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The National Education Plan (2014-2024) and the valorization of Physics teaching

O Plano Nacional de Educação (2014-2024) e a valorização da docência em Física

El Plan Nacional de Educación (2014-2024) y la valorización de la enseñanza en Física

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Abstract: Brazil, despite being one of the largest economies globally, experiences significant social inequalities, ranks poorly on the Human Development Index, and lacks a welfare state. The National Education Plan serves as an essential framework for tackling these challenges, with the objective of defining the National Education System and setting forth goals and strategies to improve education across all levels. This analysis examines goals 15 and 16, which pertain to the valorization of education professionals, particularly in the context of training Physics teachers. This analysis examines the primary aspects of both goals, indicating that they remain significantly unachieved. The quality of training and initial teacher education is crucial when establishing educational goals.
Keywords*:* National Education Plan; Physics Teaching; Educational Goals; Basic Education Census.

Resumo: O Brasil, embora possua uma das maiores economias globais, enfrenta consideráveis desigualdades sociais, ocupa uma baixa posição no Índice de Desenvolvimento Humano e carece de um Estado de bem-estar social. O Plano Nacional de Educação é uma ferramenta crucial para abordar essas questões, visando articular o Sistema Nacional de Educação e estabelecer metas e estratégias para aprimorar o ensino em todos os níveis. A análise concentra-se nas metas 15 e 16, que abordam a valorização dos profissionais da educação, com ênfase na formação de professores de Física. Analisamos os principais aspectos de ambas as metas, evidenciando que estão distantes de sua realização. Ressaltamos a importância de levar em conta a qualidade da formação e a formação inicial dos docentes ao estabelecer metas educacionais.

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Palavras-chave*:* Plano Nacional de Educação; Ensino de Física; Metas Educacionais; Censo da Educação Básica.

Resumen: Aunque cuenta con una de las economías más importantes a nivel mundial, Brasil se ve confrontado con significativas disparidades socioeconómicas, una posición baja en el ranking del Índice de Desarrollo Humano y la ausencia de un sistema de protección social. El Plan Nacional de Educación resulta fundamental para enfrentar dichos asuntos. El propósito es coordinar el Sistema Nacional de Educación y establecer metas y tácticas para potenciar la educación en todas sus etapas. El análisis se enfoca en el cumplimiento de los objetivos 15 y 16 referentes a la evaluación de los docentes, con especial atención en la formación de profesores de Física. Abordamos elementos fundamentales de ambas metas, evidenciando que todavía se encuentran distantes de lograrse. Es fundamental tener en cuenta la calidad y la preparación inicial de los maestros al establecer los objetivos educativos.
Palabras clave: Plan Nacional de Educación; Enseñanza de la Física; Metas Educativas; Censo de Educación Básica.

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Introduction

No historical example exists of a country that has successfully evolved and sought power without first making systematic and extensive investments in education, research and technology, followed by industrial growth. Science and technology are fundamental to industry and progress. Education is crucial for social advancement, necessitating appropriate employment and equitable income distribution (Amaral, 2023).

Despite being a developing country with one of the twelve highest Gross Domestic Products (GDP) globally, our Human Development Index (HDI) ranks near the 87th position, highlighting significant inequality. Historically, Brazil has not established a welfare state and has been influenced by lobbyists advocating for a reduction in the perceived *Brazilian cost*. To address socioeconomic inequalities, Brazilian society must prioritize the implementation of a governmental strategy via the National Education Plan (PNE). The PNE is a ten-year plan designed to articulate the National Education System within a collaborative framework. It establishes guidelines, objectives, goals, and implementation strategies to maintain and develop education across all levels, stages, and modalities through integrated actions by public authorities across various federal spheres (Brasil, 2009). A historical battle of educational movements, the creation of a National Education System is viewed as "a mechanism that articulates the collaborative regime within the federal pact, which advocates national unity while respecting the autonomy of federated entities." Conceived from the defense of public, free, secular, democratic, inclusive, and high-quality education for all, it seeks to eliminate

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disparities and recognize diversity in the defense of educational excellence as a social right. The inclusion of a national subsystem for the training and evaluation of teaching professionals in the nation's National Education System is acknowledged to be crucial.

To address the critical issues in Brazilian education regarding access, retention, quality, inclusion, and social diversity, it is essential to utilize the PNE as a framework for formulating state policies. In this context, it is essential to ensure concrete tools that facilitate systematic monitoring and evaluation of the attainment of its objectives (Educação & Sociedade - Editorial, 2010). This work will examine Goals 15 and 16 of the PNE (2014-2024), focusing on the evaluation of education professionals and emphasizing teacher training in Physics. The objectives are considered strategic for achieving the fundamental goals of ensuring the right to high-quality basic education, alongside those related to valuing diversity and reducing inequality (Brasil, 2014). Below we reproduce these two goals, for clarity:

> Goal 15: Establish a national policy for the training of education professionals as outlined in subsections I, II, and III of the main body of Article 61 of Law No. 9.394, of December 20, 1996, within one (1) year of this PNE's validity. This policy should be implemented in a collaborative regime between the Union, the States, the Federal District, and the Municipalities. It should guarantee that all basic education teachers have specific higher education training, acquired in undergraduate courses in the field of knowledge in which they work.
> Goal 16: By the final year of this PNE's validity, 50% (fifty percent) of basic education teachers will have received postgraduate training. Additionally, all basic education professionals should have ongoing training in their field of expertise, taking into account the needs, demands, and contexts of the educational systems.

Since Physics is one of the subjects most impacted by the *urgent need for teachers with the right training*, we defend our focus on it by asking "how many teachers with the right training are needed to replace those teaching the subject without the right training in 2022?" (Bof; Caseiro; Mundim, 2023).

Background of the PNE's Development and Approval (2014–2024)

When the PNE 2011/2020 was being developed in 2009 to replace the previous one (PNE, 2001-2010), it was intended to follow a different logic than the conventional one, working from the bottom up instead of the top down. The general public must express their expectations about the issues and difficulties that will arise with regard to public policies for education during the ensuing decade. In a democratic process that emphasized the expectations of the Brazilian society to be addressed by the future PNE, a sizable number of

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people diligently and enthusiastically participated in municipal, state, and Federal District conferences (Bodião, 2016).

Guidelines and action plans for the development of a new PNE as a state policy were discussed and suggested at the 2010 National Conference on Education (CONAE). Increasing public spending on education to 7% of GDP by 2011 (the PNE 2001-2010 target) and aiming for 10% by 2014 were the most significant proposals pertaining to financing and education organized within a National System. As a first step toward implementing the student-quality cost (SQC), the Union's complement to National Fund for Basic Education (NFDBE) was also approved to be increased immediately to 1% of GDP (it was only 0.2% in 2010).

The Final Document, which explicitly opposes neoliberal and privatization objectives, from the 2010 CONAE, was subsequently submitted to the governmental entities tasked with preparing the legislative document for presentation to the National Congress. What was not expected was that its approval would be a lengthy and painful process; after all, our country was presided over by two center-left governments, the Lula Government (2003-2010) and the Dilma Government (2011-2016), during which there was a partial reorientation of the measures implemented since 1990.

From 2003 to 2015, several governmental programs for the social sector were developed with significant financial resources, including Bolsa Família, Minha Casa Minha Vida, Farmácia Popular, and the University and Federal Institutes Expansion Program, among others. The Union's expansion in GDP and tax income, together with the center-left federal government's backing of these policies, made it possible to undertake these projects. From 2006 to 2012, the Ministry of Education (MEC) had budget executions that exceeded the previous year's inflation by more than 10 percentage points, making it the third most favored Ministry in terms of budget execution during that time period (Amaral, 2017).

Despite a progressive scenario for the approval of the new PNE, the federal government submitted to the House a brief document – Bill No. 8.035/2010 – that excluded many of the demands discussed within the framework of CONAE, particularly those relating to the establishment of the National Education System and the allocation of 10% of GDP to public education. The federal government also implemented a number of initiatives that not only ignored many of the goals articulated in the CONAE Final Document, but also connected public-private interactions in education with privatization interests.

Thus, the House and, later, the Senate witnessed an unending discussion of the document. Civil society responded strongly to the project's processing in the House, ensuring that the original text's conclusions were followed. The battle continued in the Senate, where significant setbacks occurred regarding the House's text, especially concerning the public

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authorities' disclaimer of responsibility for guaranteeing the right to education, encouraging privatization, the ambiguity in defining the percentage of GDP allocated to education, and the role of evaluation in a National Education System (Educação & Sociedade - Editorial, 2013). The National Congress finally passed Law 13.005/2014, the National Education Plan (2014-2024), on June 3, 2014, following numerous revisions to the Executive's initial proposal that had already stifled much of the CONAE 2010 discussions. The accepted text's privatist turn was one of the many reasons it was praised. Despite potential opposition and mobilizations throughout municipal, state, and national conferences, private interests - particularly between 1998 and 2018 - predominated. Parliamentarians' relationships with private Higher Education Institutions (HEIs) and the existence of HEI owners in the House's Education and Culture Committee were well-known at the time (Minto, 2018).

Minto (2018) analyzes pertinent elements of the approved law's final text to comprehend its content, especially with regard to the conflicts between the public and private sectors. He draws attention to a crucial component in understanding its evolution: the PNE actions are what give educational policies tangible form, particularly when they involve allocating financial resources and outlining the duties of public authorities. The creation of a PNE is seen by the private sector as a potential restructuring of its interests in connection with the State, primarily in the direction of increasing its methods for obtaining public funding. However, progressive forces believe that in a nation with high levels of social inequality, a PNE should guarantee high-quality education as a state-guaranteed right for everyone. Due to social, political, and economic tensions, it developed and was accepted during a time when class interests and opposing worldviews were at odds.

The issue of funding for higher education is critical to achieving goals 15 (ensuring that all basic education teachers have specific higher education training, obtained in undergraduate courses in the field of knowledge in which they work) and 16 (training 50% of basic education teachers at the postgraduate level by the last year of this PNE). Goal 20 deals with increasing public investment in public education, with the goal of reaching progressive levels: 7% in 2019 (the fifth year of the plan's validity) and 10% of GDP by 2024 (the tenth year). However, as Minto (2018) points out, there is no absolute guarantee that higher education will be funded. The mechanisms offered to extend public funding to private HEIs were far more explicit than the increase in funding for public HEIs, which remained relatively ambiguous (strategy 20.3). Strategy 15.2, for instance, calls for the consolidation of student loans for students enrolled in teacher training programs who have received a favorable evaluation from the National System for the Evaluation of Higher Education (SINAES). This includes the repayment of the remaining balance through

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effective teaching in the public basic education system (Brasil, 2014). Furthermore, in some strategies (like 16.5[4]), the allocation of resources – which may involve public or private institutions and networks – is not made clear. If there are any doubts about how public resources will be distributed under the PNE, it is clear that mechanisms for transferring resources to the private sector will be favored and expanded.

According to Minto (2018), the PNE ultimately strengthened the distinction between the public and private sectors in education and teacher training. It also fostered an interpretation that views the private sector as inexorable, because without private HEIs, the right to higher education would not be universalized; and if public HEIs do not allow themselves to be permeated by business reasoning (efficiency), they will not contribute to access democratization. The transfer of public resources to the private sector will no longer be temporary measures, but rather state policy. Deputy Ângelo Vanhoni (PT-PR), the PNE rapporteur approved by Congress, stated that the financing policy [Program University for All (PROUNI) and Student Financing Fund (FIES)] in an eloquent way: "This financing policy [PROUNI and FIES] was correct and in total we are talking about only R$13 billion per year" (Minto, 2018, p. 14). According to Chaves and Amaral (2014), the country's deficits in higher education coverage and finance have accumulated to such an extent that, even if the PNE objectives are completely reached, they may just "ratify" current trends rather than modify them. According to the authors, appropriate financial support for the proposed growth would require raising the present 0.8% to about 1.54% of GDP spent in higher education, with 10% of GDP already allocated to education by the end of the decade. Nonetheless, it would have a low per capita value when compared to other countries.

Regarding the nature of teacher training, CONAE stated the requirement for initial teacher training to be completed in-person, permitting remote education as an exemption for education professionals in service where in-person courses are unavailable. Contrary to this proposal, the PNE supported the expansion of distance learning courses, which are mostly provided by private HEIs. In particular, strategy 15.1 delegated responsibility for training to public and community higher education institutions in the states, federal districts, and municipalities, leaving open the question of whether training courses for education professionals will be in-person or distance learning.

[4] Strategy 16.5: Increase the availability of post-graduate scholarships for teachers and other basic education professionals.

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Context for PNE Implementation

One year after the start of the PNE's implementation period, the Dilma Government appointed a business reformer[5] as Minister of Education, and the Movement for Base (led by the Lemann Foundation) was prominent in drafting the first version of a Proposal for the National Common Curricular Base (BNCC).

Although the PNE text emphasized the importance of establishing a national curriculum base constructed on rights, learning, and development objectives, a discursive maneuver was used to combine opposing discourses: rights and learning objectives were interchangeable with competencies and skills. The idea that a "national curriculum base" would be a normative framework like the BNCC appears to be an odd manner of matching educational goals with interests and national ambitions that are not supported by the 1988 Constitution. The PNE makes no mention of an obligation to construct a BNCC, either in its substance or in the way in which it was developed. Investing so many resources on the BNCC without recognizing the fundamental limitations on teaching job, with low pay and bad career plans that indicate the profession's devaluation, is analogous to "putting the cart before the horse." Such an endeavor revealed the power dynamics of privatist fronts that interfere in the Brazilian state, notably inside the Ministry of Education, running a philanthropy 3.0, as described in Ball's research (2011). Rather than being a Brazilian product, these organizations are linked to multinational networks of corporations that sell their products and operate globally (Selles 2018).

Several organizations, including the National Association of Graduate Studies and Research in Education (ANPED) and the Brazilian Association for Research in Science Education (ABRAPEC), opposed the BNCC, describing it as a prescriptive curriculum that responded to international trends of curriculum uniformity and centralization, standardized assessments, and teacher and manager accountability (Ostermann; Rezende, 2021). With President Dilma Rousseff's impeachment in 2016, we saw an increase in educational, political, economic, and social setbacks imposed on the Brazilian people by the new government, which criminalized social movements and promoted the withdrawal of social rights, in violation of the 1988 Federal Constitution.

During this time, the passage of Constitutional Amendment 95/2016, which established the country's New Fiscal Regime (NRF), is noteworthy. This modification jeopardized the PNE's goals and strategies by decreasing the resources required for their

[5] A coalition of politicians, media, entrepreneurs, educational corporations, private institutes and foundations, and researchers established with the common belief that the private sector has a better plan to "fix" education.

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implementation. Under this fiscal system, from 2018 to 2036, the Executive Branch's budget, which includes the Ministry of Education (MEC), could not be altered by more than the preceding year's inflation rate. Primary costs were halted; nevertheless, payments for the financial sector were issued. As a result, the opportunities for enacting new public policies targeted at lowering Brazil's massive disparity were extremely restricted (Amaral, 2017).

Contrary to this scenario of fiscal restraint through "reduction of public spending," the PNE's (2014-2024) goals, that require a significant increase in the volume of financial resources committed to Brazilian education to be met, were jeopardized. Goal 20 outlines the funding of these goals, stating that by 2024, public resources equivalent to 10% of GDP should be committed to Brazilian education, thus almost doubling the amount of financial resources (Amaral, 2017). But what may be expected in the scenario of a "fiscal adjustment?"

When analyzing the evolution of financial resources allocated to the Ministry of Education (MEC) in the years 2014, 2015, 2016, and 2017, Amaral (2017) found that achieving the PNE goals was extremely unlikely, as financial values were not adjusted by percentages even equal to the inflation measured by the Broad National Consumer Price Index (IPCA) in 2015 and 2016. For the year 2017, financial resources that would enable the development of actions aimed at executing these goals were also not glimpsed.

With the establishment of the Temer government (2016-2018), educational policies were altered, programs were halted, and various councils, including CONAE, were dissolved and restructured. The makeup of the National Education Forum and the arrangement of the National Education Conferences were also changed, posing an obvious danger to democracy and indicating a greater movement toward neoliberalism. Despite criticism and suggestions, the MEC prepared a second version of the BNCC in 2016. The third edition of the BNCC, involving Early Childhood Education and Elementary Education (Brasil, 2017a), drafted by the MEC Steering Committee in 2017, received harsh criticism from scientific organizations such as National Association of Education Policy and Administration (ANPAE), ANPED, National Association for Education Professionals (ANFOPE), and ABRAPEC. Nonetheless, the document was authorized during the same year (Ostermann; Rezende, 2021).

The BNCC for High School (BNCC-EM), which received widespread criticism from associations, teachers, and students, was authorized by the National Education Council in 2018. One of the biggest critiques levelled at this text is its utilitarian reasoning, which is imposed by the logic of competencies, which is based on international assessment models such as Programme for International Student Assessment (PISA). Consistent with the BNCC-EM (Brazil, 2018), the High School Reform Law (Brazil,

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2017b) updates the 1996 Law of Guidelines and Bases of National Education (LDB), increasing the length of this educational level from 800 to 1000 hours per year, while also emphasizing the professional aspect of young people's education. Secondary education was divided into two stages: the first focused on general education (up to 1800 hours) and the second, with a workload of 1200 hours distributed between five formative routes. However, by legislation, schools are only required to teach one of the five formative routes, resulting in a full degradation of secondary education. Frigotto (2021) believes that increased educational variability will undermine young people's universal right to basic education of equal quality. The author believes that, given the existing state of public schools and the potential that the law allows for collaborations with the private sector, the "arrangement" described in the legislation may take the form of professional training, which is being currently materialized in numerous states. Due to a shortage of teachers in fields such as Natural Sciences, particularly the Physics curriculum component, public schools may be limited to the technical and professional pathway, which needs non-teaching professionals to have just "notorious knowledge." Given that more than 80% of Brazilian high school students attend public schools, it is apparent that this reform will leave all of these young people with merely professional training (Ostermann; Rezende, 2021).

Since the 1996 LDB, there has been a new wave of disputes over basic and continuing teacher training policies. Along with the educational reforms proposed for basic education at the time, this training underwent a regulatory process to ensure that it adhered to the principles outlined by the LDB and the National Curriculum Guidelines for Basic Education. This regulation was instituted via the National Curricular Guidelines for the Training of Basic Education Teachers (Brazil, 2001b), which, in accordance with basic education documents, embraced the following guiding principles for teacher professional preparation: the concept of competencies as a fundamental notion; the alignment between the training offered and the anticipated practice of future educators; and an emphasis on research pertaining to the teaching and learning process (Deconto; Cavalcanti; Ostermann, 2016).

Concurrently, distinct rules were established for each undergraduate subject. Nonetheless, in the training of Physics educators, in opposition to a proposal for establishing a singular identity for teacher training programs, as advocated by the National Curricular Guidelines for the Training of Basic Education Teachers (Brazil, 2001b), the National Curricular Guidelines for Physics courses (Brazil, 2001a) reexamined the 3+1 model, altering it to a 2+2 structure. This curricular framework

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entails a two-year common core with the Physics Bachelor's degree, followed by two years focused on teacher training for the "physicist-educator." The two documents ultimately manifest the existing tensions between the Physics departments and the Education Faculties, and, despite their incompatibility, must be concurrently adhered to in the development of course pedagogical projects, as stipulated by CNE/CES Opinion No. 220/2012 (Deconto; Cavalcanti; Ostermann, 2016).

Thirteen years after the implementation of these legislations, the National Curricular Guidelines for initial higher education training (teacher training courses, pedagogical training for graduates, and second teacher training courses) and for continuing education (Resolution CNE/CP No. 02/2015) were ratified. The information supporting this Resolution was extensively deliberated with the educational community and recognized by educators engaged with national teacher training policy as a significant and well-articulated synthesis of historical challenges in the field. Consequently, it garnered extensive backing from the representative bodies of educators, articulated via numerous positive indications for its prompt execution. Notwithstanding this, the execution of its implementation by the training institutions experienced unjustified delays (Bazzo; Scheibe, 2019).

Coimbra (2020) posits that three training models coexist within the Brazilian environment, based on an examination of the historical, political, social, cultural, and economic frameworks of Brazilian training models:

> The content-based model (1939-present) has the longest chronological span and is deeply integrated into contemporary teaching concepts and practices. The transitional model (2002-present) walks away from content supremacy by incorporating practices as curricular components. Lastly, the resistance model (2015-present) increases workload, preserves practices as curricular components, maintains the integrity of training, and emphasizes professional valorization at its core (p. 17).

Coimbra (2020) notes that on December 20, 2019, a fourth model of teacher training was introduced under the Bolsonaro Government (2019-2022) through Resolution CNE/CP No. 2/2019. This resolution outlines the National Curricular Guidelines for Initial Teacher Training for Basic Education and establishes the Common National Base for Initial Teacher Training for Basic Education (BNC-Formação), effectively revoking the 2015 Guidelines. The author characterizes this fourth model as anachronistic, as it is named for its interpretation of a temporal inversion within its framework. The author argues that this legislation undermines the historical trajectory established in the development of a national profile for the training of Basic Education teachers since Brazil's political opening. Resolution CNE/CP No. 02/2019 employs

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concepts and ideas from a previous era to educate subjects from a different historical context, incorporating references from realities outside of Brazil. Since its approval, criticisms from educators, researchers, and scientific organizations have increased significantly. Deconto and Ostermann (2021) provide a comprehensive analysis of the criticisms directed at a specific document. They emphasize that the document exhibits a neotechnical character, was created by business reformers without engaging educational entities and public universities and relies on manipulated "scientific evidence." Furthermore, it incorporates elements from previously criticized policies, revives the contentious pedagogy of competencies, aligns teacher training with the BNCC, reduces educational practice to the application of BNCC content, and prioritizes teacher accountability and control over the valuation of education professionals.

The accountability of teachers for student performance in large-scale exams, which has become the primary focus of recent educational policies, is unfounded and has been demonstrated by Cavalcanti, Nascimento, and Ostermann (2018) to be a fallacy. An empirical study utilizing microdata from the 2016 ENEM and two INEP indicators concerning teacher training and working conditions revealed that various factors affect student performance. These factors include students' socioeconomic status, teachers' working conditions in schools, and the alignment between training and teaching practice. Consequently, while teacher training is a significant factor in enhancing the national Basic Education landscape, it does not position the teacher as the primary agent of school failure.

The approval of disastrous Resolution CNE/CP No. 02/2019 under the Bolsonaro Government coincided with the dismantling of numerous educational policies and significant reductions in education funding. The government's focus shifted to the homeschooling system and the establishment of civic-military schools, eliciting significant criticism from the professional educator[6] community. The implementation of the PNE objectives and strategies was hindered during this period, marked by a far-right administration and the insufficient expertise of MEC members, including the Minister of Education himself.

In 2023, Lula returned to the presidency, with one year left in the PNE's term. Despite considerable pressure from students, educators, and scientific organizations, the government did not revoke the BNCC, the High School Reform, or the 2019 Guidelines, thereby disappointing the expectations of advocates for quality public education for all Brazilians. In July 2023, the budget for the Ministry of Education was reduced by R$ 332 million, while the

[6] Professional educators function as social agents who recognize education's capacity for social transformation. They focus on fostering solidarity among individuals, promoting students' self-organization and collaborative efforts, and respecting cultural diversity.

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Health Ministry's budget was decreased by R$ 452 million, posing additional challenges to the attainment of the PNE goals.

An examination of goals 15 and 16 in relation to the training of Physics educators

Following the approval of the PNE and substantial engagement from the educational community regarding teacher training, the National Curricular Guidelines for initial training at the higher education level (including teacher training courses, pedagogical training courses for graduates, and second teacher training courses) and for continuing training (Resolution No. 2, dated July 1, 2015) were established. The National Education Council acknowledged the substantial challenge in teacher training, noting that a significant proportion of teachers in basic education lacked the requisite higher education qualifications, amounting to 25.2% of the total 2,141,676 teachers. The Teaching Profile in Regular High School (INEP, 2015) study is emphasized, focusing on the analysis of teacher characteristics, including age range, the number of schools and shifts worked, and subjects taught. It aims to assess the initial training of teachers, estimate the number needed to fulfill subject demands, and evaluate the educational system's capacity to prepare students for teacher training courses (Brazil, 2015).

This study revealed that among the 50,543 high school teachers, 27.1% teach exclusively Physics, while 72.9% teach Physics in conjunction with other subjects. The majority of this latter group instruct in Physics and Mathematics. Additional significant indicators disclosed pertinent traits of teachers instructing Physics in standard high schools, which are essential for initial training policies. These indicators facilitate the projection of the effective demand for the training of these professionals, the estimation of the teaching staff nearing retirement, and the efforts required to ensure specialized training. The indicators facilitated the characterization of teachers instructing Physics in standard high school settings as follows: 60.15% fall within the age range of 30 to 49 years; 88.2% possess higher education qualifications; 26.8% have received specific training, indicating that 73.2% lack such training. Among high school Physics teachers, 71.6% received their specialized training in public higher education institutions. Also, the percentage of teachers who exclusively taught Physics at the high school level and other educational stages was 67.4% (Brasil, 2015).

An analysis of the relationship between enrollments, registrations, and graduates in the Physics course revealed a notably low ratio of entrants to graduates. The Physics course highlights a significant finding, indicating that a major challenge in Physics teacher training is rooted in the training processes and the structural issues associated with the teaching profession. In 2013, the study indicated that the ratio of graduates to

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entrants from 2010 was merely 20.5%, highlighting considerable dropout rates in these programs. The profile of the Physics teacher in Brazil can be characterized as follows: the "typical" teacher lacks specific training, instructs in Physics alongside other subjects, with Mathematics being the most prevalent (Brazil, 2015). The Guidelines acknowledge that calculating the demand for teachers with specialized training in Physics in Brazil is contingent upon the definition of workload and the organization of the system. However, this demand is likely to diminish if the High School Reform is not rescinded. The proposed "dilution" of the Physics curriculum component within the Natural Sciences and Technologies framework by the BNCC for high school (Brazil, 2018) legitimizes a reduction in the number of teachers specifically trained in Physics education. The absence of a requirement for public schools to provide all five formative itineraries suggested by the High School Reform, encompassing the four areas of knowledge and professional education, diminishes the demand for qualified Physics educators. The scenario presented by this reform suggests that it represents an inadequate response to the shortage of teachers in public schools in certain disciplines, with Physics serving as a prominent example.

The Innovative Teacher Training Incentive Program (PRIL) was initiated in 2021, aligning with the 'economistic' perspective of seeking straightforward solutions to complex problems. This program was proposed by the Secretariat of Basic Education (SEB) of the MEC in calls No. 35, issued in June 2021, and No. 66, issued in September 2021. The purpose of these calls is to align with the current curriculum policy of basic education and teacher training, promoting the establishment of licensures by area of knowledge. The text of the proposal clearly articulates its objective to support the attainment of goal 15 of the PNE 2014-2024 (Brazil, 2021). The evolution of the meaning attributed to goal 15 over the years is evident. During the discussions in 2013, the adequacy of training received in licensure courses related to teachers' expertise was a central concern. At that time, it was not anticipated that the concept of knowledge areas would be entirely redefined, moving away from the perspective of school disciplines. In conclusion, even if goal 15 were quantitatively achieved, which remains unverified, it would stem from an illegitimate reform of the basic education system and cannot be deemed a positive outcome without thorough analysis. The adequacy of teacher training is a critical concern in education, as research demonstrates its significance for the effective functioning of educational processes (Cavalcanti; Nascimento; Ostermann, 2018; Nascimento; Cavalcanti; Ostermann, 2020).

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The analysis of goal 16, which focuses on postgraduate teacher training, requires the examination of several pertinent issues. It is important to note that the objective in question suggests the necessity to

> [...] train, at the postgraduate level, 50% of basic education teachers by the final year of this PNE's term, and ensure that all basic education professionals receive continuous training in their area of expertise, taking into account the needs, demands, and contexts of the education systems (Brazil, 2014).

The goals and associated strategies are applicable to both types of postgraduate training, whether lato sensu or stricto sensu. A public policy addressing teacher training requirements must clearly distinguish between specialization courses and master's and doctoral programs. This discussion does not advocate for one training type over another; instead, it emphasizes the necessity of distinguishing between them due to their fundamentally different characteristics, which precludes their equal evaluation in an assessment process. Thus, the significance of specifying the type of postgraduate training is highlighted. For enhanced visualization of this detail, we utilized data from the 2019 edition of the Basic Education Census, compiled by INEP. We utilized the complete version of the microdata, accessible from the INEP website prior to February 2022, when experts from this institution determined that such disclosure could jeopardize student identities and conflict with the General Data Protection Law (LGPD). Nonetheless, the original data remain accessible[7], enabling the reproduction of the study presented in this work. All analyses and graphs presented herein were conducted using R software (R Core Team, 2024).

The year 2019 was selected for study as it represents the most recent period prior to the onset of the pandemic in 2020. INEP's decision to alter the disclosure method was grounded in a study conducted by UFMG, which found that the prior data disclosure approach "subjects data holders to considerable privacy risks, including re-identification and inference of sensitive attributes, a circumstance that could constitute a violation of the LGPD" (Brazil, 2022). The publicly available data from INEP currently does not support the level of detailed studies achievable in previous analyses, leading to dissatisfaction and protests from the academic community at that time. Our objective is to create a comprehensive visualization of Physics teacher training to assess the extent to which goals 15 and 16 are being met. It is crucial to determine whether these goals are sufficiently clear to avoid inconsistent implementation, particularly regarding the relationship between goal 16 and goal 15, which stipulates that "all basic education

[7] The data acquisition is conducted via *Base dos Dados* website (https://basedosdados.org). For further information, refer to Dahis et al. (2022) and the concise explanations provided in the text.

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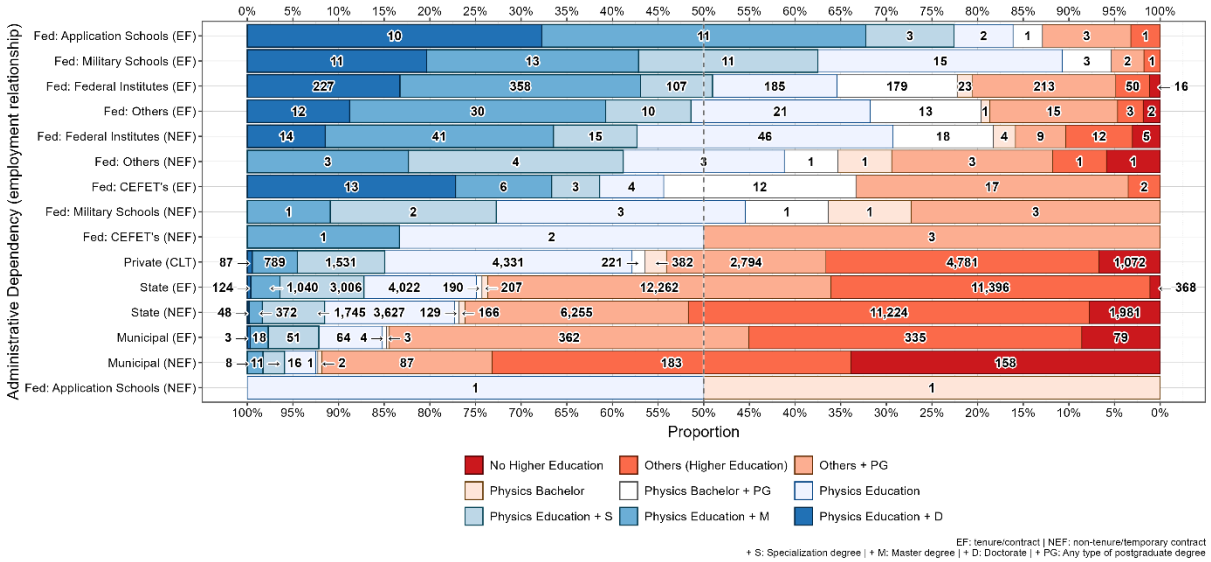
teachers must have specific higher education training, obtained in teacher training courses in the area of knowledge in which they work" by 2024 (Brazil, 2014).

After some initial procedures[8], a query expressed in SQL language is created, as specified below:

SELECT *ano, sigla_uf, id_municipio, rede, id_escola, etapa_ensino, id_turma, tipo_turma, id_docente, escolaridade , tipo_contratacao, situacao_curso_1, id_area_curso_1, id_curso_1, licenciatura_1, id_area_curso_2, id_curso_2, licenciatura_2, id_area_curso_3, id_curso_3, licenciatura_3, disciplina_fisica, especializacao, mestrado, doutorado, mediacao_didatico_pedago* ***FROM*** *`basedosdados.br_inep_censo_escolar.docente`* ***WHERE*** *ano = 2019* ***AND*** *disciplina_fisica = 1*

To identify the various types of federal schools, we obtained an auxiliary table from the Base dos Dados that translates the school identification code[9] (variable *id_escola*) into the school's name, which we then used to construct a code for distinguishing these types.

Figure 1 – Physics teachers in Brazilian schools and their training profiles, taking into account various administrative dependencies.



Source: chart created by the authors.

Figure 1 presents the proportion and number of teachers at various levels of training in the subject of Physics across different administrative dependencies, with the federal level categorized into multiple types, each prefixed by "Fed:". Public schools categorize tenure/contract (EF) and non-tenure/temporary contract (NEF) separately (variable *tipo_contratacao*) to provide clearer distinctions between these cases. This figure comprises

[8] The initial procedures are relatively simple. After registering on the Base dos Dados website, we connect to the data query page for teachers in the Basic Education Census, at the link here. From this point, the data can be obtained.

[9] For accessing the data, simply visit https://basedosdados.org/dataset/33b49786-fb5f-496f-bb7c-9811c985af8e?table=29bcfdae-bd8b-4659-9a90-033abef9bfae. Once there, go to the *Acesso aos dados* tab and click the download button located below the variable descriptions.

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62,386 Physics teachers from a total of 62,622. A total of 216 teachers engaged exclusively in the distance education modality (EAD, variable *mediacao_didatico_pedago* = 3) were excluded, along with 10 teachers exhibiting questionable characteristics. For instance, one teacher claimed to work concurrently in 176 distinct schools across 60 municipalities, instructing 1,223 different groups, all during the evening shift.

The training of each teacher (variable *escolaridade*) was categorized into nine levels, with the ideal training level defined as a Physics Education complemented by postgraduate studies (variables *id_curso_1*, *id_curso_2*, and *id_curso_3*), in accordance with the articulation of goals 15 and 16. In cases that fulfill both criteria, we employed shades of blue in the graph, representing the highest levels of training: Physics Education + S (graduation + specialization), Physics Education + M (graduation + master degree), and Physics Education + D (graduation + doctorate). Intermediate training levels that fail to satisfy both criteria (Physics Education, Bachelor's in Physics, and Bachelor's in Physics + PG) were represented by soft color scales, while the lowest training levels were depicted with reddish tones. These levels include educators lacking a Physics Education degree, categorized as Others + PG, Others (Higher Education), and No Higher Education. The distribution of these levels across each administrative dependency enables the visualization of the teacher training profile within the respective schools. The figure presents the number of teachers at each level for each administrative dependency, arranged in descending order based on their proximity to achieving goal 16. The quantity of educators at each educational level across the nation is indicated at the top of Figure 2, accompanied by the acronym BR. Figures 1 and 2 indicate that a substantial proportion of the teachers in this study, specifically those holding a Physics Education degree and a doctorate ($100 \times 227/509 \sim 44.6\%$), are tenured professors at Federal Institutes. Careers in these institutions and other federal entities are more appealing than those in other administrative sectors, making it unsurprising that postgraduate studies, particularly at the doctoral level, serve as a pathway to Federal Institutes. The fact that only approximately 2% of the teachers examined here are affiliated with the Federal Institutes indicates a notable asymmetry. This requires additional deep research, and we do not aim to conjecture on this matter. State and municipal schools exhibit the least favorable conditions regarding the training profile of teachers. The acronym CEFET refers to the Federal Center for Technological Education, which is quite similar to Federal Institutes.

The training profile most aligned with the objectives of goals 15 and 16 is that of federal schools, particularly regarding tenured teachers. Among tenured Physics teachers in federal schools across various types, over 50% possess a degree in Physics Education. Federal Institutes, which constitute the majority of federal schools and offer Physics teacher training

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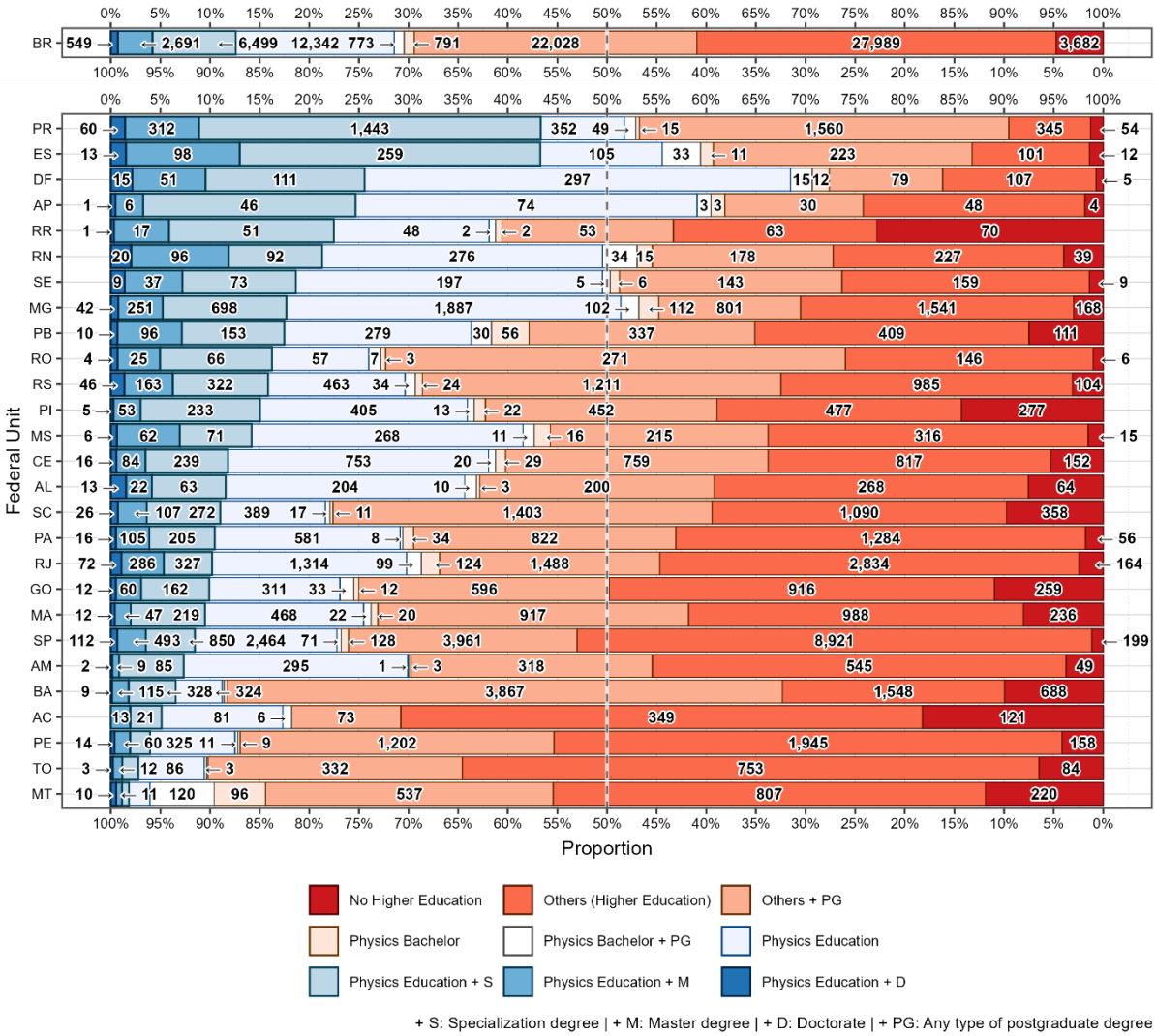
courses, are expected to employ numerous teachers holding a Physics Education degree along with postgraduate qualifications. Such training is regarded as highly advantageous in the competitive selection process for permanent positions within these institutions.

It is pertinent to examine the configuration of Physics teacher training at the state level. Figure 2 presents a visualization akin to that in figure 1 but aggregated by federal unit. To ensure clarity, the number of teachers at all training levels was omitted in specific instances depicted in Figure 2. Applying the stringent criterion that a school must employ 50% of teachers with postgraduate education and degrees in Physics Education, no state has achieved goals 15 and 16. The Federal District is the federal unit that most effectively achieves goal 15, with nearly 70% of teachers possessing training in their specific subject area. Paraná and Espírito Santo are the leading states in goal 16, as they approach the target of 50% of teachers possessing postgraduate degrees in Physics Education.

Figure 2 – The profile of teachers specializing in Physics across Brazilian schools, categorized by their training in each federal unit. The upper bar, referred to as BR, displays the national profile.



Source: chart created by the authors.

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It is crucial to examine the relationship between the quality of basic education and the level of teacher training. Physics provides insight into this scenario, particularly through the National Professional Master's in Physics Teaching (MNPEF), which is one of the most extensive training programs in the country, supported by the Brazilian Society of Physics (SBF) and distributed across multiple institutions. A significant number of studies have examined this training policy in recent years. The findings suggest that, despite the substantial number of graduates (estimated at over two thousand), the training conception, curriculum structure, and profile of supervising teachers (Antunes Jr.; Ostermann; Cavalcanti, 2019; Rebeque; Ostermann; Viseu, 2020; 2021) raise concerns regarding the effective return on investment in these programs for the qualification of basic education in the Physics discipline. This discussion does not assert that the MNPEF policy fails to address the social realities of participating teachers; rather, it questions the connection between postgraduate training and the qualification of basic education, which is the aim of the PNE goals. Therefore, even if all educators possessed postgraduate training, the effectiveness of their qualifications for functioning within the school context would remain uncertain under the proposed model. An effective goal should address the appropriate type of postgraduate training while considering the foundational training of educators. Therefore, in light of the aforementioned issues, a goal that emphasizes quantity alone, without qualifying the intended training, cannot serve as a valid indicator of educational quality.

Conclusions

This study proposes an analysis of Goals 15 and 16 of the PNE (2014-2024). Initially, it is important to note that neither of the two objectives was accomplished throughout the ten-year duration of the Plan. This is demonstrated by examining teachers in the field of Physics, a discipline commonly facing a shortage of educators, particularly in state and municipal schools. Nevertheless, even if these trainings were accomplished, the quality of their execution remains questionable. Most Physics teachers received their initial training at private higher education institutions and through distance education courses. In contrast to the standards set by CONAE (2010), which emphasized the necessity of in-person initial training and permitted distance education only under exceptional circumstances. In relation to goal 16, we examined the issues stemming from the ambiguity surrounding the type of postgraduate training targeted by the PNE. The text does not address this aspect, resulting in a weak equivalence between *lato sensu* and *stricto sensu* courses. Nonetheless, even when

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specified, the case of the National Professional Master's in Physics Teaching raises questions regarding the direct correlation between a postgraduate degree and the quality of basic education. Previous studies demonstrate that this relationship is not direct, and concerns may arise regarding the quality of this training. A robust public policy is essential to guarantee that continuing education remains pertinent and effective in enhancing teachers' pedagogical practices. Continuing education programs must be flexible and adaptable to the diverse realities and challenges encountered by educational systems nationwide.

The examination of goals 15 and 16 of the PNE (2014-2024) concerning Physics teacher training highlights the complexities and challenges inherent in improving basic education in Brazil. Addressing the quality of initial and continuing teacher training, differentiating types of postgraduate courses, and considering local needs are essential for enhancing the value of Physics teaching and, subsequently, improving the quality of basic education in the country.

The results and conclusions presented here must be critically assessed, despite their relevance to public policy evaluation. A secondary database was utilized, comprising data gathered by an instrument not specifically designed for this research. A further limitation was the reliance on data collected before the implementation of the LGPD, potentially leading to discrepancies with the current context. Future research may explore similar investigations in additional fields of study. This approach will provide a comprehensive understanding of the effects of recent public policies on the initial and continuing education of teachers.

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