



INTERDISCIPLINARY PRACTICES IN THE INITIAL TRAINING OF TEACHERS OF NATURAL SCIENCES: DIFFERENT CONTEXTS, SIMILAR INQUIRIES

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ABSTRACT:

The idea of interdisciplinarity has established itself in the Brazilian educational scenario in recent decades, leading to demands for interdisciplinary activities in the school context. Contrary to what curriculum documents advocate, such practices do not happen naturally. Anchored in Goodson, we argue that school subjects have no dimmed boundaries. Thus, we investigate how interdisciplinary practices are engendered in the initial training of natural science teachers, within the scope of supervised internships in two Brazilian public universities, one in the northeast region, the other in the southeast. Through the Discursive Textual Analysis (DTA), we analyze reports and scripts produced by the undergraduates. Although they indicate possibilities for interdisciplinary work, it is noted that the establishment of such practices is not trivial. The remarkable belonging to the area and the robustness of the disciplinary structure within the school indicates the importance of negotiating and working together for carrying out interdisciplinary practices.

Keywords:

Interdisciplinarity;
Initial training teachers;
School subject.

PRÁTICAS INTERDISCIPLINARES NA FORMAÇÃO INICIAL DE PROFESSORES DE CIÊNCIAS DA NATUREZA: CONTEXTOS DISTINTOS, INDAGAÇÕES SIMILARES

RESUMO:

A ideia de interdisciplinaridade se estabeleceu no cenário educacional brasileiro nas últimas décadas, levando a demandas pela realização de atividades interdisciplinares no contexto escolar. Ao contrário do que preconizam os documentos curriculares, tais práticas não acontecem naturalmente. Ancorados em Goodson, argumentamos que as disciplinas escolares não apresentam fronteiras esmaecidas. Assim, investigamos como práticas interdisciplinares são engendradas na formação inicial de professores das Ciências da Natureza, no âmbito de estágios supervisionados em duas universidades públicas, uma no Sudeste, outra no Nordeste brasileiro. Analisamos relatórios e roteiros produzidos pelos licenciandos com a Análise Textual Discursiva. Apesar de indicarem possibilidades de se trabalhar interdisciplinarmente, nota-se que o estabelecimento de tais práticas não é trivial. O notável pertencimento à área de formação e a robustez da organização disciplinar dentro da escola sinalizam a importância das negociações e do trabalho coletivo para o engendramento de práticas interdisciplinares.

Palavras-chave:

Interdisciplinaridad;
Formación inicial;
Disciplina escolar.

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PRÁTICAS INTERDISCIPLINARIAS EN LA FORMACIÓN INICIAL DE PROFESORES DE CIENCIAS NATURALES: DISTINTOS CONTEXTOS, PREGUNTAS SIMILARES

RESUMEN:

La idea de interdisciplinariedad se ha asentado en el escenario educativo brasileño en las últimas décadas, generando demandas de actividades interdisciplinarias en el contexto escolar. Al contrario de lo que recomiendan los documentos curriculares, estas prácticas no ocurren de forma natural. Basados en Goodson, argumentamos que las materias escolares no tienen fronteras borrosas. Así, investigamos cómo las prácticas interdisciplinarias se engendran en la formación inicial de los profesores de Ciencias Naturales, en el ámbito de las pasantías supervisadas en dos universidades públicas, una en el sureste y otra en el noreste de Brasil. Analizamos informes y guiones elaborados por los estudiantes de grado con Análisis Textual Discursivo. Si bien indican posibilidades de trabajo interdisciplinario, se observa que el establecimiento de tales prácticas no es banal. La notable pertenencia al área de formación y la solidez de la organización disciplinaria dentro de la escuela señalan la importancia de las negociaciones y el trabajo colectivo para el desarrollo de prácticas interdisciplinarias.

Palabras clave:

Interdisciplinariedad;
Formación inicial;
Disciplina escolar.

INTRODUCTION

In the last decades, the Brazilian curricular scenario has been distinguished, as regards the documentary sphere, by the presence of the idea of interdisciplinarity, since the publication of the National Curriculum Guidelines for Secondary Education in the late 1990s (Diretrizes Curriculares Nacionais, 1998) until the recent promulgation of the controversial Secondary Education reform (Lei n. 13.415, 2017).

These documents present the proposal for the organization of traditional school subjects in areas of knowledge by considering their epistemological affinities. With regard to official curricular policies, the most recent document approved by the National Education Council on Secondary Education recommends the organization of pedagogical work in areas of knowledge, completely eliminating any mention of disciplinary fields (Resolução CNE/CP n. 4, 2018). In this sense, the National Common Curricular Base (Base Nacional Comum Curricular – BNCC) for Secondary School has developed a proposition in which school contents in Natural Sciences are related and articulated, without clearly defining the specific contributions arising from the subjects Biology, Physics and Chemistry.

As a result of this scenario that has pervaded the last decades, demands for interdisciplinary work within the scope of teaching have arisen, leading to a naturalization of interdisciplinary practices as common activities (Bortolato, & Iglesias, 2017; Feistel, & Mestrelli, 2009; Goodson, & Petrucci-Rosa, 2018; Lima, & Ramos, 2017; Mozena, & Ostermann, 2016).

On the other hand, it can be argued that disciplinary boundaries are not fragile, inasmuch as a school subject is not constituted just by a set of knowledge contents to be taught, but brings with it the characteristics of a disciplinary community (Abreu, 2012; Goodson, 1997). Other research shows that difficulties and limitations are imposed before the demands, arising mainly from curricular documents, through interdisciplinary work (Moura, 2014; Mozena, Ostermann, 2014; Petrucci-Rosa, 2018).

In this sense, the performance of interdisciplinary practices, in the sphere of teaching action, does not constitute a trivial activity. There is a complexity in working beyond the limits of each of the school subjects, which can be understood as territories, so that together they make up a curriculum-allotment, a metaphor proposed by Petrucci-Rosa (2007) in which

The curriculum as an allotment has stabilized in the basic school where specialization – the strongest trait of its inspiring source: modern science – is what prevails. In this allotment, the dispute within the “time-space” of the week becomes dynamic, inventing ‘winners’ and ‘losers’, more deserving or less worthy of attention, in the training process that the school proposes to do (Petrucci-Rosa, 2007, p. 55).

The school discipline in the midst of these issues is configured as a *locus*, where not only the scientific knowledge of reference occupies space. The characteristics and demands of the community of subjects that compose it are also present. These territories compete with each other to guarantee spaces and meet the desires of the inhabitants of the disciplinary *homeland* (Petrucci-Rosa, 2007), whose limits are not easily blurred. We argue, therefore, that interdisciplinary practices cannot be treated as simple processes, which would naturally be developed in the teaching work, as can be inferred from reading the official documents (Matriz de Referência, 2009; Orientações Curriculares Nacionais, 2006; Parâmetros Curriculares Nacionais, 1999; Resolução CNE/CEB 2, 2012).

Thus, we argue based on Goodson’s studies (2018), which attribute the stabilization of a discipline in the basic school curriculum to the corresponding university career. Teachers in the final stages of basic schooling, therefore, carry with them the traditions and culture(s) of a field of knowledge that have permeated the teacher since the first years of his education. It cannot be forgotten, therefore, that school subjects carry a strong symbolism in them, which would not be easily erased in the face of interdisciplinary questions. Therefore, the exercise of teaching takes place through a lens with the filters of language and the episteme of the discipline to which it is linked (Petrucci-Rosa, 2018).

To constitute the object of study of the present work, we will focus on the initial teacher education as a possible way to think about interdisciplinary practices, considering the potential of such formative spaces as supervised internships, as shown by some researches (Bortolato, & Petrucci-Rosa, 2013; Cabral, & Flôr, 2016; Massena, 2015; Moretti, & Petrucci-Rosa, 2015; Paniago, Sarmiento, Medeiros, & Nunes, 2018).

Initial training has been chosen as the research focus because interdisciplinary practices could become substantial if they are problematized and deemed possible since the first years of professional contact with the school institution. Thus, the scope of this investigation is outlined within the sphere of supervised internships for undergraduate students in the area of Natural Sciences, considering the insertion in the school environment from the perspective of supervised internships.

In order to dialogue with our investigative question, empirical material was created based on reports and scripts referring to the context of Supervised Internship disciplines of two Brazilian public universities, in which undergraduates are invited to work together with colleagues from other disciplines. The methodological path is based on the principles of Discursive Textual Analysis (DTA), which will guide the analysis of interns’ written productions (Moraes, Galiazzi, 2016).

THE IDEA OF INTERDISCIPLINARITY: A FEW CONSIDERATIONS

Although the emergence of the theme can be related to the first universities in the Western world, issues related to interdisciplinary knowledge have notably emerged throughout the 20th century, especially from the second half onwards. The development of Science and the consequent specialization of knowledge seem to have been the main factors that led to epistemological studies on the possibilities of interface and integration across disciplines (Mathurin, 2002). The compartmentalization of knowledge gave rise to criticisms that spread from the academic to the school universe.

So, the defense for the adoption of interdisciplinary practices in the school context has historically emerged as an answer to the problems and difficulties listed by education subjects about the teaching-learning processes. Considering the 1970s as a starting point, Veiga-Neto called this debate the *Pedagogical Movement for Interdisciplinarity* (Veiga-Neto, 2010).

This movement, relative to the Brazilian scenario, began to unfold in the 1970s and was consolidated in later years, guided by the works of Hilton Japiassu and Ivani Fazenda (Veiga-Neto, 2010). In the midst of this movement, one can highlight these authors' theoretical perspectives about interdisciplinarity. Among their diverse contributions, we can highlight, respectively, questions about the compartmentalization of knowledge and an integral understanding of the world, as well as the perception that interdisciplinarity would occur through attitudinal changes (Fazenda, 1994; Japiassu, 1976).

It is important to underline that, in addition to the epistemological considerations about the dynamics of knowledge in the contemporary world, Japiassu, based mainly on French scholars, brought propositions to understand what *interdisciplinary* would be. Conjugated to three other terms – multidisciplinary, pluridisciplinary and transdisciplinary – this author weaves the meanings of each one from the level of interaction between disciplines.

This form of interaction between disciplines can be understood as a gradation that starts in the multidisciplinary, understood as just a convergence of the disciplines, without a dialogue between their contents. Then would come the pluridisciplinary, in which a degree of relationship between the disciplines could be considered, yet without an effective integration of their knowledge contents. Therefore, the interdisciplinary approach would correspond to an effective interaction between knowledge contents, which would contribute to the improvement of the disciplines. Finally, the transdisciplinary would be characterized as a high level of integration, which could consist of relations between alleged interdisciplines constituted at the previous level (Japiassu, 1976; Veiga-Neto, 2010)

In the field of science education, there is a range of investigations and reflections on the possibilities of interdisciplinarity. We can mention the article by Mozena and Ostermann (2014) and the work by Lamego and Santos (2017), who studied the bibliographic production on interdisciplinarity. The former focused the analysis on national and international journals concerning Education, Qualis A1 and A2, with a time frame between 1980 and 2012. The latter was dedicated to examining the Proceedings of the National Research Meeting in Science Education (ENPEC), in its first ten editions, covering the years from 1997 to 2015.

The analysis developed by Mozena and Ostermann (2014) was based on the review of 112 papers, in which the defense of interdisciplinarity in science education is present in all. The authors also point out that many of these works present and discuss ideas and themes for interdisciplinary activities in the Natural Sciences disciplines. They also summarize that the main difficulties for the development of interdisciplinarity can be grouped into four axes, namely: institutional, methodological, relative to teachers and relative to students. Lamego and Santos (2017), when reviewing 85 publications from a set of ten proceedings of ENPEC, point out that the authors most cited in these works were Hilton Japiassu and Ivani Fazenda, in addition to the frequent advocacy of interdisciplinarity and discussions about theoretical issues on the terms multidisciplinary, pluridisciplinary, interdisciplinary and transdisciplinary. Both studies show that the authors most cited in the reviewed papers, in addition to the Brazilians already mentioned, were Edgar Morin, Jurjo Santomé and Yves Lenoir.

There is also research that shows the stability of school subjects and communities in the curricular practices of the Brazilian basic school (Abreu, 2010; Petrucci-Rosa, & Ramos, 2015; Petrucci-Rosa, 2018, among others). Such investigations show that interdisciplinary work takes on a great dimension in the school context, besides the epistemological and attitudinal one.

Still referring to Veiga-Neto (2010), there seems to be two great “waves” of interdisciplinarity in the recent Brazilian educational history, namely: the first, of an academic nature, constitutes the circulation of works by Japiassu and Fazenda; the second, of a political nature, is marked by the approval of a set of curricular documents. Thus, from the curricular documents of the late 1990s, the interdisciplinary theme came into vogue in the field of Education and Science Teaching and started to circulate narratively in Brazilian curricular public policies in the first two decades of the 2000s.

Considering the questions raised by the official curricular documents on interdisciplinarity, there seems to be a certain naturalization about interdisciplinary work, often considered to be the exclusive responsibility of teachers. It is this point that moves us along the path of the present investigation, as we recognize that the idea of interdisciplinarity does not constitute a curricular panacea, but on the contrary, it demands studies and understanding in the dimension of teacher education.

In this sense, considering the context of basic school, especially Secondary Education, there is a significant influence of the culture of the disciplinary fields (Goodson, & Rosa, 2018; Petrucci-Rosa, 2007) in the initial training of teachers and in the dynamics of school routine and teaching work. When approaching the interdisciplinary theme in the context of teaching practice, we do it within a disciplinary perspective, considering that

Being a teacher of a certain school subject is a condition that goes beyond the epistemological or cognitive dimension – it is also carrying with you the practices that come from the symbolic field configured in the power relations present in your academic reference community (PETRUCCI-ROSA, 2007, p. 58).

The disciplinary fields, therefore, emphasize their importance in curricular organizations, justifying the strength and continuity in the school context. The teachers of each discipline, especially those in the final years of elementary and high school, and therefore constitute disciplinary communities (Goodson, 2018). In this sense, we reiterate that interdisciplinary practices are not configured as something natural in the teaching work. Teachers in the final stages of basic schooling are teachers of a discipline, in other words, it is possible to affirm that the discipline takes on a kind of “surname” of the teacher: teacher “Alzira” is *of* Chemistry, teacher “Abelardo” is *of* Physics...

As Goodson points out, the traditions and cultures of the disciplinary fields are elements that guarantee the maintenance of the status and curricular space of a school discipline (Goodson, 2001, 2007, 2019). With these considerations, we assume that the conditions for the development of interdisciplinary practices do not depend only on a change in attitude and epistemological paradigm, but on the complex web of cultural and pedagogical relations that are woven in the school. Interdisciplinary practices are therefore established in the midst of collective work as a pedagogical issue (Petrucci-Rosa, 2018).

Therefore, the present work aims to discuss the complexity of interdisciplinary practices in the initial training of teachers, starting from the context of experiences in supervised internship disciplines, which took place between the years 2013 to 2017, in two public Brazilian universities: one located in Southeast and another in the Northeast.

METHODOLOGICAL PATHS

The empirical material of the present investigation consists of textual productions of undergraduate students from the activities produced during the period in which they undertook supervised internship. In both institutions there are undergraduate courses for all subjects present in the curricular organization of the basic school. The southeastern university is organized into several institutes and colleges that carry the respective names of the disciplines they represent. The university in the northeast, in turn, is organized into departments by areas of knowledge. We describe below characteristics common to the internships carried out in the two institutions. Then we detail the contexts of development of these internships in universities in the southeast and northeast.

In both universities, the experiences of teachers in training were configured from the weekly meetings of the disciplines related to the supervised internship. As an initial proposal, students are invited to carry out a set of readings on immersion in the school universe. In the interaction with internship advisors and supervisors, teachers responsible for the disciplines and teachers of the basic school, respectively, the undergraduate students build a path of conducting and acting in the internship field.

Within the scope of this work, we highlight two sets of internship experiences, one from each university, involving undergraduates in the disciplines of Natural Sciences. In common, they all developed projects

and classes to be worked on in the school context. The practices resulting from these activities resemble the construction of interdisciplinary activities planned within the scope of initial teacher training courses and were developed in public schools.

Regarding the southeastern university, we bring three experiences that involved Chemistry and Biology undergraduates in interaction with colleagues in the Humanities, Mathematics and Languages, due to the very nature of the internship at that institution, detailed below. In the case of the northeastern university, the internship experience took place in the contact between chemistry and physics undergraduates, accompanied by two master students from the same university, linked to the graduate program in science and mathematics education. One has a degree in Biology and the other in Chemistry. All of these situations occurred under the guidance of the professor responsible for the internship discipline at the respective university. This information is summarized in Table 1.

The internship experience at the university in the southeastern region of Brazil is centered on two pillars. One is based on the specific context of the discipline in which the student will graduate and is developed by the respective institute/faculty. The other is the responsibility of the Faculty of Education and common to all degrees. In this case, the proposal for carrying out the internships does not reside in the disciplines themselves, but in the understanding of the complexities of the school space and the teaching activity. The different classes of the supervised internship discipline are organized into projects, in which the undergraduate students can enroll considering their affinities with the theme. In this way, students from different degrees can share their internship experiences. Thus, the total workload of the internships is shared, so that students experience moments specific to their disciplinary field and broader discussions about educational spaces.

The development of these experiences, in the case of the southeastern university, culminated in the production of reports. Students enrolled in the internship discipline organize themselves in groups with three/four members, usually from different courses. Each group chooses a theme, which contemplates the disciplines involved, and develops an interdisciplinary proposal to explore together in a public school. At the end of the process, the group collectively writes a single report, in which the entire process of immersion in the school, observation of classes and development of the interdisciplinary project is described. In these documents, there are excerpts with the identified reports of each student and the analyses, impressions and joint reflections of the interns. The reports were prepared in three different offers from one of the internship disciplines, covering the period from 2013 to 2017. They will be named by the acronym R, followed by the final two numerals of the year of their production.

At the university in the northeastern region of Brazil, supervised internships are carried out under the responsibility of the departments where the undergraduate courses are based. In each of them, there are teachers in the academic area who teach the respective disciplines and develop internship projects in conjunction with public schools. The internship hours that must be completed are related to four or three subjects, depending on the course. The first half of the internship is aimed at approaching and observing the school field, while conducting takes place in the other half.

Thus, in the context of the northeastern university, the undergraduates produced class scripts with an interdisciplinary nature, from which three are selected. The themes of these activities are shown in Table 2 in the next section. The scripts, which show the development sequences of the stages of the proposed classes, were developed in 2017. They will be identified by the acronyms Sc1, Sc2 and Sc3, as shown in Table 1. Sc1, Sc2 and Sc3 were organized for activities to be carried out in up to five meetings of 1 hour and 15 minutes. The classes were composed of students from the 1st and 2nd years of high school. The activities were built in the moments of Complementary Activity (CA) that occur once a week for 2 hours in public state schools with the participation of schoolteachers, university professors, undergraduate and master students, subjects from the areas of Biology, Physics, Chemistry and Mathematics. Classroom activities were carried out by a schoolteacher and an undergraduate student.

In the analysis of the empirical material, the letter “U” represents the undergraduate student involved, also accompanied by the initial letter of the course. A Biology undergraduate, for example, is referred to as UB. It is worth mentioning that specific excerpts from the speeches of students from courses in the other areas that make up the reports do not constitute an object of analysis, considering the theme of this article.

Region	Type of material	Code	Disciplines involved
Southeast	Report - 2013	R13	Sociology, Biology and Chemistry
	Report - 2014	R14	Biology, Philosophy and Chemistry
	Report - 2017	R17	Biology, Portuguese Language, Mathematics and Chemistry
Northeast	Script 1 - 2017	Sc1	Physics, Mathematics and Chemistry
	Script 2 - 2017	Sc2	Biology, Physics, Mathematics and Chemistry
	Script 3 - 2017	Sc3	Biology, Physics, Mathematics and Chemistry

Figure 1. Empirical material analyzed.

Source: Prepared by the authors, 2020.

The analysis of the reports and scripts that compose our empirical material is generated by the perspective of a qualitative research (Bodgan, Bicklen, 1994; Minayo, 2012). As a methodological device, we consider the principles of Discursive Textual Analysis (DTA) developed by Moraes and Galiazzi (2016), which consists of four stages, namely: a) dismantling of texts, b) establishment of relationships, c) capture of the emerging new, and d) an organized process. In other words:

Organized in four focuses, Discursive Textual Analysis aims, initially, to dismantle the texts, examining the smallest details. In the sequence, the relations between each unit are established, looking for the identity between them, to, soon after, capture what emerges from the totality of the text, towards a new understanding of this whole. Finally, the research process, in this methodology of analysis, is self-organized, requiring from the researcher an immersion, a complete impregnation in the information of the analyzed text, this rigor being a necessity so that the new is able to be evident (Pedruzzi, Schimdt, Galiazi, & Podewils, 2015, p. 591-592).

Thus, all the empirical material was read and the analyzed *corpus* comprised, therefore, the texts of the reports and scripts. The process of dismantling the texts begins with a thorough reading of these materials in search of statements regarding the aspects to be discussed, such as interdisciplinarity and teacher training. The establishment of relationships occurs through the categorization itself, gathering close elements found in the texts. The capture of the emerging new is associated with the reading and impregnation of the materials to be analyzed. There is thereby a new understanding of the whole and in this stage, the writing of the metatext is constituted, in order, finally, to allow the emergence of new understandings of the whole with the cycle of analysis. Thus, there is a self-organized process (Moraes, & Galiazzi, 2016).

Considering the four steps mentioned above and imbued with the reading of the empirical material, we arrived at the definition of three emerging categories, namely: a) the disciplinary home; b) coping with the school environment, and c) abandoning the homeland. We will discuss them below.

THE EMPIRICAL FIELD AND ITS ANALYSIS

The data will be discussed from the categories previously defined in conjunction with the methodological approach taken in this work.

- a) The disciplinary home – “protection of contents”

In general, teacher training in undergraduate courses takes place in a disciplinary way with undergraduate students being trained in specific fields that can momentarily dialogue with each other. Considering this aspect, when they arrive at the 'teaching of' disciplines and are challenged to articulate different disciplinary fields, they perceive important difficulties, since thinking and acting in this way requires a renunciation of the protection and security that the disciplinary contents provide. When asked to work in an interdisciplinary way, undergraduates need to enter the "home of the other" while the doors of their own homes are open. Naturally, they resort to their areas of origin when carrying out disciplinary projects in the context of the supervised internship, and the fluency with which the undergraduates talk about their own disciplinary field is noteworthy.

For example, in R14 in which Biology, Philosophy and Chemistry undergraduates are involved, they decide to develop a proposal for an interdisciplinary activity based on the scientific method theme. However, during the activity they worked in isolation, based on their knowledge of their disciplines. As we have argued elsewhere, the school discipline is not an isolated entity that reproduces knowledge of the corresponding scientific discipline, but one that integrates a complex web that is the disciplinary community (Goodson, 1993). Each teacher is a teacher *of* a discipline, which reinforces belonging to a specific place, to a disciplinary home, a homeland. In the words of the Biology undergraduate:

As a second part of the class, I, representing Biology, introduced myself to the students, and continued to explain what the scientific method is. Next, I wanted to materialize the idea of scientific method with a practical example – a little story. I told them the story of a young boy who loved biology and wanted to discover something, wanted to be a researcher. For that, he knew that he should start by observing a fact of nature, since biology is a natural science (R14, UB).

This intern reinforces his identification with the discipline of origin, by announcing himself as a representative of Biology and placing it as central to understanding the scientific method. Together, the three undergraduates proposed an intervention through an experimental procedure on photosynthesis, which would represent an interdisciplinary interface between Chemistry and Biology, besides enabling a discussion on the construction of knowledge. We realized through their reports that the disciplinary logic of the content prevails, as we highlight in the excerpt below.

Through collisions between the molecules of the photosynthesis reagents (water and carbon dioxide), their chemical bonds are broken and new bonds are formed in the products of this reaction (glucose, oxygen and water). Thus I finished the theoretical-scientific part of chemistry (R14, UC).

Teachers in initial training propose discussions about the scientific method, each within their own disciplinary field, as the Chemistry undergraduate emphasizes when he says that he finished "the theoretical-scientific part of chemistry". There is no evidence in the report that they worked effectively together, articulating different knowledge contents.

The interns seem to speak fluently in the context of their own disciplinary field, showing even a concern with the rigor of the contents to be taught. In another internship experience, represented by report 13, in which Biology, Chemistry and Sociology undergraduates decided to work with the theme "Medicinal plants", the Biology student expresses her anxieties with the impossibility of having taken a more detailed description of the contents of her discipline:

As we were in a circle and in a very informal way, I struggled to measure what I would say and at what level of depth. One of the reasons that caused me this anguish was that we had scheduled part of the following class for a more in-depth chemical and biological discussion. However, at the time of the discussion, the opportunity arose to deal with subjects such as ethnobotany and secondary metabolites. I was not able to go into details and I didn't think I should, but the way I ended up speaking left me with the feeling that I did not approach it properly and deeply enough and, as at first there was a more specific space for these matters, especially the metabolites part, which is very interesting because it opens up space for a discussion related to evolution, I ended up saying that we would address it in more detail the next day (R13, UB).

The concern with the specific knowledge of the disciplines is present in all of the scripts and reports prepared by the undergraduates. The representatives of each homeland advocate in favor of their fields when they discuss in great detail about the contents of their “disciplinary homes”. The beginning Chemistry teacher who makes up the R13 team, when telling his impressions about the classes he attended, points out inaccuracies in the explanation of the conducting teacher. Paradoxically, at the same time that he criticizes, he recognizes the limitations of the context of high school classes, without abandoning, however, the defense for the correct observance of chemical principles. Referring to the influence of temperature on chemical reactions, he says:

Although I also learned that way in high school, at college I saw that the increase in temperature favors (in the sense of increasing speed) all reactions, whether they are endothermic or exothermic, and that in the case of chemical equilibrium, the increase in temperature favors the endothermic reaction more than the exothermic one (R13, UC).

Also, after mentioning the Arrhenius equation, which brings a mathematical apparatus – exponential function and logarithm – relatively complex to medium level content, he recognizes:

I understand that this level of detail may not fit in a high school class, but I was a little uncomfortable to see students learning something the same way I learned when I was in their position, in only a partially correct way (R13, UC).

Despite the considerations on the differences between school and scientific knowledge and on the concept of didactic transposition that can be made from the previous excerpt, the discomfort felt by the Chemistry undergraduate with the non-observance of scientific rigor and the contents of his disciplinary field signals the strength that the “disciplinary home” represents. For interdisciplinary practices to be effective, negotiations and concessions on the part of those involved are necessary. As Petrucci-Rosa (2007) argues, the school space-time, with “its losers and winners”, with more or less class hours, is a web of complex relationships with different rites and subjects occupying places. An interdisciplinary work implies abandoning certain certainties and idiosyncrasies and carrying others. The integration of knowledge from different disciplines demands a constant “attachment” and “detachment” to the contents.

Specific knowledge contents sometimes turn out as walls, sometimes as foundations of the different disciplinary homes, in spite of the interdisciplinary proposals built by the interns. In the case of the members of the group that prepared R17, whose theme was depression and anxiety, the Biology and Chemistry undergraduates were very thorough in describing the content they mobilized. Regarding biological knowledge, the undergraduate brought many details about the functioning of the nervous and endocrine systems, as well as dealing with depression-related neurophysiology. Regarding chemical knowledge, there is a lot of specific information about organic compounds. Likewise, the scripts are centered on the moments of the classes reserved for discussing the disciplinary contents.

In addition to interns’ notable concerns in properly working on the epistemological principles of each discipline, which seems to guide the different practices, students need to deal with a complex universe constituted by the school routine, which also influences the conditions for interdisciplinary practices to occur.

b) Coping with the school environment

When undergraduates are faced with living in the school environment, many concerns and fears come to the fore. First, this experience will undergo a detachment from the figure of being a student, since the undergraduate starts to exercise the role of teacher, taking on coping with practical issues of the classroom routine and, among them, the organization of space and time.

Such a role can mobilize a set of contradictory beliefs, feelings and emotions, which to some extent affect the pedagogical practices of beginning teachers.

We struggled with the planning of the classes. And not because we were unable to join the disciplines under the same theme or because it was difficult to reconcile the schedules. The difficulties were external to our group, more specifically due to the time made available by the school to develop the project at the school (R13).

Thus, it seems that one of the main characteristics of the school dynamics that causes strangeness is the organization of the school's space-time. Petrucci-Rosa (2007, p. 54-55) when proposing the metaphor of an allotment curriculum when referring to the timetable of school subjects, argues that "the dispute within the 'time-space' of the week becomes dynamic, inventing 'winners' and 'losers', more deserving or less worthy of attention". So, in order to think about different activities outside the disciplinary scope, undergraduates end up negotiating the precious resource that is class time. In their words:

Developing such a project allowed the perception that the organization of time is extremely important and that it is often difficult to reconcile this factor with the pre-established planning by the school or by the teachers themselves, since different teachers have different routines and commitments (R17).

In addition, other issues emerge in the interns' reports, such as access to pedagogical projects, adolescents' behaviors, attitudes and expectations regarding the teaching-learning process, and their presence in classes. Regarding the latter:

I was introduced to the students and they seemed to celebrate receiving a treat. They clapped, whistled, screamed, it was a very funny scene. The teacher explained to me later that they love interns because our presence there implies that, at some point, they will do something different from the daily dynamics of the classroom (R14, UB).

From the excerpts highlighted, we can point out that there is a certain rigidity in the organization of the school environment. The presence of a third figure in the classroom is enough to cause euphoria in the students. The traditional format of classes, with a single teacher, often isolated, occupying a well-defined time, constitutes a normality established in the school's daily life. As the other fragments indicate, school time is a barrier to be overcome so that interdisciplinary practices can be present. Undergraduates still need advisory professors to give up their respective classes for the feasibility of interdisciplinary intervention. The biology undergraduate reports in R13 the difficulty faced by the group concerning the school "modus operandi".

Negotiating to get classes to develop the project was not easy. We then had to make an "edition" of what we had originally planned. Which, in my opinion, was at the same time very difficult and disappointing, because the theme we chose (Medicinal Plants) directly involves the three areas of knowledge involved (Chemistry, Biology and Sociology) and allows an opening to do a range of things (UB, R13).

In this sense, it seems credible to say that the establishment of interdisciplinary practices is not limited only to the universe of the contents of school subjects and the undergraduates' willingness to build dialogues. Beyond the possibilities of integrating knowledge, the dynamics of the school is an important factor for the success of such practices. It would be important to think in terms of interdisciplinary spaces, so that the interaction between teachers occupying and sharing the same space and time is facilitated by the school structure.

As reported by the biology undergraduate, from R14, her presence represented a break, albeit subtle, from the normality established in the disciplinary territory, which has the specialist professor as its symbol, who has possession of the time interval that is called "class". Thus, we question whether it is plausible to consider that interdisciplinary practices can be established with each subject in isolation approaching contents on a theme.

Facing the school environment, therefore, is also facing the "loneliness" of the disciplinary territory. The classroom, as the basic unit of the distribution of school time, is always associated with a field of knowledge in the final years of basic school. This segmentation is naturally present in the planning of the proposed interdisciplinary activities.

The undergraduates of R17, for example, refer to the project developed as "Depression according to chemistry, biology, mathematics and the Portuguese language", highlighting the contributions of each discipline to the understanding of the theme. In the report they bring details about the contents of their disciplines and there is almost no concern about sharing the same space. Only in one of the stages foreseen by

them does one notice the coexistence of subjects of the Portuguese language and mathematics: “Presentation of several non-literary genres and statistical data”.

Abandoning the “disciplinary home” is not a simple task and the school environment itself, with its established cultures and traditions, which is constituted as the place where the abandonment of the homeland can happen, where it is possible to rehearse the rupture of standards, imposes many challenges for negotiation in favor of interdisciplinary practices.

c) Abandoning the “homeland” – themes as the possibility of expanding the knowledge produced

As the activities should present proposals for interdisciplinary interventions, it is interesting to understand how the themes were chosen, which are summarized in Table 2 below.

Code	Theme	Disciplines involved
R13	Medicinal Plants	Sociology, Biology and Chemistry
R14	Theorization and construction of scientific knowledge	Biology, Philosophy and Chemistry
R17	Depression and Anxiety	Biology, Portuguese Language, Mathematics and Chemistry
Ro1	Food energy	Physics, Mathematics and Chemistry
Ro2	Licit drugs – medicines	Biology, Physics, Mathematics and Chemistry
Ro3	Illicit drugs	Biology, Physics, Mathematics and Chemistry

Figure 2. The themes worked on in the interdisciplinary activities

Source: Prepared by the authors, 2020.

In the reports produced in the context of the activities experienced in the Southeast, what is observed is that the choice of the theme came from questions about the relevance of the theme and the ease of integration of the different disciplines. In the case of R13:

The theme for the interdisciplinary project came up by thinking more about the diversity of undergraduate disciplines of the group members than about something that possibly would have emerged at school. At first we thought about working on something related to the environmental issue, but the mother of one of the group members suggested the theme of Medicinal Plants and we took the suggestion, since the use of traditional plants is part of the daily life of many families (...)

The question is: when appropriating the knowledge of medicinal plants, does science restructure the relations and distribution of knowledge in society? (R13).

In the case of R14, the idea was, based on the theme “Theorization and construction of scientific knowledge” and an experience on Photosynthesis, to discuss how the curricular components help in the construction of knowledge. R17 mentions the discussion of the theme “Depression and Anxiety” as of relevance to the school’s youth. It should be noted that this decision-making process is not simple and requires dialogue between the representatives of the disciplines, as well as a solid knowledge about their field. In the undergraduates’ words:

The stage of creating the interdisciplinary project showed us how studies are still needed to really understand interdisciplinarity and then be able to apply it in the classrooms. Besides showing us, through the difficulty of communication due to terms specific to each area, for example, that we are more rooted in our training than we realize (R17).

On the other hand, the themes of the scripts (Sc1, Sc2 and Sc3) developed in the context of the experience lived in the Northeast were defined based on a conversation with schoolteachers about the importance

of discussing healthier eating and students' consumption of licit and illicit drugs. The scripts feature in their activities the initial problematization of the theme by presenting some questions for the debate, the use of videos, simple experiments, discussion of package inserts, reading of short texts and a chemical jury.

It seems evident that the discussion based on themes can be an important strategy to exercise abandoning the *homeland* (Petrucci-Rosa, 2007) of the disciplinary contents, setting out to an exercise of articulating different fields of knowledge.

DIALOGUING WITH INTERDISCIPLINARY EXPERIENCES IN THE CONTEXT OF INITIAL TEACHER TRAINING

Despite the difficulties reported by the undergraduate students, it is essential to highlight the recognition of the effort made by each group in the process of defining a topic in which it was possible to articulate disciplinary knowledge. The intense relationship that students demonstrate with the contents of the training area seems to be an indication of how the essentially disciplinary practices, which value specialized knowledge, endure. Future teachers are challenged to think about interdisciplinary practices, ways of integrating knowledge, at the moment they are immersed in the context of the supervised internship.

We consider, therefore, the complexity of teacher training processes in undergraduate courses related to interdisciplinary practices, with special attention to curriculum areas configured by supervised practice. In undergraduate courses, other curricular spaces where interdisciplinary knowledge is approached or constructed are rarely found. In general, disciplinary degrees rely on curricula marked by knowledge specific to each scientific area, with special emphasis on specializations.

In these courses, the curricular space represented by the supervised internships is configured as an important place of resignifying about the importance of knowledge and its didactic possibilities for its transformation into school knowledge. This can explain the perception of the importance of the “disciplinary home” as an aspect of teaching identity that occupies a central place in the pedagogical practices planned and developed in the context of schools. The speech of the Biology undergraduate student, from R14, when she says “I represent Biology” is a notable expression of this identity aspect and shows that the abandonment of the homeland does not happen entirely.

This observation leads us to what Goodson (2019, p.65) points out, quoting Kliebard, who states: “the strength that proved to be practically impregnable was school discipline”. Kliebard refers to a study of historical perspective developed on the American curriculum in the period between 1893 and 1958. However, this strength still seems to remain evident in the curricular practices meant to be interdisciplinary, developed in different contexts of the initial formation. In Sc1, for example, there is an emphasis on the specific contents of Physics and Chemistry, just as in Sc2 and Sc3 chemical structures are valued. Likewise, undergraduates in R14 are based on the process of photosynthesis for an interdisciplinary dialogue between Biology and Chemistry. After proposing an experimental activity, the undergraduates of these disciplines favor the discussion of specialized knowledge in their areas, to the detriment of the contributions of each discipline to the global understanding of photosynthesis.

The valorization of knowledge in the disciplinary field itself stands out in the configuration of interdisciplinary practices, which constitutes a way of guaranteeing disciplinary stabilization, as argued by Goodson (2018). According to this author, this character of disciplinary strength takes place mainly through the mobilization of school knowledge of academic tradition. In this sense, in the reports and scripts, we perceive the concern to mention and mobilize academic knowledge from each specific disciplinary field. The Chemistry undergraduate, in R14, praises the definitions of “collision theory” and “activation energy”, treating general aspects of a chemical reaction more than the transformations that occurred in photosynthesis itself.

From these considerations, setting out in the curricular internships the possibility of producing school knowledge of an interdisciplinary nature turns out to be almost a transgression that requires special effort and openness to the collective teaching work. Besides the disciplinary homeland displacement movement, the success of these interdisciplinary practices in the initial training of these teachers also depends on overcoming the institutional bonds established in the school. As the undergraduates told us, winning advisors' teaching time took a lot of effort and negotiation. Without the involvement of the collective dimension on the part of interns, teachers and the school, the planning of interdisciplinary practices becomes even more complex.

As Goodson (2019, p. 172) states: "It is in the broader institutional arenas that teachers perceive both the great frustrations and the possibilities for significant changes". Thinking about interdisciplinary practices in the supervised internship, with its due complexities and potentials to re-signify disciplinary knowledge and the effective partnership of the school and all its entities, can be configured as a less solitary way of facing the school environment, besides enabling a rich institutional experience involving trainers – university professors – and experienced professors who receive undergraduates in the field of work.

As stated in Petrucci-Rosa (2018), the interdisciplinary experience is established mainly from two dimensions: the collective work and the pedagogical question. In the reports and scripts produced in the supervised internship experiences of the two universities, these dimensions become evident as we realize the importance of the partnerships that can be established between undergraduates and school players in the process of making and deciding on the proposed teaching processes. Considering these principles in the teaching training processes goes against what curriculum documents recommend, which assume interdisciplinarity as a trivial pedagogical practice and easily instituted in the context of the school (Goodson, & Rosa, 2018).

The undergraduates of R17, as they affirm "the stage of creating the interdisciplinary project showed us how studies are still needed to really understand interdisciplinarity", signal to us this complexity that is inherent in the disciplinary work, since one cannot forget the collective and pedagogical dimensions, as stated by Petrucci-Rosa (2018).

Interdisciplinary practices can be assumed as formative axes constituting teacher education in undergraduate courses, provided that all the deep complexity involved beyond the interactions across disciplines is considered, which demands that the precepts of collective work be given priority.

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