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The Physics Teacher Training Curriculum: an analysis of the public higher education intitutions in the State of Pernambuco [+*]

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Abstract

This article aims to examine the curriculum of physics teacher education in public higher education institutions in Pernambuco, Brazil, with a focus on the pedagogical projects of these institutions. A documentary study was conducted to explore the legislative framework governing physics education programs and review institutional documents from four federal higher education institutions in Pernambuco, that offer seven degree courses in physics. Thematic analysis was used as a methodology focusing on the analysis of curriculum organization and course syllabi, leading to the identification of seven distinct categories. The research findings reveal that the disciplines aimed at the professional interests of students often lack a comprehensive understanding of physics teaching. Additionally, there is limited integration between the core-specific disciplines and the pedagogical core. As strong points, the presence of courses designed to address learning gaps and the provision of a solid specialized education were identified. The study's main contribution lies in constructing a comprehensive overview of the difficulties experienced by students pursuing physics teacher education, which in turn enables the

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development of effective strategies to meet the needs of prospective teachers.

Keywords: *Initial Education of Physics Teachers; Curriculum; Thematic Analysis; Categories.*

I. Introduction

In the Brazilian teacher training research field, there is a considerable number of studies that point to the lack of basic education teachers in some specific areas as a factor that directly influences the quality of the offered teaching (Cruz, 2017; Vilela et al., 2020; Jesus; Araújo, 2021). Many authors claim that this lack of teachers is related to teaching training courses, which provide rigid training focused on training bachelors in physics, without articulation with the pedagogical domain, as well as to the discredit that the teaching profession carriers; these are factors that can influence the low quality of teaching (Cruz, 2017; Deconto; Cavalcanti; Ostermann, 2016).

Regarding the Physics Teacher Training Degree, the teacher training adequacy indicator (Brasil, 2021) shows that only 53% of acting Physics teachers have specific training. The Northeast region presents one of the worst performances in this scenario, followed by the Central-West region. Specifically, in the State of Pernambuco, 40% to 60% of its high school teachers have adequate training (Brasil, 2021). No research dealing with the training of physics teachers in Pernambuco has yet been identified. Therefore, the main objective of this research is to analyze the physics teacher training curricula of federal higher education institutions in Pernambuco based on their pedagogical projects. To this end, below we present the theoretical developments of this work.

II. Theoretical Framework

There is a set of historically produced difficulties in the initial training of physics teachers in Brazil. We present some excerpts from the legislation that directly impact it.

II.1 The Physics Teacher Training Curriculum

Curriculum is considered by many to be a list of subjects to be taken, which determines which grade the student is in (Sacristán, 2013; Tagliati, 2013). More narrowly, it is what constitutes the student's activity, the contents that make up their training, the organization of what they must learn, and in what order they must do it to be certified (Sacristán, 2013).

Three elements of the curriculum are associated with the teaching and learning process: the objectives, the activities developed, and the results. The curriculum aims to articulate "[...] the isolated episodes of actions, without which they would be disordered, isolated from each other or simply juxtaposed, causing fragmented learning" (Sacristán, 2013, p. 17). However, the curriculum is also shaped by the contexts in which the school's activities are inserted (Sacristán, 2013).

Thus, the curriculum is a social construction created based on the desired professional (meeting social demand), enabling quality reforms in education since the quality of teaching is related to what and how it is taught (Tagliati, 2013; Sacristán, 2013).

In higher education courses, the curriculum must provide knowledge of the training area and the tools to deal with different situations. In undergraduate courses, the future teacher must be exposed to training that encompasses the knowledge of the specific field, and pedagogical training and to relate these two areas with other areas of knowledge (Cruz, 2017).

According to Gatti (2014), when it comes to teacher training, higher education institutions still maintained a complementary format to the bachelor in Physics degree, with rigid and fragmented curricula, when their study was performed. Currently, although there is still some difficulty in articulation in some curricula, it is considered that there has been a lot of progress, mainly with the creation of disciplines with specific methodologies and integrative disciplines, which bring together the specific and the pedagogical content parts, to break with the strong disciplinary tradition (Brasil, 2019). In this way, it is understood that the curriculum performs a double function of separating and uniting: it separates the composing disciplines, and at the same time, it seeks unity of articulation between them (Sacristán, 2013).

The scenario described above seems to fit into Physics degree courses, where the teaching staff is mostly made up of physicists, specialists who do not promote integration with other areas of knowledge, often because they were not trained for this. It is necessary to go beyond this curriculum juxtaposed by disciplines, delving into the meaning of the choices that are made and what they are made for, even if, to do so, "[...] the result of certain traditions must be reviewed and modified" (Sacristán, 2013, p. 23), admitting that the curriculum also encompasses ethics, attitudes, and preparation for the world.

II.2 Physics Teacher Training: an overview of the disciplinary scenario, difficuties, and obstacles

Since the creation of Physics degree courses in Brazil, in 1939, following Decree nº 1190/39, the curricular matrix of the physics course has aimed to train bachelors in Physics and, with a complementary course in didactics in the last year of training, the licensee certification was obtained (Araújo, 2010).

Therefore, initial training is common to the Bachelor in Physics Degree and the Degree in Physics Teacher Training, the only difference being adding just one year of pedagogical subjects to prepare for teaching. These subjects made up the complementary didactics course (Brasil, 1939). The so-called "3+1" system is then constituted, which, quite clearly, separates specific training from pedagogical training (Araújo, 2010; Biasus, 2006; Santos, 2022), differentiating itself from the current format, which proposes certain articulation between specific and pedagogical contents, through the relationship between theory and practice, even though current guidelines are not detailed about how such articulation should occur (Brasil, 2024).

However, basic education was lacking of teachers in physics and other specific areas and, as a way of trying to solve the problem, short-term degrees were created (Brasil, 1971), requiring, to teach:

> *a) in primary education, from the 1st to the 4th grades, specific 2nd degree qualification;*
>
> *b) in primary education, from the 1st to the 8th grades, specific higher education qualification, at undergraduate level, represented by a 1st degree degree obtained in a* ***short course****; [...]*
>
> *§ 2 The teachers referred to in letter b* ***will be able to reach****, in the exercise of teaching, the 2nd grade of secondary education through* ***additional studies corresponding to at least one academic year*** (Brasil, 1971, emphasis added).

This was a way of minimizing the problem of the lack of teachers in certain areas, in this case, physics, and also brought other possibilities. The legislation established that they could still teach "[...] candidates qualified in sufficiency exams regulated by the Federal Education Council (CFE) and carried out in official higher education institutions indicated by the same Council" (Brasil, 1971, article 77), or even:

> *When the supply of licensed teachers is not sufficient to meet teaching needs, professionals who graduated in other higher-level courses may be registered with the Ministry of Education and Culture, by complementing their studies, in the same or related areas, where they include pedagogical training, observing the criteria established by the Federal Education Council* (Brasil, 1971, article 78).

This context provoked repulsion from the country's scientific communities, such as the Brazilian Physics Society (SBF) and the Brazilian Society for the Progress of Science (SBPC). Members of such scientific communities repudiated the permissiveness and placed on their agendas a position contrary to the decisions imposed by the CFE (Araújo, 2010).

In an attempt to overcome the problem, a Committee of Experts in Science Teaching (CEEC) was created, responsible for studying and proposing alternatives that would minimize the problem; unsuccessfully however, since the main issues that brought forth opposing positions were maintained (Araújo, 2010).

At that time there was little change in the scenario of teacher training in Brazil: concerning the curriculum, the "3+1" model, short degrees and the multipurpose teacher predominated (Araújo, 2010; Biasus, 2006). At the time, scientific activities focused on teaching were mostly neglected, while research in science teaching had a consolidated space, different from the current scenario, in which Research in Physics Teaching has gained more space (Ferreira; Silva Filho, 2021). The valorization of research in the specific part of physics and the devaluation of teaching and training of physics teachers caused a drop (which was no longer large) in the demand for degree courses (Araújo, 2010).

Given this scenario, the new National Education Guidelines and Bases Law (LDB) was approved in 1996, establishing standards ranging from educational principles, and the right to education to the organization and modalities of the educational system (Brasil, 1996). The LDB emphasized the need for specific training for teaching in basic education through article 62: "[...] the training of teachers to work in basic education will take place at a higher level, in a degree course, full undergraduate course, in universities and higher education institutes [...] (Brasil, 1996).

What seemed to be an achievement, brought forth conflicts regarding the permission given to higher education institutes to offer pedagogical training programs for holders of undergraduate diplomas, which were similar to the "3+1" model (Biasus, 2006). Given this scenario, the National Curricular Guidelines for the Training of Basic Education Teachers were established (Brasil, 2001a). There were many problems to be faced in its execution, such as "[...] the **inadequate preparation of teachers** whose training, in general, predominantly maintained a traditional format, **which does not include** many of the characteristics currently considered as inherent to **teaching activity**" (Brasil, 2001a, p. 4, emphasis added).

It was the first time that the quality of basic education teacher training was formally questioned with its own definition of a curriculum for the degree. According to the guidelines, the degree received:

> *[...] as determined by the new legislation, terminality and **completeness** in relation to the Bachelor in Physics Degree, **constituting itself as a specific project**. This **requires the definition of a specific curriculum for the Teacher Training degree that cannot be confused with the Bachelor in Physics degree** or with the old teacher training, characterized as the "3+1" model* (Brasil, 2001a, p. 6, emphasis added).

In the same year that the national curricular guidelines for the training of basic education teachers were promulgated, specific guidelines for undergraduate courses were established. These guidelines guide what should be expected from physicist educators, researchers, technologists, and interdisciplinary modalities, with a minimum of 2400 hours of training (Brasil, 2001b).

General curricular guidelines allow training institutions the autonomy to define their own guidelines, as long as there is a common core for the entire physics course modality (approximately half of the course's total workload) and another part made up of specialized modules, following the choice of one's professional training. This teaching scheme became known as the "2+2" model (Araújo, 2010).

Legally, the Physics Degree was subject to two documents: the National Curricular Guidelines for the Training of Basic Education Teachers, at higher level, degree course, full degree (CNE/CP 9/2001) and the National Curricular Guidelines for Physics Courses

(CNE/CES 1304/2001). The first offered the degree its own integrality; the second was still fragmented.

Another point that was highlighted with the promulgation of the National Curricular Guidelines for the Training of Basic Education Teachers was the importance given to the practice, removing its appendix character:

> *§ 1 - the practice, in the curricular matrix, cannot be reduced to an isolated space, which restricts it to the internship, disjointed from the rest of the course; § 3 - Within the areas or disciplines that constitute the curricular components of training, and not just in the pedagogical disciplines, all will have their practical dimension* (Brasil, 2001a, p. 67).

The guidelines establish an increase in the then minimum dedicated to practices from 300 hours to 400 hours, justifying that "[...] three hundred hours are just the minimum below which it is not possible to meet the quality requirements" (Brasil, 2001c, p. 10). Such a scenario was different from the then-current position. The new National Curricular Guidelines for Basic Education Teacher Training no longer reserve 400 hours allocated to practice as a curricular component. The document mentions that there must be practice components, but demands no minimum accounting, or how it should occur (Brasil, 2024).

The 2001 Curricular Guidelines for Basic Education Teacher Training (Brasil, 2001a) still advocated that the mandatory internship "[...] must be experienced throughout the entire training course and with sufficient time to address the different dimensions of professional performance [...] these 'periods at school' must be different according to the objectives of each moment of training" (Brasil, 2001a, p. 57-58), with a total duration of no less than 400 hours (Brasil, 2001c).

The internship is seen as the main teaching-learning environment (Silva; Gaspar, 2018), and should receive greater importance when presenting situations happening at the university and in the world of work. The internship provides an opportunity to teach and learn how to teach, strengthening the relationship between theory and practice (Brasil, 2001c), as much as allowing the teacher in training to realize that this profession goes far beyond knowing concepts.

The guidelines were criticized for only dealing with initial teacher training, requiring more comprehensive regulation. In this space appears Resolution 2/2015, which explains that initial training courses for teachers working in basic education at a higher level must include: a physics teacher training degree, pedagogical training for non-graduates, a second physics teacher training degree, and also courses for continued training, reaffirming that the degree must have its own identity (Brasil, 2015).

The most noticeable change brought about by Resolution 2/2015 was the increase in the minimum workload for undergraduate courses, which went from 2800 hours (Resolution CNE/CES 9/02) to 3200 hours, following the regulations, which established a minimum of 4 years to complete the degree (Leite et al., 2018). This way, there would be more time dedicated to the training of undergraduate students in aspects specific to teacher training.

Idealizing an integral and civic education, that could meet social demands, Resolution CNE/CES 07/2018, establishes that "at least 10% of the total curricular credits of undergraduate courses in extension activities should be reserved, oriented primarily towards the areas of great social relevance" (Brasil, 2018, p. 2). In this way, extension becomes mandatory, as part of the educational process, inseparable from research and teaching, with institutions having up to three years to implement what the Resolution recommends.

Also in the sense of integral education, a right for all, the Common National Base for the Initial Training of Basic Education Teachers (BNC-Formação) was established (Brasil, 2019). The document establishes a direct relationship between the general competencies provided for in the National Common Curricular Base (BNCC – Basic Education) and BNC-Training, as "[...] essential learning to be guaranteed to students, regarding the intellectual, physical, cultural, social and emotional aspects of their formation, with the perspective of the full development of people, aiming at Integral Education" (Brasil, 2019, p. 33).

To achieve the desired comprehensive education, undergraduate training is directed according to three fundamental dimensions: professional knowledge, professional practice, and professional engagement, which in a non-hierarchical way complement each other in teaching (Brasil, 2019).

Professional knowledge is the core of building teacher training skills. Without it, there are no ways for the students to mobilize themselves to act in different classroom situations and the best way to carry out the activities, which is built from professional practice (Brasil, 2019). BNC-Formação places professional practice as a mechanism for appropriating pedagogical content knowledge linked to the cognitive and socio-emotional processes indicated in the BNCC. The document indicates that teaching is the fusion between the objects of specific knowledge and teaching, which materializes in the teacher's professional engagement (Brasil, 2019).

BNC-Formação maintained the workload for initial training courses for Basic Education, at a higher level, at what was established by resolution 2/2015: a minimum of 3200 hours in the dimensions of professional knowledge, practice, and engagement. Other points were emphasized, such as the profile of the graduating student and what skills they need to have at the end of the degree, advising that degree courses are more focused on practice, with periods of experience in schools since the beginning of the degree (Brasil, 2019).

BNC-Formação is understood as a document that reinforces that the undergraduate must have active experience in the classroom in the first semesters of the course, not leaving this experience only for the mandatory internships. The document also expresses concern about the physical and mental health of the future teacher and the appreciation of the exercise of autonomy, resilience, ethics, and morals, among other elements, which were not included in previous documents.

In 2024 new curricular guidelines for Basic Education Teacher Training were approved (Brasil, 2024). Although they are not specific guidelines for physics teacher training, it is understood that there will be an impact on the training of this sort of professional. Resolution CNE/CP 04/2024 presents some important changes: i- the maintenance of the minimum of 3200 hours for undergraduate courses; ii- the absence of 400 hours of practice as a curricular component (PCC); iii- the absence of policies for valuing teaching professionals (mentions, but no expanations) and iv- the absence of socio-emotional skills[2].

The absence of the PCC raises the question of how the student will relate specific content and pedagogical knowledge about a given object. In other words: how is this content taught? Concerning the lack of appreciation for teachers, one might wonder: how can more young people develop an interest in the teaching profession if no discussion about better working conditions is undertaken?

To summarize, Table 1 shows the main information about the various models of Physics Teacher Training, what has been inserted or modified in the official documents in force at the time and currently, as well as the legislation that guarantees such a change.

Table 1 – Main changes in Physics Teacher Training Courses according to legislation.

Year	**Type of training/Inserted in training**	**Workload**	**Legislation**
1939	"3+1" model	Does not establish	-Decree 1190/39
1968	Short degree/ multipurpose teacher	1200h - 1500h	-Law 5540/68 -Law 5692/71 -Resolution 30/74
1996	"2+2" model: common core + specific core	2800h	-Lar 9394/96 -Opinion CNE/CES 1304/01 -Resolution CNE/CP 2/02 -Resolution CNE/CES 9/02
2015	Simultaneous theory and practice	3200h	-Resolution CNE/CP 2/15
2018	Extension curriculum	3200h	-Resolution CNE/CES 7/18
2019	Inseparability between theory and practice	3200h	-Opinion CNE/CP 22/19

[2] Socio-emotional skills are understood as the individual capabilities that are consistently manifested in patterns of thoughts, feelings and behaviors and can be developed throughout the ind8ividuals' lives (Brasil, 2019).

	from the first year		
2024	Absence of Practice as a Curricular Component	3200h	-Resolution CNE/CP 4/24

Source: Adapted from Araújo (2010)

Based on the National Curricular Guidelines for the Training of Basic Education Teachers (CNE/CP 9/2001) and the National Curricular Guidelines for Physics Courses (CNE/CES 1304/2001), points of divergence can be seen in the sense that specific guidelines differentiate the training of undergraduates and bachelors in Physics only "[...] based on the addition of 'pedagogical' subjects and internships" (Caldatto; Silva, 2019, p. 227), maintaining fragmented training.

The format became known as "baccalaureate + didactics" (Caldatto; Silva, 2019, p. 226). It was a configuration in which the undergraduate presented "[...] a background rich in content, but without understanding how to articulate it with pedagogical practices" (Massena; Monteiro, 2011, p. 1476).

Many criticisms began to emerge about this training common to the bachelor in Physics degree, being refuted with the justification that differentiated training was not necessary to be a good teacher, as what was essential was content knowledge. It is not a question of knowing what should be taught, but rather how the teaching will take place, because, for Massena and Monteiro (2011), it is to learn different ways of presenting the content that the degree exists.

In turn, the general guidelines for degrees reinforce the need to break with the "3+1, fragmented model, in favor of an articulated model" (Deconto; Cavalcanti; Ostermann, 2016, p. 210). The authors state that the two guidelines point in opposite directions. As one guideline defends the articulation and need for the identity formation of the Physics Teacher Training Degree, the other understands the degree with an identity very close to the baccalaureate degree.

Furthermore, the study conducted by Sampaio *et al.* (2002) on the situation of Basic Education teachers, through teacher training, indicates a shortage of teachers in the final stage of primary and secondary education. In the same sense, in 2007 a report studying possible actions that could overcome the lack of teachers in secondary education was released (Brasil, 2007), also identifying the lack of teachers, mainly in physics and chemistry.

Rabelo (2015), when evaluating the present and future supply of physics, chemistry, mathematics, and biology teachers in basic education in Brazil, identified that physics and mathematics are the subjects with the worst projections. For the author, "[...] in the cases of physics and mathematics, even in the most optimistic scenario, the supply in the last projection year, 2028, would not even be enough to maintain the current level of teachers in the classroom" (Rabelo, 2015, p. 108), as identified in the study by Jesus and Araújo (2022), which also showed the inefficiency of public policies.

An overview of Physics Degrees in Brazil can be seen from the research by Vizzotto (2021), which signals the demand for policies to encourage teacher training at the national level and by States, as, for the most part, the supply of physics teachers in training does not correspond to the need for qualified teachers in the area. Nascimento (2020) observed the same scenario, noting that "[...] only 9 thousand teachers who teach Physics have a degree in the area, which corresponds to just 20 percent of the total" (p. 2).

Additionally, Uibson, Araújo, and Vianna (2015) identified a "387% increase" (Uibson; Araújo; Vianna, 2015, p. 3) in the number of places offering Physics Degree courses, showing that, although teacher training has become an objective of public policies, efforts need to be even greater, as almost 37% of vacancies are still unfilled and "concerning other higher-level courses, dropout rates in Physics Degree courses are higher" (Uibson; Araújo; Vianna, 2015, p. 6).

Lack of preparation in teacher training also stands out, which appears recurrently in research and signals agreement among authors in this field (Deconto; Cavalcanti; Ostermann, 2016; Caldatto; Silva, 2019; Vilela et al, 2020). Research suggests that teacher unpreparedness may be a reflection of the lack of articulation between specific training and pedagogical disciplines, resulting in teachers who know a lot of content, but do not know how to teach (Deconto; Cavalcanti; Ostermann, 2016; Cruz, 2017).

For Massena and Monteiro (2011) and Santos (2022), the lack of articulation between the specific and pedagogical components meets a model of technical rationality that, in the educational field, more specifically in the curricular structure, separates the specific components from the pedagogical ones, placing the former in a condition of superiority to the latter (Deconto; Cavalcanti; Ostermann, 2016; Massena; Monteiro, 2011; Santos, 2022).

The devaluation associated with the teaching career, the lack of incentives given to teachers who work in basic education (financial and working conditions), and the difficult teaching journey may be associated with the low percentage of physics teachers who work at this level of education. The panorama described is worrying, as it is a course that does not fill all the vacancies offered and has a small number of undergraduates throughout its training history (Brasil, 2007; Deconto; Cavalcanti; Ostermann, 2016; Jesus; Araújo, 2021).

Another constant factor in Physics Teacher Training courses is the presence of a teaching staff made up of physicists, who are unlikely to undertake research in the field of education and teaching and

> *[...] often do not know the reality of basic education schools (since they normally do not have experience at this level of education), they know little about the official documents that guide basic and higher education and are unaware of the didactics specific to the subjects they teach* (Deconto; Cavalcanti; Ostermann, 2016, p. 204).

Thus, when considering that "how" to teach is as important as "what" to teach, it is emphasized that the pedagogical components are equally significant to those of specific training, avoiding mistaken discourses that declare that they teach the "hard" part of the curricular component, but not pedagogical one (Cavalcanti, 2021).

The Degree in Physics Teacher Training has a very characteristic higher education course profile, accompanied by a high dropout rate in the first semesters, the main reason being the difficulty that undergraduates present in the contents originating from high school and failure in basic cycle subjects, such as general physics and calculus (Vizzotto, 2021).

This profile represents, for the most part, a student with a learning deficit in many subjects. According to Cruz (2017), “[...] the majority of young people who opted for a degree and who, therefore, will be able to act as new basic school teachers, come from popular sectors or what is called the lower middle class” (p. 1176).

Therefore, a curriculum designed to minimize the students’ difficulties entering the Degree in Physics Teacher Training can help them remain on the course and work professionally as Basic Education teachers. Given this, aiming to analyze the training curriculum for physics teachers at federal public higher education institutions in the State of Pernambuco, the research methodology will be presented below.

III. Methodology

Considering that the objective of this study is to analyze the curriculum for physics teacher training at federal public higher education institutions in Pernambuco based on the pedagogical projects of these institutions, this research is characterized as a qualitative documentary study, whose characteristic is “[...] to take as a source of data collection only documents, written or not, which constitute what are called primary sources” (Marconi; Lakatos, 2017, p. 208). To achieve the objective, we analyzed the pedagogical projects for the courses (PPC) of the seven Degrees in Physics offered by federal public higher education institutions in the State.

The analysis of PPCs followed a Thematic Analysis approach, as proposed by Braun and Clarke (2006) and Clarke and Braun (2013), in the search for patterns and homogeneity in texts and documents. Initially, the Pedagogical Projects (PPC) were carefully read to familiarize us with the content. From this reading, the coding phase began, where excerpts that reflected recurring patterns and themes were identified. The categories emerged inductively, that is, they were developed directly from the data, without imposing pre-existing categories.

From reading the PPCs, seven main categories were identified: 1) Subjects aimed at filling learning gaps, 2) Teaching of specific Physics subjects and the approach to teaching, 3) Didactic-Pedagogical components, 4) Practice as Curricular Component, 5) Supervised Internship, 6) Elective Subjects and 7) Extension curriculum. Each of these categories was supported by multiple snippets of data that illustrated the corresponding theme, ensuring the robustness and validity of the categories.

Regarding institutions, aiming to present a general overview, it is worth highlighting that the Higher Education Institution (IES) “A”, the oldest, offers a Degree in Physics Teacher Training in two centers with different curricular structures. Their courses were named A1 and

A2. IESs “B” and “C” offer only one Physics Teacher Training degree course each, whose acronyms used for reference are B1 and C1, respectively. IES “D”, the newest institution, offers three Physics Teacher Training Degree courses in different units. Therefore, the encodings D1, D2, and D3 were used to represent the degrees at this institution. Therefore, the coding used was from the oldest IES to the newest. In total, there are seven Physics Degree courses offered by four IESs in the State of Pernambuco.

Concerning the seven categories raised and named the Physics Teacher Training Degree courses in Pernambuco, some excerpts from analyzed PPCs are presented. We believe these excerpts can help elucidate the characterization of the categories already mentioned.

Regarding learning gaps, the seven Physics Teacher Training Degree courses offer the possibility of reducing students’ difficulties in Basic Education content as many students come from public schools and have a learning deficit mainly in mathematics and physics. In this way, “[...] recognizing training gaps in secondary education that are still present in them” (A1) is a good example of what was found in the analyzed PPCs.

Table 2 – Number of Physics Teacher Training degree courses offered by the federal educational institutions investigated.

Institution	A	B	C	D
Number of Physics Teacher Training Degree courses offered	2	1	1	3
Coding	A1 e A2	B1	C1	D1, D2 e D3

Source: Authors’ own (2023).

Regarding the teaching of specific physics subjects and the teaching approach, we considered it pertinent to verify whether the Degrees in this study make such an approach and in which subjects. The section “[...] didactic interventions in the field of Mechanics” (C1) points out that there is an approach, but the type of intervention is not mentioned. The excerpt is one of the few that shows a close relationship between teaching – here understood as didactic intervention – and pure physics. The other approximations are made in the specific subjects of physics teaching.

The didactic-pedagogical components represent a core of teacher training, with the cores of general training, practice as a curricular component (PCC), and supervised internship, and are therefore characterized as categories. Below are excerpts representing each of the groups, in the mentioned order.

“*[...] the teaching-learning process, planning of pedagogical practices; objectives, contents, procedures, resources and evaluation of the teaching-learning process” (B1).*

"*[...] the space (of the PCC) should be used for the active participation of the student, through discussions, presentations of topics related to the content, text production or activity that stimulates the critical spirit, resourcefulness, self-confidence and mastery of tools" (B1).*

"*[...] moment of professional training, either through direct exercise on-site, or through a participatory presence in educational environments, under the responsibility of an already qualified professional and the supervision of the training institution [...]" (A2).*

The category related to elective subjects emerged from the identification of a few subjects focused on teaching physics. Regarding the definition of an isolated discipline, it is presented that it is intended for "[...] deepening studies, when the student, among a list of disciplines offered by the different Departments of the Institution, needs to choose to take four elective disciplines to complete the course" (B1). The excerpt makes the objective of the elective subjects clear, but the availability of the offer makes it impossible for the undergraduate to delve deeper into teaching in their training.

The last category emerged due to the absence of extension as a curricular component in almost all documents analyzed, in disagreement with the Guidelines for Extension in Brazilian Higher Education (Brasil, 2018).

After characterizing the categories, some information on the Physics Degree courses in Pernambuco is presented, through a numerical overview.

IV. Pernambuco's Physics Teacher Training Degrees in numbers

Below, we present information about the operation of Physics Teacher Training Degree courses in the State of Pernambuco.

Table 4 – Data from Pernambuco's Physics Teacher Training degrees.

Course	**Start Year**	**Duration in semesters**	**Number of vacancies offered per year**	**Offered shift**	**Total workload in hours**	**Year of last PPC redesign**
A1	1968	8 (14 max.)	30 (1 entry)	Evening	2895	2015
A2	2009	9 (14 max.)	80 (2 entries)	Evening	3180	2011
B1	1989	10 (18 max.)	80 (2 entries)	Afternoon Evening	2895 2865	2015
C1	2010	8	40	Evening	3210,5	2019

		(16 max.)	(1 entry)			
D1	2006	8 (16 max.)	60 (2 entries)	Afternoon Evening	3210	2019
D2	2015	8 (16 max.)	60 (2 entries)	Morning Afternoon Evening	3090	2015
D3	2017	9 (17 max.)	70 (2 entries)	Morning Evening	3300	2022

Source: Authors' own (2023).

The Pedagogical Projects (PPC) A1, A2, B1, and D2 have not been redesigned recently (the redesigned document is unavailable online). Out of these, A1 and B1, the oldest, have a workload considerably below the 3200 hours established by Resolution 2/2015 and maintained by Opinion 22/2019.

The B1 presents a 30-hour difference in workload between the shifts offered (Table 3). This is due to the physical education subject, mandatory for the afternoon course, and there is no such component in the evening course. For everything else, the formative curricular organization is the same. C1, D1, and D3 have a workload slightly above the minimum established by Resolution 2/2015 and Opinion 22/2019. D1, D2, and D3, although offering their courses in different shifts, do not individually differ in the formative curricular organization.

From Table 3, it can be seen that four of the seven Physics Teacher Training Degrees do not meet Resolution 02/2015 (Brasil, 2015) regarding workload. Of these four Degrees, three stated that they were in the process of reformulating their PPCs, to adapt to the workload and other demands, and the fourth did not provide any feedback.

The results found are presented and discussed below.

V. Presentention and discussion of the findings

Based on the study of the main document that governs undergraduate courses – the PPCs – we present the findings of the analysis below, divided into the seven categories that emerged from the research.

V.1 Subjects aimed at filling learning gaps

A1 and D1 offer specific training courses in the first semester, to review high school contents. Their objectives point to the need for undergraduate students to identify gaps in their training. The A2 Physics Degree offers five curricular components in the first semester aiming to address learning gaps. In the syllabi of these components, the terms "elementary" and "basic" are widely used, although the bibliography is not compatible with the proposal.

All but B1 offer subjects to fill the gaps left by high school mathematics, but not all of them do so for the subject in which the student will graduate: physics. C1, D2 and D3 do not offer any discipline with this purpose, compromising learning in subsequent studies.

The analysis of PPCs regarding the problem of learning gaps for physics undergraduates was highlighted in studies by Cruz (2017), Corrêa and Leonel (2021), and Vizzotto (2021). The authors point out that most of the students who enter teacher training courses often have insufficient basic training, and professors rarely consider this deficit as a starting point. This was already acknowledged as a challenge in the general guidelines for Basic Education Teacher Training (Brasil, 2001a).

According to the general guidelines "[...] it is necessary that preparation courses for future teachers take upon themselves the responsibility **of making up for any deficiencies in the basic education they carry from both primary and secondary education**" (Brasil, 2001a, p. 20, emphasis added). Therefore, courses C1, D2, and D3 do not provide conditions for every student to fill their learning gaps. Although B1 does not offer any subject for this purpose, there are mini-courses on the notions of basic physics for those who have seen very little of this curricular component, providing students with the conditions to make up for deficiencies in learning high school Physics, as discussed by Cruz (2017) and endorsed by Corrêa and Leonel (2021) and Vizzotto (2021).

For the authors, subjects aimed at filling learning gaps can help reduce retention rates, for coming from public schools, students tend to have high retention rates in the course due to the number of pre-requisits this degree presents.

V.1.1 Pre-requisits

In the case of A1, if the student presents difficulties in physics and mathematics and fails the leveling curricular components, they will not be able to enroll in four of the six subjects offered in the second semester: Calculus 1, Linear Algebra 1, Practice in General Physics 1, and Physics Laboratory I, which is a co-requisite of Calculus 1. A very similar scenario was identified in A2 and B1.

Corrêa and Leonel (2021) and Vizzotto (2021) clarify that curricula with this relationship between subjects make it difficult for students to persist, as they tend to remain idle and consequently lose interest in continuing, believing that they are not capable, arriving to consider the possibility of abandoning the semester, the course or the system, corroborating the findings of studies by Gomes *et al.* (2019) and Lima Júnior (2013).

This compromise of certain subjects due to prerequisites and learning gaps shows convergence between the studies by authors Corrêa and Leonel (2021), Gomes et al. (2019) and Lima Júnior (2013), in the sense that they are some of the explanations for the lack of physics teachers working in Basic Education. Therefore, a curriculum that meets this demand is essential, not just a juxtaposition of subjects (Felício e Silva, 2017; Sacristán, 2013).

V.2 The teaching of specific physics subjects and the approach to teaching

When analyzing Pernambuco's Physics Teacher Training curricula, we can see a homogeneous distribution of specific physics subjects throughout the entire course in B1, D1, and D3. In this study, a specific discipline is considered to make up the core of physical training or hard core, such as Mechanics and Electromagnetism. This way, students are in contact with specific training content throughout the course, without overload.

In A1, A2, C1, and D2, the first two years of the degree have a small number of specific physics subjects. In such degrees there is an overload exactly when the in-depth subjects are being offered, requiring the undergraduate to engage in more study periods.

Few are the curricular components that include teaching in specific physics training, in line with the findings of Santos (2022), when he states that "[...] in the spaces where physics is learned, teaching is rarely learned" (p. 199). Table 4 presents the number of specific physics subjects and the number of subjects that bring teaching closer to its contents, presenting the undergraduate student with a general view of teaching.

Table 4 – Number of specific physics subjects that approach teaching.

Physics Teacher Training Degree	**A1**	**A2**	**B1**	**C1**	**D1**	**D2**	**D3**
Number of specific physics subjects	19	15	16	24	20	22	20
Number of subjects that include teaching in the specific part of physics	6	4	2	7	3	5	5

Source: Authors' own (2023).

The subjects that establish the rapprochement between specific physics training and pedagogical components (Table 4) are those that deal with physics teaching methodologies, instrumentation for teaching, or laboratory of teaching practice. Even in these disciplines where pedagogical actions are required, the articulation between the physics contents and the didactic and methodological ones is little noticed, a characteristic also highlighted in the discussion by Santos (2022) and Tagliati (2013).

The Physics degree courses that most closely approximate teaching are the A1 and C1 courses, with 31.6% and 29.2% of their specific physics subjects approaching physics teaching, respectively. Courses A2, D3, and D2 follow with percentages of 26.7%, 25%, and 22.7%, respectively. D1 and B1 make the least connection between the specific and pedagogical parts: 15% and 12.5%, respectively.

As already mentioned, this approach occurs in subjects related to specific methodologies and practices for teaching, with no such approach being found in subjects such as Mechanics, Electromagnetism, General Physics, or Experimental Physics. Santos (2022) and Tagliati (2013) infer that physics courses carry a belief that certain curricular components must be part of the hard core, so there is no feasibility of approaching teaching, in line with the findings of this research.

In view of this, our findings ar in agreement with Santos (2022), when stating that Physics Teacher Training degree courses are permeated with technical rationality when separating specific disciplines from the pedagogical ones of Education, such as Didactics and Fundamentals of Education, for example, maintaining the "[...] perpetuation of the dichotomies that we want to overcome in teacher training" (Deconto, Cavalcanti and Ostermann, 2016, p. 203).

It is believed that it is essential to bring the specific disciplines of physics closer to the pedagogical ones so that the specific contents are also studied from their pedagogical perspectives, breaking with "a training focused on the transmission of knowledge, in which the incorporation of pedagogical and of professional practices, even if in the initial part of them, are seen as a factor in training weakening" (Vilela et al, 2020, p. 266).

The results show a gap in the integration between the specific Physics disciplines and the pedagogical ones, which bring teaching closer together. This problem aligns with what Gatti (2014) describes as complementary training to the baccalaureate degree, as curricula remain poorly articulated and fragmented. The little articulation between these two curricular cores is an obstacle to teacher training, as it does not allow future teachers to develop an integrated understanding of the content and teaching methodologies.

V.3 Didactic-pedagogical components

The workload dedicated to the didactic-pedagogical core in the Physics Degree courses in the State of Pernambuco whose curricula were investigated varied between 750 hours and 1026 hours, already including Practice as a Curricular Component (PCC). The highest workload was identified in C1 and the lowest in A1.

In the case of A1, the lower workload dedicated to didactic-pedagogical components may be associated with the traditionalism that the course carries by offering only the mandatory subjects of this core and the minimum established by legislation for the PCC, which are 400 hours distributed throughout the course (Brasil, 2001c).

It is in this core of knowledge that the theories underlying teaching and learning, the structure and functioning of basic schools, teaching methodologies, and evaluation of educational processes are presented. According to Santos (2022) and Deconto, Cavalcanti, and Ostermann (2016), it is through these disciplines that undergraduates get closer to teaching, being subjected to an articulated teaching model that is closer to the scenarios they will encounter in their professional lives.

Still within the didactic-pedagogical core, Scientific Methodology or Research

Methodology was identified in almost all courses (except A1). It was found that the courses that offered this component had the profile of training teachers to work in Basic Education and researchers capable of developing their investigations in the teaching of physics or in the area of Education, as discussed by Ferreira and Silva Filho (2021).

V.4 Practice as a Curricular Component (PCC)

Through Practice as a Curricular Component (PCC), undergraduates are closer to teaching subjects at the beginning of their training. Brazilian official documents (Brasil, 2015; Brasil, 2024), by establishing 400 hours of PPC, compelled undergraduate courses to create subjects that met this demand.

Even with the establishment of a minimum workload dedicated to PCC, there is evidence that undergraduate courses generally do not prioritize training for teaching. It was observed that the subjects who reserve part of their workload for PCC do so without minutiating how it should be applied in the classroom experience. In "[...] general terms, it is just an arithmetic adjustment in which the division of the workload only seeks to comply with the determinations of the guidelines and resolutions", as argued by Vilela et al (2020, p. 275).

It was possible to identify the creation of subjects that met PCC: physics teaching methodologies and physics teaching laboratory practices, in this study. Due to the high workload, more than one subject of Physics Teaching Methodology was created (1 and 2, for example) and the same happened with laboratory practices. Most investigated courses created such subjects, except B1.

The only Physics Teacher Training Degree that divided the 400 hours of PCC between existing subjects was B1, dividing this workload into several curricular components, whether specific components of physics or Education. However, the syllabi do not elucidate the type of activity to be performed as a PCC or the criteria for fractionation. The courses' syllabi contain information that it is a 60-hour course, with 45 hours of theory and 15 hours of PCC, for example.

Santos (2022) points out that this possibility of flexibility – creating new subjects or dividing the workload between existing ones – ends up masking the activities that are developed at PCC: the workload is offered, but the type of activity to be carried out is not specified.

PCC is seen as "[...] a way to guarantee the articulation between the theoretical and practical dimensions of teacher training" (Brasil, 2015, p. 11). Caldatto e Silva (2019), Felício e Silva (2017), and Tagliati (2013) discuss in their works the identity of the degree, which is constructed from the beginning of training, based on the prescription of the document, ensuring more contact with disciplines focused on teaching from the beginning of the course. In the new guidelines for teacher training (Brasil, 2024) there is no mention of the PCC and, therefore, there is no guarantee that the student will still have contact with teaching beyond the internships, compromising the inseparability between theory and practice of BNC-Formação (Brasil, 2019).

V.5 Supervised Internship

Along with PCC, internships direct the student to do and act as a teacher according to Cruz (2017) and Silva and Gaspar (2018), through a minimum of 400 hours, generally distributed across four disciplines for the analyzed courses, except D2 which does so in three curricular components. As it is an activity where one learns to be a teacher, it is believed that it is necessary to know specific basic contents of physics and the area of Education, although no specific physics discipline has such indication for internships in any of the courses analyzed.

For degrees A1, A2 and B1, prerequisites for supervised internships are the subjects of Physics Teaching Methodology, Didactics, Organization and Operation of Basic Schools, and Learning Assessment. For the other courses, there are no prerequisites, signaling concern regarding the lack of obligation regarding what must be seen beforehand, before entering the classroom. As it is an experience to be developed in the future teacher's working environment, Silva and Gaspar (2018) defend the need for preparation to experience the discipline, as the internship allows the approach of different dimensions of professional activity (Brasil, 2001a).

Santos (2022) emphasizes that the student, when inserted into classrooms during internships without due preparation, is not capable of reflecting on teaching action, as they have not yet constructed their theoretical framework. By not going through discussions that promote their academic maturity in mandatory subjects that precede the internship, the student may still have a reductionist and immediate vision of Basic Education.

In general, the working environments for physics undergraduates in supervised internships are the 9th year of elementary school (EF) and the three grades of high school (EM). Below, we provide information about such environments.

Table 5 – Operating environment for supervised undergraduate internships.

Physics Teacher Training Degree	**A1**	**A2**	**B1**	**C1**	**D1**	**D2**	**D3**
Internship 1	Observation management activities	EF Observation + teaching	EF and EM Observation + teaching	EF and 1st EM Observation + teaching	1st EM Observation + teaching	EF Observation + teaching	EF Observation + teaching
Internship 2	Observation Nonspecific grade	EM Observation + teaching	EJA and EP	2nd EM Observation + teaching	2rd EM Observation + teaching	1st EM Observation + teaching	1st EM Observation + teaching
Internship 3	EF and 1st EM	Observation management	EAD e ENF	3rd EM Observation	3rd EM Observation	2nd or 3rd EM	2nd EM Observation

	Observation + Teaching	activities		+ teaching	+ teaching	Observation + teaching	+ teaching
Internship 4	2nd and 3rd EM Observation + Teaching	ENF	At the discretion of the student	At the discretion of the professor	Conducting at the student's discretion	None	3º EM Observation + teaching

Caption: EF - Elementary Education; EM - High School; EP - Vocational Education; EJA – Youth and Adult Education; EAD - Distance Education; ENF - Non-Formal Spaces of Education.

Source: Authors' own (2023).

Few courses go beyond traditional classrooms, placing the undergraduate in other spaces such as museums and scientific dissemination units. It is still an experience focused on EF (9th year) and EM, with minimal inclusion of youth and adult education in internship environments (Table 5), in line with the study by Silva and Gaspar (2018).

The authors point out that supervised internships provide opportunities for experiences specific to the exercise of teaching, being, therefore, the main teaching-learning environment, though they should not be the only ones. Felício and Silva (2017) and Santos (2022) state that internships, together with PCC, enable the integration of theoretical concepts and practical activities, presenting the undergraduate with the environment of their professional performance, also covering situations that deal with human and social conditions. It is understood, then, that it is in the context of the internship "that the curriculum finds elements to be deepened in the learning process so that it becomes increasingly relevant" (Felício; Silva, 2017, p. 159).

Understanding that the teaching activity goes beyond the task of teaching, the activities proposed in the syllabi of the supervised internship subjects were sought. The main activities listed are presented in Table 6.

Table 6 – Main activities identified in the supervised internship subjects.

Activities	**Physics Teacher Training Course**	**Activities**	**Physics Teacher Training Course**
Observation of teaching activities in basic education classes	A1, A2, B1, C1, D1, D2, D3	**Investigation of school organization and management**	A1, A2, B1, C1
Teaching	A1, A2, B1, C1, D1, D2, D3	**Observation of processes for organizing non-school**	A2, B1

		spaces for scientific dissemination	
Planning teaching activities	A1, A2, B1, C1	**Development of an intervention project**	A1, A2
Preparation of lesson plans	A1, A2, C1, D3	**Participation in meetings held by the school**	A2, C1

Source: Authors' own (2023).

It can be seen that only observation and teaching activities are common to all courses whose curricula were analyzed (Table 6), with observation of teaching activities being present in stages 1 and 2 and conducting classes in stages 3 and 4. In the first two stages, school organization and management are also observed, while in the last two (before teaching) activities, lesson plans, and, in some cases, intervention projects are planned. Activities related to out-of-school spaces and participation in meetings in general are allocated in the final stages.

C1 is the course most concerned with training undergraduates for the majority of situations that can be experienced in the classroom, covering three-quarters of the listed activities (Table 6).

In addition to the activities listed in Table 6, in the theoretical workload of the internship, the C1 degree promotes the verification of how physics is taught in official national documents, guides the analysis of the textbook adopted by the institution that receives the undergraduate intern, promotes seminars to monitor observations and conduct classes and analyze assessment methods. Therefore, this degree stands out positively, as the supervised internship is the main space where one learns to be a teacher (Santos, 2022; Silva and Gaspar, 2018).

Research literature suggests that the teaching profession goes beyond specific training, the act of teaching or learning to teach a subject, permeating human and social conditions (Cruz, 2017; Santos, 2022; Silva and Gaspar, 2018). In this way, the D1, D2, and D3, as they do not develop activities other than observing and conducting classes, are unable to adequately prepare their students to manage the various situations that appear in the daily life of the teaching profession, therefore standing out negatively.

V.6 Elective Subjects

Curricular components are within the list of subjects approved by the course board, among which the student can choose freely, are considered elective (Santos, 2022; Tagliati, 2013). The elective components are not on the list of subjects offered by the course but, because they are offered by the institution, they can be taken to account for the workload, as long as they are approved by the course coordination. Such curricular components meet professional objectives in a specific area, shaping the undergraduate's training according to their interests.

We identified many subjects that undergraduate students can choose to supplement their course load. However, among these subjects, a very small percentage corresponds to subjects focused on teaching physics itself, a characteristic also pointed out by Santos (2022) and Vilela et al. (2020).

In A1, the course's pedagogical project (PPC) contains 40 elective subjects. Of these, 13 are classified as pedagogical components and the others are in the fields of physics, chemistry, mathematics, and computing. Among these 27 subjects, the majority are in fact physics, but only two are focused on physics teaching, corresponding to just 5% of the total electives offered.

Except for B1, which does not provide a set of elective subjects, allowing the undergraduate to choose any elective subject that they are able to take within the institution, the same analysis was carried out for the other degree courses and the information is presented in Table 7.

Table 7 – Percentage of elective subjects focused on physics teaching.

Physics Teacher Training Degree	**A1**	**A2**	**B1**	**C1**	**D1**	**D2**	**D3**
Number of elective subjects listed	40	17	-	12	23	47	15
Elctive subjects main fields	CP, F, Q M, C	CP, F	-	L, F	CP, F, M	CP, F, Q M, C, L	CP, F, M
Number of elective subjects aimed at physics teaching	2	1	-	1	2	2	0
% of elective subjects focused on physics teaching	5%	5,9%	-	8,3%	8,7%	4,3%	0

Caption: CP - pedagogical knowledge; F - physics; Q - chemistry; M - mathematics; C - computing; L - languages.

Source: Authors' own (2023).

None of the undergraduate courses in this study offer at least 10% of their elective subjects focused on teaching physics (Table 7). The situation indicates that these are courses that do not allow the students to delve deeper, on their own initiative, into techniques and methodologies for teaching physics and also research in physics teaching. The percentages presented in Table 7 are insufficient if the physics teacher in training wants to delve deeper into the specific area of teaching (Deconto, Cavalcanti and Ostermann, 2016; Santos, 2022; Vilela et al., 2020).

In institutions that also offer a Bachelor in Physics degree in Physics, it was noticed that the specific elective subjects of the Degree in Physics Teacher Training are massively curricular components of the Bachelor in Physics degree, even with the same subject syllabus. Santos (2022) points out that specific physics training is prevalent in many courses, which follows the findings of Physics Teacher Training Degrees in the State of Pernambuco. This characteristic points to a direction contrary to what the general guidelines for the training of Basic Education teachers (Brasil, 2001a) recommend, in terms of having an identity specific to the degree with a clear difference to the bachelor in Physics degree in Physics.

It is worrying that physics teacher training courses offer a very small number (if available) of subjects aimed at teaching physics. For Vilela et al. (2020), the scenario demonstrates "[...] lack of appreciation and concern for the training of Physics teachers" (p. 269), who must have the option to choose according to their interests. The power of choice must be ensured and not the obligation to take an unwanted component just because it is needed to complete the course.

V.7 Extension Curricularization

Extension is an academic activity that needs to be linked to teaching and research, whose function is to meet the demands of the community. It is also through it that citizenship education is provided so that professionals can act for and with society (Brasil, 2018). Therefore, it must be included in the curriculum of higher education courses.

To meet this demand, Resolution CNE/CES 07/2018 (Brasil, 2018) determines that no more subjects be created with extra hours; rather, at least 10% of the course workload should be executed in extension activities. Curricularization can be inserted into the course matrix through the creation of an extension-specific curricular subject or the distribution of hours of extension activities in non-extension-specific curricular components (Brasil, 2018).

As it is placed in the PPCs of the Physics Teacher Training Degree courses whose curricula were analyzed, there is almost no curricularization of extension since there is no observation of the incorporation or integration of extension activities into the curriculum of such courses. In most PPCs, it was observed that the extension is included in the "Complementary Activities" (AC) together with monitoring, teaching initiation scholarships, and participation in events, totaling a workload of close to 210 hours.

Given what was analyzed, D3 is the only one that offers a subject focused on extension: "Fundamentals of extension", with a workload of 30 hours, offered in the first semester of the course. The remaining hours that must be dedicated to extension are distributed almost entirely in the subjects of Physics Teaching Practice 1, 2, 3, and 4, with a workload of 60 hours in each component. The remainder of the course load is offered in other curricular components such as psychology, didactics, and other subjects in the pedagogical core.

C1 complies with Resolution 7/2018 by guaranteeing 10% of its workload to extension in a fractional way, between the curricular components of Laboratory and Physics Teaching Practice 1 to 6, with 54 hours in each of the subjects. The other courses do not mention the curricularization of the extension, treating it as AC only.

VI. Final Thoughts

We identified that subjects aimed at filling learning gaps are fundamental so that physics teacher training undergraduates can prepare for basic and in-depth studies, minimizing failures and retentions in the course.

Furthermore, the rapprochement between the specific contents of physics and the pedagogical components is still discreet, occurring almost exclusively through the subjects of methodology and practice of physics teaching, with the desired rapprochement not occurring with "hard" subjects such as thermodynamics and electromagnetism, for example. In supervised internships, the main activities carried out are still observing and conducting classes in regular basic education schools. Few courses use activities that can prepare the teacher in training for teaching, which is understood to go beyond teaching classes.

Elective subjects aimed at professional interests do not include the teaching of physics, even though it is a course aimed at training for teaching. No Physics Teacher Training degree course whose curricula were investigated offers more than two elective subjects aimed at physics teaching, and there are courses in which no subject with this profile is offered. Therefore, it is clear that it is not possible to delve deeper into physics teaching based on what Pernambuco's physics teacher training courses offer.

Regarding the curricularization of extension, only two undergraduate courses respect the Resolution that establishes the inclusion of extension as a curricular activity, present in the institutional document, along with teaching and research, meeting societal demands.

The main characteristic of teacher training identified is the concern with solid specific training, based on subjects offered on a mandatory and complementary basis. Positively, the existence of subjects aimed at filling learning gaps or other mechanisms aimed at the same purpose stands out, demonstrating concern for future learning, in most courses.

Regarding the challenges faced by physics teachers in training, there is a gap between specific physics disciplines and pedagogical disciplines, therefore lacking articulation between these two areas, as well as the lack of curricular components for in-depth teaching of physics, to meet the professional interests of the student.

There was a rapprochement with the literature regarding the identification of fragmented curricula with juxtaposition of subjects, reinforcing that there is little articulation between the specific components of physics and the pedagogical ones, with an emphasis on the former. However, as no studies on the training of physics teachers in Pernambuco have been identified, from a curricular perspective, this study contributes to fields beyond physics teaching, such as the exact sciences, in which there is a shortage of teachers able to work in basic education.

As practical implications, these findings provide a diagnosis of the curricular structure of Physics Teacher Training Degree courses, covering the difficulties experienced by undergraduate students. Teachers and course coordinators can use such findings to devise strategies that meet the needs of undergraduates, who are future teachers.

As for the limitations of this research, we point out the number of Physics Teacher Training degree courses analyzed, a sample unfit for generalization and, as for the methodological limitations, we emphasize the outdated documents available online. For future study perspectives, we recommended focusing on other aspects of the Physics Teacher Training Degree course and studies in other States for greater coverage and more solid indications to extend the findings.

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