ISSN 1982-5587

Articles

# Interdisciplinary Islands of Rationality in Science teacher education in the Amazon

## Ilhas Interdisciplinares de Racionalidade na formação de professores de Ciências na Amazônia

Vandressa Caldas Amorim[1]*, Luely Oliveira da Silva[2]

[1]Universidade do Estado do Pará (UEPA), Programa de Pós-graduação em Educação e Ensino de Ciências na Amazônia, Belém, PA, Brasil
[2]Universidade do Estado do Pará (UEPA), Departamento de Ciências Naturais, Belém, PA, Brasil

**HOW TO CITE:** AMORIM, V. C.; SILVA, L. O. Interdisciplinary Islands of Rationality in Science teacher education in the Amazon. **Revista Ibero-Americana de Estudos em Educação**, Araraquara, v. 19, spe 3, e19385, 2024. e-ISSN: 1982-5587. DOI: https://doi.org/10.21723/riaee.v19i00.1938502

**Abstract**

This article presents discussions from a study aimed at developing and analyzing a formative process using the Interdisciplinary Islands of Rationality (IIR) in collaboration with teachers from various areas of Basic Education (High School) at a State High School in Pará. Regarding the methodology, the study adopts a qualitative, action-research approach, utilizing semi-structured interviews and questionnaires. To understand the participants' processes and discourse, the research was grounded in Discursive Textual Analysis (DTA). As a result, the discussions fostered a space for communication and reflection on interdisciplinary praxis, connecting the unique environmental, cultural, and social characteristics of the Amazon Region. An offshoot of the research was the creation of an "Informative Journal", which enhanced the understanding of concepts. Therefore, it is inferred that there is a need for critical training that contributes to professional development and empowers teachers as agents of transformation in an educational context aligned with the Amazonian reality.

**Keywords:** interdisciplinarity; teacher education; Amazon.

**Resumo**

Este artigo apresenta discussões de uma pesquisa que objetivou construir e analisar um processo formativo, utilizando as Ilhas Interdisciplinares de Racionalidade (IIR), em colaboração com os professores de diferentes áreas da Educação Básica (Ensino Médio) de uma Escola Estadual de Ensino Médio no Pará. No que concerne à metodologia, apresenta natureza qualitativa, do tipo pesquisa-ação, utilizando entrevista semiestruturada e questionários. Com intuito de compreender sobre o processo e discurso dos participantes, apoiamo-nos na Análise Textual Discursiva (ATD). Como resultado, as discussões permitiram um espaço de comunicação e reflexões em torno da práxis interdisciplinar, conectando as características ambientais, culturais e sociais únicas da Região Amazônica. Como desdobramento da pesquisa, a criação de um "Jornal Informativo" favoreceu a compreensão de conceitos. Portanto, infere-se a necessidade de uma formação crítica que contribua para o desenvolvimento profissional e empodere os professores como agentes de transformação em um cenário educacional aplicado à realidade amazônica.

**Palavras-chave:** interdisciplinaridade; formação docente; Amazônia.

## INTRODUCTION

Focusing on education in the Amazon region, this study addresses the challenges inherent to this context, such as excessive workload across multiple school subjects, geographical isolation, and the lack of materials and infrastructure. In these circumstances, as teacher-researchers, questioning one's own practice, interrogating it, and analyzing it form part of the interdisciplinary teacher's framework of reference (Fazenda; Ferreira, 2013).

In light of this, the contributions of the Belgian professor-researcher Gerard Fourez, from the Université de Namur—who passed away in September 2018—are presented. Building upon his

***Corresponding author:**
vandressaamorim@outlook.com

**Submitted:** June 15, 2024
**Reviewed:** September 04, 2024
**Approved:** October 25, 2024

**Financial support:** nothing to declare.
**Conflicts of interest:** There are no conflicts of interest.

**Ethics committee approval:** Certificate of Submission for Ethical Appraisal nº 61193122.6.0000.8607.
**Data availability:** Data sourced from the dissertation available on the PPGEECA website (https://paginas.uepa.br/ppgeeca/?page_id=4278) and on the EduCapes Platform.
Study conducted at EEEM Prof. Heriberto Barroso de Aragão, Cametá, PA, Brasil.

principles, Fourez developed the concept of "Interdisciplinary Islands of Rationality (IIR)", discussed in his book *Scientific and Technological Literacy: On the Objectives of Science Education* (Fourez et al., 1997). The author suggests constructing these islands through eight (8) adaptable steps, as follows: 1. **Cliché:** This step involves problematization or an initial questioning. 2. **Spontaneous Overview:** This refers to expanding on the cliché. 3. **Consulting Specialists and Specialties:** At this stage, specialists are tasked with addressing the posed questions. 4. **Putting it into Practice:** Fourez describes this as "*descending to the field*". 5. **Opening a Black Box in Depth:** According to Souza et al. (2016, p. 90), "[...] *this is the disciplinary moment within interdisciplinarity*". 6. **Diagramming the Problematized Situation:** This step entails conducting a partial synthesis. 7. **Opening Some Black Boxes Without Specialist Assistance:** In this stage, further exploration occurs without relying on specialists. 8. **Synthesizing the Produced Interdisciplinary Island of Rationality:** The final stage involves a comprehensive synthesis of the entire construction of the IIR.

Thus, this methodology was chosen because "[...] it is about inventing, in response to a project, an appropriate model, sufficiently simple, yet utilizing knowledge from various disciplines—as well as everyday life experiences" (Fourez et al., 1997, p. 69, emphasis in the original, our translation). In alignment with this, the present research emphasizes school-based training, aiming to "[...] generate dynamics that directly impact the institution, fostering the development of teaching teams within a specific context" (Imbernón, 2016, p. 152).

The narrative of teachers in the Amazonian context reveals an Amazon visible to the world but still concealing the educational challenges faced by its people (Lima; Lima; Vasconcelos, 2020). In this regard, one of the primary objectives of science education is to develop the ability to interact with, observe, and critically, autonomously, and actively understand reality, overcoming technocratic, utilitarian, and reductionist views of science (Fourez et al., 1997; Mohr et al., 2019b).

Thus, a formative process designed and grounded in the Interdisciplinary Islands of Rationality (IIR) could facilitate less fragmented teaching, enabling science teachers to perceive themselves as transformative intellectuals, recognizing their role within the Amazonian context and contributing to their professional development.

Therefore, this study aims to employ this methodology in collaboration with teachers from various areas of basic education (high school), to promote a theoretical and methodological foundation for the development of interdisciplinary pedagogical practices within the perspective of integrative science education in the Amazonian context. To this end, a training course focused on constructing the IIR, based on Gerard Fourez's framework, was investigated.

## METHOD

The research was conducted at EEEM Professor Heriberto Barroso de Aragão, located in the Juaba District, within the municipality of Cametá. Six (6) teachers participated in this study: one Mathematics teacher, one Physics teacher, one Portuguese Language teacher, one History teacher, one English Language teacher, and one Geography teacher. These participants[1] were coded using the initial letter of the subject they teach, followed by an ascending Arabic numeral. Accordingly, they were designated as follows: M1, F2, L3, H4, I5, and G6.

Regarding the methodological procedures, this research adopts a qualitative approach, based on the guidelines of Robaina et al. (2021). Data collection involved the use of semi-structured interviews and questionnaires, analyzed through "Discursive Textual Analysis - DTA" (Moraes; Galiazzi, 2006). Furthermore, the study is characterized as action research, as it engaged researchers and participants in a participatory manner (Thiollent, 1986). Accordingly, the methodological process was organized into the following phases: **Planning**: In this phase, an initial diagnosis was conducted using semi-structured interviews, which were transcribed and analyzed through DTA.

**Action**: After the diagnosis, the development and implementation of the training course began, structured in five stages, which occurred according to the steps suggested by Gérard

[1] The activities were conducted only after approval by the Research Ethics Committee (CEP), under the Certificate of Ethical Appreciation Presentation (CAAE) nº 61193122.6.0000.8607, ensuring compliance with all ethical principles.

Fourez et al. (1997). However, an additional step—Step Zero—was required, as suggested by Pietrocola, Alves Filho and Pinheiro (2003), aimed at identifying a motivating problem-situation, which was done through a questionnaire. Chart 1 illustrates the stages developed according to the context of application, as well as the temporal details of the constructed formative process.

**Reflect**: This phase of the action research involves the process of evaluating and validating the results, which was carried out through a final questionnaire.

**Chart 1.** Comparison between the sequence of stages of the IIR proposed by Fourez and the one used in this research, along with its temporal detailing.

| STAGE | Fourez et al. (1997) | TRAINING PROCESS | MOMENTS[2] | MODALITY |
|---|---|---|---|---|
| 0 | ---------- | Zero Stage | 1º Moment | On-line (Google Meet) |
| 1 | *Clichê* | *Clichê* | 2º Moment | In Person |
| 2 | Spontaneous Panorama | Spontaneous Panorama | | |
| 3 | Consultation with Specialists and Specialties | Abertura aprofundada de uma Caixa-Preta | 3º Moment | In Person |
| 4 | Going into Practice | Opening some black boxes without the help of experts | | |
| 5 | Deep Opening of a Black Box | Outlining the Problematized Situation | | |
| 6 | Outlining the Problematized Situation | Consultation with Specialists and Specialties | | |
| 7 | Opening some black boxes without the help of experts | Going into Practice | 4º Moment | Extra class |
| 8 | Synthesis of the Interdisciplinary Island of Rationality produced | Synthesis of the Interdisciplinary Island of Rationality produced | 5º Moment | In Person |

Source: Authors (2023).

## RESULTS AND DISCUSSION

### Towards the construction of metatexts: initial discussions and reflections from the diagnostic investigation

Based on the personal and professional information, it was identified that all the teachers have postgraduate degrees, at least eight (8) years of experience, and are aged between 32 and 44 years. Furthermore, all have participated in continuing education courses. In this regard, we reflect on Marcelo's (2009) perspective that the professional identity of teachers is constructed through their years of practice, initial academic education, and ongoing training.

For the preparation of text dismantling and establishment of relationships, we created a coding system. Considering the constructed pattern, the code E1M1U1 refers to the response from the first data collection through the semi-structured interview (E1), identified by the initial letter of the teacher's subject followed by the Arabic numeral according to their participation (M1), also followed by the first Unit of Analysis extracted from their speech (U1). It is important to highlight that the Empirical Units of Meaning (EUMs), or units of analysis, were grouped by similarity around a single title, as shown in Chart 2, below.

This reorganization amidst the "chaos" entails the categorization of units into initial, intermediate, and final categories, with the initial categories being a priori, as they were predetermined (Moraes, 2003). All previous processes are represented in the second final category (Chart 3), aiming to achieve the final stage: the construction of metatexts, as presented below.

[2] These moments are meticulously detailed in the Educational Product derived from this research, which can be accessed in eduCAPES (Brasil, 2024).

**Chart 2.** Process of Unitarization and Categorization of the semi-structured interview corpus.

| **Units that spoke about: Teaching conception of interdisciplinarity** | **Categorization** | | **Final Category Emerging** |
|---|---|---|---|
| **E1M1U2** – "*Unite several disciplines*"; **E1F2U2** – "*Interconnect some areas of knowledge within a specific theme*"; **E1L3U2** – "*Different fields of knowledge to address a specific theme or subject*"; **E1H4U2** – "*Play a concept and check the use of other disciplines*"; **E1I5U2** – "*The encompassing of disciplines, using a little of each*"; **E1G6U2** – "*A set of themes that involve more than one discipline, mainly related to the same field of activity*" | Initial Category<br><br>*A priori*<br><br>Conceptual divergences among teachers | Intermediate Category<br><br>Epistemological definitions arising from formative experiences. Therefore, there is no static concept | Navigating between solitude and solidarity: the two faces of interdisciplinary identity |
| Units that talked about: Interdisciplinary Approach<br><br>**E1M1U3** – "*I have worked, but not directly with other teachers*"; **E1F2U3** – "*Because I am also a mathematician, I end up leaning a little towards physics*"; **E1L3U3** – "*I have already approached this when I worked on comic books*"; **E1H4U3** – "*History and geography go hand in hand, for example*"; **E1I5U3** – "*What I usually do are comparisons between the English language and the Portuguese language, but I have never worked with other areas*"; **E1G6U3** – "*I discuss environmental issues, the environment and population issues a lot*" | Initial Category<br><br>*A priori*<br><br>Individual teaching action | Intermediate Category<br><br>Solitary initiative reflects on the construction of teaching individualism | |
| Units that talked about: Curricular limits of subjects<br><br>**E1I5U4 –** "*Students are limited to knowing other languages, which does not allow them to work on other subjects*"**; E1G6U4** – "*There is a part that involves cartographic questions that involve knowledge of mathematics and that generate some difficulties, but with study we can manage*" **E1I5U4 –** "*Students are limited to knowing other languages, which does not allow them to work on other subjects*"; **E1G6U4 –** "*There is a part that involves cartographic questions that involve knowledge of mathematics and that generate some difficulties, but with study we can manage*" | Initial Category<br><br>*A priori*<br><br>Methodological and curricular rigor of the areas of knowledge | Intermediate Category<br><br>Cooperation between teachers could enhance interdisciplinarity | |
| **E1M1U5 –** "*We don't sit with other teachers and the time, the rush, only that 15-minute break*"; **E1F2U5 –** "*A lot of resistance towards our own colleagues, I usually say that sometimes it's a lot of work and we don't want to work*"; **E1L3U5 –** "*Lack of teaching materials*"; **E1H4U5 –** "*Coworkers don't sit together to think, they prefer to be alone*"; **E1I5U5 –** "*Lack of resources and we don't have this issue of working together, more because of the time issue*"; **E1G6U5 –** "*It's much more part of my performance than exactly a dialogue with other coworkers*" | Initial Category<br><br>*A priori*<br><br>Lack of adequate planning: space and time | Intermediate Category<br><br>Lack of teaching and learning materials reflects the absence of incentives for integrative work | |

Source: Authors (2023).

**Chart 3.** Strategy for Unitarization and Categorization of the semi-structured interview corpus.

| Units that talked about: Interdisciplinary Islands of Rationality | Categorization | | Final Category Emerging |
|---|---|---|---|
| **E1M1U1 –** "*I haven't heard of this term yet, but I've heard about interdisciplinarity*"; **E1F2U1** – "*Not really in my undergraduate course, but in my specialization I've read some readings about this topic*"; **E1L3U1** – "*I've never heard of it and I don't know it*"; **E1H4U1** – "*I've heard of it in my specialization course in history teaching methodology*"; **E1I5U1 –** "*Not yet in relation to this topic*"; *E1G6U1* – "*I don't know it*" | Initial Category<br><br>*A priori*<br><br>Lack of training focused on interdisciplinary praxis | Intermediate Category<br><br>Expansion of interdisciplinary methodologies occurs only in postgraduate studies | Teacher Training: redefining pedagogical practice in the face of the "*ocean of ignorance*" |
| Units that talked about: Possibilities of interdisciplinarity<br><br>**E1M1U6** – "*The history of mathematics can involve many disciplines, such as reading, history and some graphs*"; **E1F2U6** – "*Of course, we need to be willing*"; **E1L3U6** – "*I believe and have even tried to do it*"; **E1H4U6** – "*I believe it is possible*"; **E1I5U6** – "*I believe so*"; **E1G6U6** – "*As long as there is planning and a much more organized discussion*" | Initial Category<br><br>*A priori*<br><br>Interdisciplinarity can be exercised in the educational field | Intermediate Category<br><br>Intentionality of interdisciplinary work: will and commitment | |
| **E1M1U6 –** "*All training is important, you go there to acquire some knowledge and there is always more knowledge that you can acquire*"; **E1F2U7** – "*Training is an ongoing process, we do it at a certain point and this training needs to be updated*"; **E1L3U7** – "*Training that addresses the new high school education that is based on interdisciplinarity, I think is a path that could be pertinent*"; **E1H4U7** – "*I think face-to-face training is better*"; **E1I5U7** – "*We need to be encouraged to be interested and research the subject even after training*"; **E1G6U7** – "*You can never have too much knowledge*" | Categoria Inicial<br><br>*A priori*<br><br>Training needs | Categoria Intermediária<br><br>Interest and motivation in continuing education | |

Source: Authors (2023).

### Communication of the overall understanding through descriptive and interpretative texts

*Navigating between the solitary and the solidary: the two facets of interdisciplinary identity*

The "*Solitary Navigation*" portrays teacher individualism. From this perspective, Tardif and Lessard (2020) question whether this results from the organization of work or is merely a trait of teachers' personalities. In this dichotomy, **E1F2U5** states: "*A lot of resistance toward our own colleagues, I often say that sometimes it's too much work, and we just don't want more work*", which reveals that many are individualistic by strategic choice. Evidently, time constraints (**E1M1U5**: "*We don't sit with other teachers because of time, the rush, just those 15 minutes during the break*") and lack of resources (**E1L3U5**: "*Lack of teaching materials*") reinforce that these behaviors are reflections of teachers adapting to an unfavorable environment.

It can be inferred that teachers also face challenges in implementing interdisciplinary proposals. Consequently, they reaffirm the methodological nature of their fields of knowledge, as reflected in **E1L3U4**: "*My field of expertise is still very rigid, grammatical, and this makes it a bit difficult*". Within this discussion, the absence of a shared professional identity hampers teacher collaboration, as "[...] *one may teach for twenty years alongside a colleague without ever discussing pedagogy or knowing more about their practices than mere rumors* [...]" (Perrenoud, 2002, p. 96).

Furthermore, conceptual divergences among teachers are evident, as seen in the corpus of **E1M1U2**: "*Bringing together various disciplines*", **E1F2U2**: "*Interconnecting some areas of knowledge within a specific theme*", and **E1I5U2**: "*Encompassing disciplines, using a bit of each*". However, defining interdisciplinarity is not an easy task, and even in bibliographic research, there is no consensus.

Within a curricular context, according to the document (Area 38) by the Coordination for the Improvement of Higher Education Personnel – CAPES (Brasil, 2019a), education is inherently interdisciplinary. However, it becomes evident that interdisciplinarity is addressed only on an individual level, as reaffirmed by the corpus of **E1F2U3**: "*Because I am also a mathematician, I tend to lean a bit toward the physics side*".

Moreover, teachers adopt the practice of "[...] *solitary interdisciplinarity*", that is, "[...] *pedagogical practices developed by a single teacher* [...]" (Shaw, 2018, p. 30). However, we propose a collaborative practice, rooted in the concept of solidarity from the Latin solidus: "[...] *reciprocal dependence of the elements of a whole, whether it is a living organism or a society*" (Durozoi; Roussel, 1993, p. 444). It is emphasized that if interdisciplinarity is defined as the union of disciplines, the focus remains solely on its curricular framework. However, if it is defined as an attitude and a quest for knowledge, one must consider aspects that include the culture of the context in which teachers are trained (Fazenda, 2008).

**Teacher training: reframing pedagogical practice in confrontation with the "*Ocean of ignorance*"**

The "*ocean of ignorance*"—a metaphor used by Gérard Fourez—can be understood by analyzing a complex problem-situation in which individuals may be unable to use the available information for its resolution. In this context, "*black boxes*" are observed. Through this interpretation, the "*ocean of ignorance*" is represented by a collection of "*black boxes*" (Nicoletti and Sepel, 2015). Thus, the curricular nature of disciplines allows for increasingly detailed knowledge about increasingly narrower subjects. Consequently, teachers must broaden their knowledge to reduce the extent of the "*ocean of ignorance*".

However, it was observed that IIR (Interdisciplinary Inquiry-Based Research) remains an underutilized methodology during undergraduate studies, as noted in the corpus of **E1L3U1**: "*I've never heard of it and don't know about it*". In graduate studies, it is addressed only briefly and without much discussion, as reflected in **E1F2U1**: "*Not during my undergraduate degree, but in my specialization, I did have some readings on this topic*".

Nevertheless, teachers are open to the possibilities of interdisciplinary work, as indicated by **E1I5U6**: "*As long as there is planning and a much more organized discussion*", and **E1F2U6**: "*Certainly, we need to be willing*". Regarding the potential for formative processes, **E1M1U6** states: "*All training is important*; *you go there to acquire some knowledge, and there is always additional knowledge you can gain*".

This confrontation with the "ocean of ignorance" is the first step toward reframing pedagogical work, and there is no doubt, that it will only be feasible if there is genuine willingness and interest.

**Continuing the construction of metatexts: the results of the IIR – waste as an interdisciplinary theme: the cooperation between disciplines**

In the process of constructing the IIR, the teachers took on the task of identifying a problem-situation. To achieve this, they responded to a questionnaire, and the results were analyzed using the ATD (Chart 4). It is important to note that the identification codes were maintained, but the code for Professor G6 will not be used, as this individual was unable to complete the questionnaire. In this process, the code **R1M1U1** was employed – indicating the order of responses to the questionnaire (R1), the initial of the subject and the teacher's order of participation (M1), as well as the first unit of analysis (U1). From this, the metatext was constructed.

From this point, we can discuss the final category identified: ***waste as an interdisciplinary theme: the cooperation between disciplines***. For this discussion, the term "waste" is conceptualized as any material without value or utility, also defined as the byproduct of human activities (Manfio; Turmena; Pizzolatto, 2021). Although the term "solid waste" is used as a synonym for "waste", it has a broader definition and refers to anything that has been discarded.

**Chart 4.** Unitarization and categorization of the questionnaire corpus.

| Units that spoke about: Locality potential | Initial Category | Final Category |
|---|---|---|
| | ***A priori*** | **Emerging** |
| **R¹M1U1 –** "*yes*"; **R¹F2U1 –** "*yes*; **R¹L3U1 –** "*yes*"; **R¹H4U1 –** "*yes*"; **R¹I5U1 –** "*yes*" | Existing themes in the community can be used in the teaching and learning process | *Waste* as an interdisciplinary theme: cooperation between knowledge |
| Units that talked about: Adversities in the community<br>**R2M1U1 –** "*Disposal of community waste, as there is no suitable place*"; **R2F2U1 –** "*Disposal of waste, for example, is a very serious problem, as the community does not have a suitable place to dispose of waste*"; **R2L3U1 –** "*Problems with the waste collection and storage process*"; **R2H4U1 –** "*The environmental issue*"; **R2I5U1** – "*Lack of resources*" | The issue of waste is an environmental problem present in the area | |
| Units that talked about: Possibilities of the theme of "waste" in the classroom<br>**R³M1U1 –** "*Yes, the amount of waste dumped daily could be analyzed*";**R³F2U1 –** "*Yes, this topic has even been addressed at times in the Integrated Natural Sciences Project, but still in a very superficial way, with more theory than practice*";**R³L3U1 –** "*yes*"; **R³H4U1 –** "*It is a way, methods and content that can be worked on*"; **R³I5U1 –** "*yes*" | Teachers agree that "waste" has interdisciplinary potential | |
| **R⁴M1U1 –** "*yes*"; **R⁴F2U1 –** "*Undoubtedly*"; **R⁴L3U1 –** "*I think it is possible*"; **R⁴H4U1 –** "*Yes! It allows you to integrate different areas of knowledge*"; **R⁴I5U1 –** "*Yes*" | It is possible to integrate knowledge across all disciplines through the theme of "waste" | |
| **R⁵M1U1 –** "*More ease with the subjects: Physics, Biology, Chemistry and Geography. It would be more difficult with the subjects of History, Philosophy and Sociology*"; **R⁵F2U1 –** "*It is easier to communicate with mathematics, I believe I would have difficulty communicating with a foreign language*"; **R⁵L3U1 –** "Ease of dialoguing with human sciences disciplines and difficulties with the area of mathematics"; **R⁵H4U1 –** "*Geography subject, the hardest would be mathematics*"; **R⁵I5U1 –** "*Foreign language, as a discipline, permeates and covers areas of knowledge easily*" | Interdisciplinarity should happen not only when there is affinity between fields of knowledge | |
| **R⁶M1U1 –** "*Yes, science teaching is often linked to exact sciences*"; **R⁶F2U1 –** "*My subject is integrated into the teaching of natural sciences, in this sense, much of this dialogue is already taking place, although still superficially*"; **R⁶L3U1 –** "*yes*"; **R⁶H4U1 –** "*I believe so, as it encompasses several skills that a student needs to prepare and think about real-world problems*"; **R⁶I5U1 –** "*sim*" | Numerous possibilities for interdisciplinary construction using science teaching | Waste as an interdisciplinary theme: cooperation between knowledge |

Source: Authors (2023)

Furthermore, the term "waste" is mentioned in the BNCC: **EF05GE11** "Identify and describe environmental problems occurring in the vicinity of the school and home (landfills, polluting industries, destruction of historical heritage, etc.), proposing solutions (including technological ones) to these problems" (Brasil, 2017a, p. 379).

Therefore, the early selection of the issue facilitated the identification of strategies for discussions, beginning with the knowledge of the context of the problem-situation and the photographic recording of the waste in the "Nature Fields". A hypothetical context was also created, and a poem was chosen that could express dialogues between the teachers. Here, the role of the "Zero Stage" in the initial organization of the IIR is justified.

**From cliché to spontaneous panorama**

Considering the construction of the IIR, the teachers were introduced to the poem "*O LIXO*" – João de Sá Barreto (1974) and invited to reflect on its stanzas. Subsequently, photographs of the issue were presented. In this way, for the "Cliché", the teachers created questions to express their doubts about the context I had developed:

> *José and Gabriel are two students in the 3rd year of high school at EEEM Prof. Heriberto Barroso de Aragão who, as usual, play soccer on a sand field located near the village of Juaba. On their way to the field on a game day, they notice changes in the landscape caused by the disposal of waste collected by the city, which ends up in the natural environment. They observe that the discarded materials persist over time, becoming part of the location. This scenario raises concerns among the students. As a basic education teacher—considering your experience and professional training—how would you perceive this situation if you were witnessing it? Do you identify any problems in this context? How might it be addressed?*

After Stage 1 (as illustrated in Chart 1), the problematization was expanded, and, collaboratively, we organized it by area of knowledge, selecting learning objectives – spontaneous panorama (Stage 2), as shown in Chart 5. This collaborative development involved interactions between biodiversity, local communities, and environmental challenges, reinforcing the idea that analyzing the issue requires multiple perspectives and that disciplinary boundaries are permeable.

**From partial synthesis to teacher autonomy**

Regarding the in-depth opening of a black box (Stage 3), topics related to the Natural Sciences were addressed: Sanitation Manual (Brasil, 2019b); Diseases related to solid waste (Brasil, 2004); Difference between Waste and Solid Waste; Leachate – Organic and Inorganic Pollutants (Dias *et al*., 2022); Sanitary Landfill and National Solid Waste Policy (PNRS); Law No. 12,305/2010 (Brasil, 2010). Finally, the data were synthesized in a conceptual map, in which the teachers opened black boxes with their disciplinary knowledge (Figure 1).

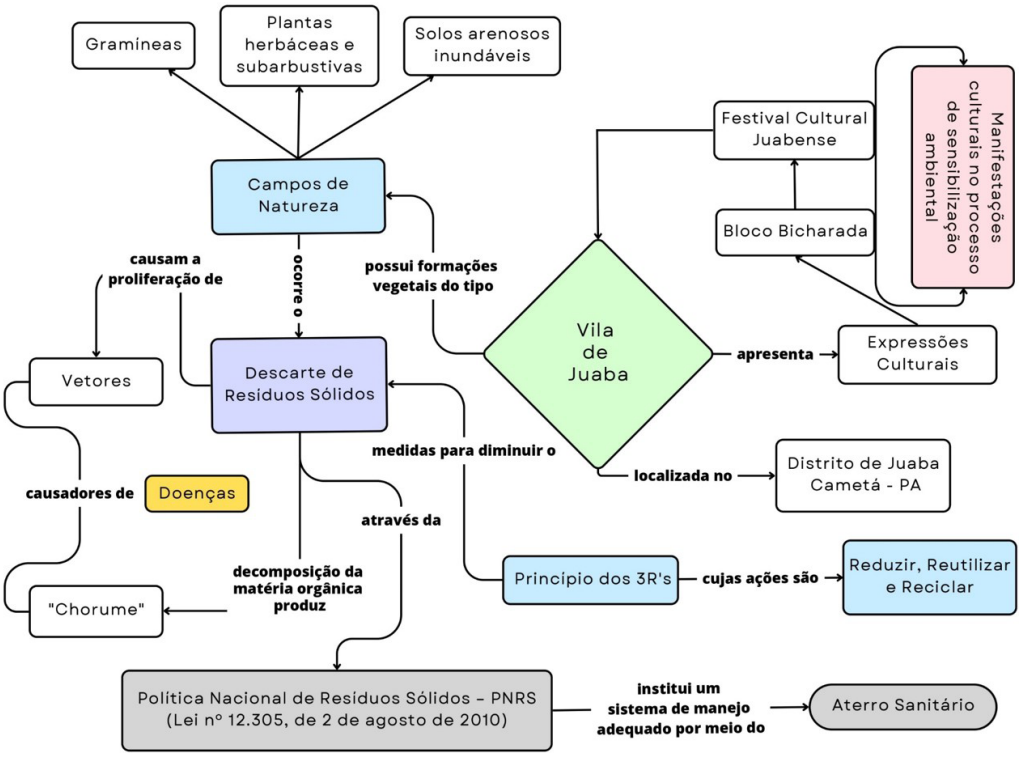


**Figure 1.** Concept map developed by the teachers as an initial synthesis of the IIR. Source: Survey Data (2023).

**Chart 5.** Questions prepared by teachers and their learning objectives.

| HUMAN SCIENCES | LEARNING OBJECTIVES |
|---|---|
| Why use the village's nature reserve for waste disposal?<br><br>Which social groups are most affected by the fate of waste in the natural environment?<br><br>Are there spaces around the village that could be used more safely to dispose of waste?<br><br>Did the Public Authorities discuss with the population the use of the natural field for waste disposal in that location?<br><br>Has there been any intervention (inspection) by environmental agents to assess the socio-environmental impacts on site?<br><br>Near the waste dump, are there water sources that are used by people in some way?<br><br>Was this natural field frequented by the population before it was turned into a waste dump?<br><br>Is the nature field used for other socioeconomic activities (fruit picking, sand extraction, farming, etc.)? | Understand how the historical process of waste disposal in the natural field occurred, identifying the social, economic, environmental and political aspects, as well as the changes in geographic space. |
| **MATHEMATICS** | **LEARNING OBJECTIVES** |
| What is the daily average of waste dumped irregularly?<br><br>If some materials (plastic, aluminum, etc.) were recycled, how much waste would be dumped?<br><br>How long does it take for discarded waste to decompose? | Utilizar os conhecimentos matemáticos para compreender as dimensões dos impactos causados pelo descarte do lixo. |
| **NATURAL SCIENCES** | **LEARNING OBJECTIVES** |
| What are the possible vectors and diseases caused by improper waste disposal?<br><br>What threats does waste pose to flora and fauna?<br><br>Are landfills the solution to waste?<br><br>Can waste cause chemical contamination of the soil through the entry of toxic substances?<br><br>What toxic substances are released by waste incineration?<br><br>What are the impacts of chemical waste on the environment? | Analyze the characteristics of the environment and identify the problems faced by fauna and flora, understanding how waste disposal can modify and harm the environment, in addition to affecting human health. |
| **LANGUAGES** | **LEARNING OBJECTIVES** |
| How can animals be an agent of awareness about the waste disposal process?<br><br>How can the Juabense Cultural Festival contribute to raising awareness of the wastee collection process?<br><br>What public policies can be adopted to reduce or eliminate this illegal dumping of waste in Juaba Village?<br><br>How can the 3Rs principle be used to prevent and avoid waste generation in the field of nature?<br><br>How can knowledge of cultures influence awareness of waste reuse in the village? | Understand how laws work and how they operate in the locality, as well as Public Policies that can be developed to guarantee the rights of the population. Furthermore, the role of cultural expressions and advertising campaigns in the process of raising awareness about waste disposal. |

Source: Survey Data (2023).

Moreover, conceptual maps allow for the visualization of how teachers organize their knowledge, identifying aspects that need to be revisited (Correia *et al*., 2016). This facilitated the identification of the "black boxes" and the "specialists" (Chart 6). Therefore, "[...] both in advanced research and in ordinary life, it is necessary to rely on specialists" (Fourez et al., 1997, p. 64, own translation).

**From teacher protagonism to the integration of knowledge**

It is important to emphasize that the IIR "[...] is based on the autonomy of reflective individuals who have undergone a process that allowed them to communicate different types of knowledge and ways of viewing a problem [...]" (Mohr et al., 2019a, p. 5). Thus, the teachers made their final synthesis in an "informational newspaper" (Figure 2), chosen for its ability to incorporate different forms of language and reflect the ideologies of its editors (Paula; Torres, 2014). Its editorial process was contributed to by each participating teacher.

Regarding the Amazon, "[...] it becomes imperative not only to conduct an interdisciplinary analysis of its physical, biological, and social reality (in its various facets) but also to think and act upon this concrete and complex reality" (Staevie, 2017, p. 8). In this context, the convergence of disciplines resulted in an integrated interpretation: mathematics quantified the waste; the human sciences mapped the socioeconomic factors; the natural sciences addressed the impacts on biodiversity and human health; and language provided linguistic support.

*Final step of the metatexts journey, which for now continues: the teacher's perspective in the formative experience*

The evaluation and validation phase followed through a final questionnaire. In this way, the corpus of teachers' responses was coded using **R1M1U1**, referencing the order of responses (R1), as well as the initial of the discipline and teacher participation, followed by the unit of analysis (U1), as shown in Chart 7 below.

*It is necessary to leave the island to see the island: navigating through interdisciplinary teacher education*

At this point, I intend to draw an analogy to the renowned Portuguese author José Saramago's (1998) book, The Tale of the Unknown Island. The story follows a man who decides to find an unknown island, but all the islands had already been discovered. After insisting to the king, the man obtains a boat. On this journey, a woman wishes to accompany him, and together they sail toward the unknown, naming the boat "Unknown Island". Initially, this story might seem puzzling, as it all boils down to a boat. In this way, departing from the "known island" leads us to reflect on human restlessness. Why would it be necessary to leave the island to see the island? Well, it is essential to step out of the comfort zone and venture beyond the known limits.

**Chart 6.** Specialists listed by teachers by area of knowledge division.

| TEAMS BY AREA OF KNOWLEDGE | EXPERTS |
|---|---|
| Human Sciences | Contact with residents who live close to the problem situation to identify possible problems experienced due to waste disposal. |
| Mathematics | Employee who collects waste to identify the frequency and average amount of waste discarded. |
| Languages | Some representative of the "Bicharada[3]" group and the Juabense Cultural Festival so that they can contribute with information about these cultural expressions; Environment Department to access (if there is one) the municipal solid waste management plan. |
| Natural Sciences | Contact a biologist to detail and expand on the environmental issues of the problem. Dialogue with colleagues in the field of Chemistry to broaden the discussions. |

Source: Survey Data (2023).

[3] Since 1975, this group has honored the animals of the Amazon through themed costumes, with the participation of local residents.


**Figure 2.** Informative Newspaper developed as a summary of the training process. Fonte: Survey Data, designed by Canva (2023).

Considering these points, this tale resembles the formative process, as, just like the character searches for an unknown island, teachers in training also seek new teaching methodologies. As a result, those who venture into the unknown possess the courage to break away from established practices and the determination to experiment with new approaches and improvements.

**Chart 7.** Unitarization and categorization of the final questionnaire corpus.

| Units that spoke about: Experience in the Training Process | Initial Category *A priori* | Final Category Emerging |
|---|---|---|
| **R¹F2U1 –***"This work contributed greatly towards expanding and approaching the proposed theme, discussing it with other areas of knowledge"*; **R¹F2U2 –** "*It is possible to interact in different areas of knowledge*"; **R¹F2U4 –** "*Strengthening collective work*"; ***R1L3U1*** – "*I was able to engage in dialogue with areas of knowledge that were not part of my teaching training*"; **R¹I5U4 –** "*Dialogue and exchange of knowledge*"; **R1G6U5** – "*Interaction and rapprochement between professionals from different areas of knowledge*"; **R1M1U2** – "*I believe that the greatest contribution is this dialogue with all curricular components, thus providing a greater understanding and learning about the object of knowledge addressed*" | Integrative movement | *You have to leave the island to see the island: navigating interdisciplinary teacher training* |
| **R¹L3U2 –** "*I was able to understand a little more about the concepts of transdisciplinarity, multidisciplinarity, and interdisciplinarity*" | Polysemy of concepts | |
| **R¹L3U3 –** "*It motivated me to apply these concepts more effectively in my classroom routine with students*"; **R¹M1U1 –** "*It was a very good learning process. It showed a methodology that we can use to attract more attention from students, as it requires involving several other areas of knowledge*". | Motivation for changing methodological practices | |
| **R¹L3U4 –** "*I recognize that dialogue between different areas of knowledge is necessary to solve, including, some problems in the location where the school is located*"; **R¹L3U5 –** "*Interlocution between the local cultural events (Bicharada, Cultural Festival) and the demands for knowledge, addressing these events, as well as their importance for the locality*"; **R¹H4U4 –** "*Dialogue with other areas of knowledge, issues that permeate tension between the environment, society and education that require intense discussions between areas of knowledge on the issue of waste disposal, whether at school or outside of it*" | Social issue and interdisciplinarity | |
| **R¹H4U1 –** "*It produced remarkable reflections that influence teaching practices*" | Reflections on your practice | |
| **R¹H4U2 –** "*Construction of professional identities. Certain experiences 'mark' our posture as teachers*" | Professional Identity | |
| **R¹M1U2 –** "*The steps made the process more interesting, always expanding our knowledge on the subject*"; **R¹I5U1 –** "*It is very valid, as I only knew one dimension about the subject and was still using the wrong information due to lack of knowledge*"; **R¹I5U2 –** "*I acquired more knowledge in other areas and still associated it with mine and understood how they are interconnected*"; **R¹G6U1** – "*It helped to broaden our vision of interdisciplinarity, mainly because it made it possible to perceive the thematic nodes (common points) in different areas of knowledge*"; **R¹G6U2** – "*Application of different methodologies*"; **R¹H4U5 –** "*Expanding access to information, including in a more attractive and dynamic way*"; **R¹I5U5 –** "*Experience, knowledge about other subjects and disciplines and expansion of knowledge*"; **R¹F2U3 –** "*It allowed for an expanded discussion between all areas, which strengthens collective work and brings representation and meaning to the teaching-learning process*"; **R¹G6U4 –** "Deeper debate on certain topics; increased use of different teaching and methodological resources"; **R¹G6U6 –** "*It made it possible to present a guideline for what is possible and necessary to do*"; **R¹H4U3 –** "*It created a space full of life, dynamic, filled with emotions and feelings, with people with different experiences, values and motivations*"; **R¹I5U3 –** "*It involved other means for teaching and facilitating learning*"; **R¹G6U3** – "*The stages were structured to achieve a greater purpose, the understanding and implementation of interdisciplinary practice, considering the Amazon context and its peculiarities*" | Teacher training as a foundation for building knowledge | |
| **R²M1U1 –** "*It could be to find experts on the subjects discussed and official documents*"; **R²F2U1 –** "*Initially, there was resistance from some colleagues, but this gradually disappeared as everyone began to feel included in the proposal*"; **R²L3U1 –** "*The difference in teachers' working hours. It is difficult to have a closer, face-to-face conversation with teachers from other areas because many of them work in several schools*"; **R²H4U1 –** "*The lack of space for dialogue between teachers*"; **R²I5U1 –** "*Gather the members*; **R²G6U1** – "*The lack of or little time allocated to this debate, which creates and reinforces the distance*" | The challenges of teaching practice beyond the classroom walls | |

Source: Authors (2023).

In this regard, Fourez et al. (1997) consider a scientifically and technologically literate individual to be one who can utilize their knowledge with autonomy and the ability to communicate about concrete situations. From this perspective: **R1H4U4** – "*Dialogue with other areas of knowledge, issues that permeate the tension between the environment, society, and education, which requires intense discussions between the areas of knowledge concerning waste disposal, whether at school or outside of it*". Thus, the teachers left their "known islands", as stated in **R1I5U1** – "Very valid, as I only knew one dimension of the subject and was still using incorrect information due to lack of knowledge".

From this viewpoint, this formative process enabled the teachers to see themselves as transformative intellectuals, and "[...] in this way, they must speak out against economic, political, and social injustices both inside and outside schools" (Giroux, 1997, p. 163). I conclude by revisiting José Saramago's words: "[...] we do not see ourselves unless we step out of ourselves" (Saramago, 1998, p. 10), for by stepping out of themselves, the teachers expanded their individual boundaries, becoming culturally sensitive to the Amazonian diversity.

## CONCLUSION

During the formative process, the teachers assumed the role of protagonists and developed a critical and reflective stance regarding their actions as educators. In this context, the IIR facilitated a less fragmented form of teaching, enabling science teachers to view themselves as transformative intellectuals, recognizing their role within the Amazonian context and contributing to their professional development. Furthermore, waste was identified as an interdisciplinary theme, with the participating teachers creating multiple learning objectives for each area of knowledge, resulting in an integrated panorama of knowledge, culminating in the Informative Journal.

From this perspective, the Humanities and Social Sciences, Mathematics, Languages, and Natural Sciences intertwined in an integrated manner to reflect, discuss, and seek solutions to a problem faced by the Amazonian population. In this sense, the issue of waste encompasses the lack of infrastructure, vast geographical challenges, and environmental diversity. In light of this reality, it is evident that improper disposal causes severe damage to the Amazonian ecosystem, and in addition to seeking to solve the problem, there was a careful effort to value and preserve the authenticity of the Amazonian aspects.

In view of this, we affirm the full engagement and commitment of this formative process in creating a space for dialogue, sharing, and reflection. Likewise, we hope that this study encourages replicability in diverse educational contexts.

## REFERENCES


BRASIL. Fundação Nacional de Saúde. **Manual de saneamento**. 3 ed. rev. Brasília, 2004. 408 p.

BRASIL. Presidência da República. Departamento da Casa Civil. Lei nº 12.305, de 2 de agosto de 2010. Institui a Política Nacional de Resíduos Sólidos; altera a Lei no 9.605, de 12 de fevereiro de 1998; e dá outras providências. **Diário Oficial da União**, Brasília, DF, 3 ago. 2010.

BRASIL. **Base Nacional Comum Curricular (BNCC)**: educação é a Base. Brasília: MEC/CONSED/UNDIME, 2017a.

BRASIL. Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES. **Documento de área**: área 38: educação. Brasília: Diretoria de Avaliação, 2019a.

BRASIL. Fundação Nacional de Saúde. **Manual de saneamento**. 5. ed. Brasília: FUNASA, 2019b. 545 p.

BRASIL. Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES. **Portal eduCAPES**. Brasília, 2024. Disponível em: http://educapes.capes.gov.br/handle/capes/747777. Acesso em: 22 abr. 2025.

CANVA. 2023. Disponível em: https://www.canva.com/pt_br/. Acesso em: 22 set. 2023.

CORREIA, P. R. M. et al. Por que vale a pena usar Mapas Conceituais no Ensino Superior? **Revista de Graduação da USP**, São Paulo, v. 1, n. 1, p. 41-51, 2016. DOI: http://doi.org/10.11606/issn.2525-376X.v1i1p41-51.

DIAS, L. M. M. et al. Avaliação de metais potencialmente tóxicos em chorume proveniente de área de deposição de resíduos sólidos em Belém – Pará. **Química Nova**, São Paulo, v. 45, n. 9, p. 1047-1052, 2022. DOI: http://doi.org/10.21577/0100-4042.20170912.

DUROZOI, G.; ROUSSEL, A. **Dicionário de Sociologia**. Campinas: Papirus, 1993.

FAZENDA, I. **O que é interdisciplinaridade?** São Paulo: Cortez, 2008.

FAZENDA, I. C. A.; FERREIRA, N. R. S. (ed.). **Formação de docentes interdisciplinares**. Curitiba: CRV, 2013. DOI: http://doi.org/10.24824/978858042638.0

FOUREZ, G. *et al*. **Alfabetización científica y tecnológica**: acerca de las finalidades de la enseñanza de las ciencias. Buenos Aires: Ediciones Colihue, 1997.

GIROUX, H. **Os professores como intelectuais**: rumo a uma pedagogia crítica da aprendizagem. Porto Alegre: Artes Médicas, 1997.

IMBERNÓN, F. **Qualidade do ensino e formação do professorado**: uma mudança necessária. 1. ed. São Paulo: Cortez, 2016.

BARRETO, J. S. **O lixo**. 1974. Disponível em: https://docplayer.com.br/201603651-O-lixo-nos-bons-tempos-de-comicio-o-progresso-tem-inicio-marcado-pra-logo-mais-falam-ilustrados-doutores-e-alguns-vereadores-de-planos-fenomenais.html. Acesso em: 22 set. 2023.

LIMA, D. D.; LIMA, A. C. C. V.; VASCONCELOS, E. R. Histórias de professores na Amazônia: marcas de um contexto na formação do PARFOR. **Revista Cocar**, Belém, v. 14, p. 420-439, 2020.

MARCELO, C. Desenvolvimento profissional docente: passado e futuro. **Revista de Ciências da Educação**, Americana, n. 8, p. 7-22, 2009.

MANFIO, D.; TURMENA, L.; PIZZOLATTO, V. A. **Projeto Integrador**. Temática: lixo. Curitiba: UTFPR, 2021. v. 1. Material didático instrucional para o ensino de Ciências.

MOHR, A. *et al*. Gérard Fourez *in memoriam*: ensino de ciências na confluência da epistemologia, da ética, do papel das disciplinas científicas e da interdisciplinaridade. **Alexandria: Revista de Educação em Ciência e Tecnologia**, Florianópolis, v. 12, n. 1, p. 1-8, 2019a. DOI: http://doi.org/10.5007/1982-5153.2019v12n1p1

MOHR, A. *et al*. Um singular plural: contribuições de Gérard Fourez para a educação em ciências. **Revista Dynamis**, Blumenau, v. 25, n. 1, p. 164-179, 2019b. DOI: http://doi.org/10.7867/1982-4866.2019v25n1p164-179

MORAES, R. Uma tempestade de luz: a compreensão possibilitada pela análise textual discursiva. **Ciência & Educação**, Bauru, v. 9, n. 2, p.191-211, 2003. DOI: http://doi.org/10.1590/S1516-73132003000200004

MORAES, R.; GALIAZZI, M. C. Análise textual discursiva: processo reconstrutivo de múltiplas faces. **Ciência & Educação**, Bauru, v. 12, n. 1, p. 117-128, 2006. DOI: http://doi.org/10.1590/S1516-73132006000100009

NICOLETTI, E. R.; SEPEL, L. M. N. Organização inicial de uma Ilha Interdisciplinar de Racionalidade a partir de um tema específico da biologia. **Ciência e Natura**, Santa Maria, v. 37, n. 3, p. 808-820, 2015. DOI: http://doi.org/10.5902/2179460X17326

PAULA, C. P.; TORRES, E. C. **O uso de jornal como instrumento pedagógico no ensino de geografia**: os desafios da escola pública paranaense na perspectiva do professor PDE. Curitiba: Secretaria de Educação, 2014. Versão online.

PERRENOUD, P. **Aprender a negociar a mudança em educação**: novas estratégias de inovação. Porto: Edições ASA, 2002. (Coleção em Foco).

PIETROCOLA, M.; ALVES FILHO, J. P.; PINHEIRO, T. F. **Prática interdisciplinar na formação disciplinar de professores de ciências**: investigações em ensino de Ciências. Porto Alegre: UFRGS, 2003.

ROBAINA, J. V. L. *et al*. (ed.). **Fundamentos teóricos e metodológicos da pesquisa em educação**. 1. ed. Curitiba: Bagai, 2021. v. 1.

SARAMAGO, J. **O conto da ilha desconhecida**. São Paulo: Companhia das Letras, 1998.

SOUZA, J. R. T. *et al*. Ilhas interdisciplinares de racionalidade no ensino de ciências: uma experiência didática no PARFOR na Ilha do Marajó, Pará, Brasil. **Amazônia: Revista de Educação em Ciências e Matemáticas**, Belém, v. 12, n. 24, p. 85-98, 2016.

SHAW, G. S. L. Dificuldades da Interdisciplinaridade no Ensino em Escola Pública e Privada: com a Palavra, os educadores. **Revista Cenas Educacionais Caetité**, Salvador, v. 1, n. 1, p. 19-40, 2018.

STAEVIE, P. M. Interdisciplinaridade: contribuições para se pensar a Amazônia. **Revista Latino-Americana de Estudos Avançados**, Foz do Iguaçu, vol. 2, n. 1, p. 6-15, 2017.

TARDIF, M.; LESSARD, C. **O trabalho docente**: elementos para uma teoria da docência como profissão de interações humana. 9. ed. Petrópolis: Vozes, 2020.

THIOLLENT, M. **Metodologia da pesquisa-ação**. São Paulo: Cortez, 1986. (Coleção Temas Básicos de Pesquisa-ação).

**Authors contribution**

VCA: Methodological design of the research, Data collection, Analysis and interpretation of the results.
LOS: Study supervisor, Performing project administration, Review.

**Editor:** Prof. Dr. José Luís Bizelli

**Executive Editor for Latin America:** Prof. Dr. Vilmar Alves Pereira