pandemic, the period during which this research was conducted, co-teaching could not be implemented. Therefore, the planned IDWs were not practiced in the schools. However, it is important to emphasize that, based on the discussions presented here, co-planning has already enabled the observation of several co-teaching elements, as discussed.

## Considerations

Co-teaching associated with Interdisciplinary Didactic Workshops could be considered an interpersonal, co-formative and dialogical process, providing a different training approach, in which science teachers can act on the basis of a common and critical proposal, as this places them at the target of the process of planning problem situations that articulate culture and science for the purpose of learning that is more holistic and grounded in the social context and practice. This is due to the interdisciplinary, hermeneutic, dialectical, dialogical and complex nature of IDWs.

In order to envisage a transformative education, teachers must be involved in the training spaces in which they work. In this sense, the collaborative space proposed by the co-planning of the IDWs through the Working Group brought together the teacher trainer of the subject, the basic education teachers and the future teachers, allowing for a dialogic and co-formative context.

This context revealed a path to establishing horizontal relations between the university and the school through interactions between the co-teachers, considering that the dialogues, as noticed, were conducted at times by the teacher tutors, at other times by the undergraduate students and, on

other occasions, by the teacher trainer. This demonstrates a change in roles, which in turn allowed the teacher tutors to also act as trainers, at the same time as they were undergoing a process of continuing training. This dynamic also enabled the future teachers to take initiatives, make choices and sometimes also lead the co-planning process.

Based on the analysis of the co-plans, researchers were able to perceive that by using the creation, execution and assessment of IDWs as a space for co-teaching, teacher training occurs in a collective and dynamic format, from a perspective in which the relationship between theory and practice is inevitable, the expansion of subjects' possibilities to "be more", the encouragement of interpretation and intervention in social practices and openness to differences through co-responsibility.

The Interdisciplinary Didactic Workshops (IDW) are didactic proposals for co-teaching, positioning relationships between people at the center of the teaching and learning process, involving participants in the construction of knowledge through problem situations, turning the learning space into a space for investigation, research, construction and creativity.

In the spaces where Interdisciplinary Didactic Workshops are used, people with different knowledge and cultures meet, mediated by dialogue and practice, in the quest to promote learning and autonomy. Thus, in this collaborative and dialogical practice, co-teachers realize what Freire stated: "No one educates anyone, no one educates themselves, men educate each other, mediated by the world." (Freire, 2020, p.95)

## References

ALBUQUERQUE, E. S. C.; MAYER, M.; BASTOS, H. F. B. N. Oficina Pedagógica Interdisciplinar como estratégia para a formação da cidadania. In: ALMEIDA, M. A.; NOVAES, R. M. *Projetos interdisciplinares em ciências e matemática:* fundamentos e vivências. Recife: Bagaço, 2009. p. 105-124.

CHAGAS, J. F.; ASPESI, C. C.; FLEITH, D. S. *A relação entre criatividade e desenvolvimento: uma visão sistêmica.* In: DESSEN, M. A.; ADERSON, L. C. A

ciência do desenvolvimento humano: tendências atuais e perspectivas futuras. Porto Alegre: Artmed, 2005. p. 210-228.

ENGEL, G. I. *Pesquisa-ação.* Educar, Curitiba, n. 16, p. 181-191. Editora da UFPR, 2000.

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

FREIRE, P. *Pedagogia do Oprimido*. Rio de Janeiro: Paz e Terra, 2020.

GALLO-FOX, J.; WASSELL, B.; SCANTLEBURY, K.; JUCK, M. Warts and all: Ethical dilemmas in implementing the coteaching model. *Forum Qualitative Sozialforschung*, 7(4), [18], 2006.

GARCIA, J. *Repensando a formação do professor interdisciplinar*. Reunião Anual da ANPEd, 2002. Disponível em: http://25reuniao.anped.org.br/tp25.htm#gt8. Acesso em: 20 ago. 2023.

IMBERNÓN, F**.** *Formação docente e profissional:* forma-se para a mudança e a incerteza. 9. ed. São Paulo: Ed Cortez, 2023.

IMBERNÓN, F. *Formação permanente do professorado.* Cortez Editora. Edição do Kindle, São Paulo, 2022.

IMBERNÓN, F**.** *Formação continuada de professores*. Porto Alegre, RS: Artmed, 2010.

KARIUKI, P.; HOPKINS, B. (Producers). (2010). *The effects of an interdisciplinary program on secondary art students participating in an interdisciplinary chemistryart program and in an art only program.*

LEITE, A. C. C.; DOLABELLA, A. R. V.; SILVA, M. C. F. R.; FERREIRA, N. R. S.; CAMPOS, S. M. M. Interdisciplinaridade, práticas curriculares e a formação docente. In FAZENDA, I. C. A.; FERREIRA, N. R. S. (org.) *Formação de docentes interdisciplinares.* Curitiba, PR: CRV, 2013. p. 35-58.

MIRABENT PEROZO, G. *¡Aquí, talleres pedagógicos***!**, En Pedagogía Cubana, n. 6, La Habana, 1990.

MURPHY, C., BEGGS, J. A Five-Year Systematic Study of Coteaching Science in 120 Primary Schools. In MURPHY C., SCANTLEBURRY, K. *Coteaching in Internacional Contexts:* Research and Practice. Springer, New York, 2010.

OLIVEIRA, M. M. *Sequência Didática Interativa:* no processo de formação de professores. Petrópolis: Vozes, 2013.

ROTH, W.-M e BOYD, N. Co-teaching, as colearning, is praxis. *Research in Science Education*, v.29, n. 1, p. 51-67, 1999.

SCANTLEBURY, K., GALLO-FOX, J., WASSEL, B. Coteaching as a model for preservice secondary science teacher education. *Teaching and Teacher Education,* n. 24, p. 967 – 981, 2008.

SILVA, M.C. *Codocência e Estágio Curricular Supervisionado:* Uma abordagem discursiva da articulação entre Universidade e Escola na Formação de Professores. 290 f. Tese (Doutorado em Educação em Ciências e Saúde) – Instituto Nutes de Educação em Ciências e Saúde, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2021.

SILVEIRA, T. A. *Oficinas didáticas interdisciplinares:* teoria, prática e reflexão. São Carlos: Pedro & João Editores, 2020.

THIOLLENT, M. *Metodologia da pesquisa-ação.* 8. ed. São Paulo: Cortez, 2011.

TOBIN, K. Learning to teach through coteaching and cogenerative dialogue. *Teaching and Teacher Education*, v.17, n.2, p.133-142, 2006.

TOBIN, K., ROTH, W-M. Implementing Coteaching and Cogenerative Dialoguing in Urban Science Education. *School Science and Mathematics*, v. 105, n. 6, 2005.

TRIPP, D. Pesquisa-ação: uma introdução metodológica. *Educação e Pesquisa*, São Paulo, v. 31, p. 443-466, 2005. Disponível em: http://www.scielo.br/pdf/ep/v31n3/a09v31n3.pdf. Acesso em: 05 Jan. 2024.

VIEIRA, E.; VOLQUIND, L. *Oficinas de ensino***:** O quê? Por quê? Como? 4. ed. Porto Alegre: Edipucrs, 2002.

WASHUT-HECK, T. W.; BACHARACH, N. L.; DAHLBERG, K. R. What Makes Co-Teaching Work? Identifying The Essential Elements. *College Teaching Methods & Styles Journal (CTMS)*, 4(3), 43–48, 2008. Disponível em: https://doi.org/10.19030/ctms.v4i3.5534. Acesso em: 15 mai. 2023.

Received in March 2024.

Approved in July 2024.