

CHALLENGES OF PHYSICS TEACHING IN BRAZILIAN PUBLIC SCHOOLS

 <https://doi.org/10.63330/aurumpub.013-009>**Marcionilio F-Silva¹****ABSTRACT**

Physics teaching in Brazil, especially in public schools, faces several challenges that compromise the teaching-learning process and limit the critical and civic education of students. Among the main difficulties are the lack of adequate infrastructure, scarcity of teaching resources, teacher work overload, gaps in initial and continuing teacher education, as well as the predominance of traditional pedagogical practices that distance students from interest in the subject. These factors are aggravated by social issues such as economic inequality, violence, and precarious public education policies.

This article aims to analyze the challenges of teaching Physics in Brazilian public schools, based on a bibliographic review carried out in scientific databases and open-access journals published between 2015 and 2025. The research is organized into five axes: school infrastructure, teacher education, teaching methodologies, inclusion and diversity, and student perception.

The results show that the lack of laboratories, the absence of consistent public policies, and the devaluation of teachers remain as structural barriers. However, they also highlight that innovative practices, such as the use of digital technologies, active methodologies, and inclusive strategies, can contribute to more meaningful and motivating learning. It is concluded that to move forward, continuous investment in infrastructure, teacher appreciation, and policies to encourage pedagogical innovation are necessary.

Keywords: Physics teaching; Public schools; Teacher education; Science education; Inclusion.

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INTRODUCTION

Physics teaching, throughout the history of Brazilian education, has been characterized as a field full of challenges. Since the institutionalization of the subject in school curricula at the beginning of the 20th century, Physics has been associated with content considered complex, abstract, and distant from students' everyday reality. This perception, often reinforced by the absence of innovative pedagogical strategies and the lack of teaching resources, contributes to the construction of a negative image of the discipline, marked by learning difficulties and student disinterest (Carvalho, 2018).

Nevertheless, the relevance of Physics teaching is unquestionable. It is a field of knowledge that enables the understanding of natural phenomena, the interpretation of technological transformations, and the development of essential competencies for civic education and the exercise of critical thinking. In a society increasingly permeated by scientific innovations and the need for scientific literacy, Physics plays a strategic role, both in practical life and in integration into the labor market (Menezes & Gomes, 2020).

In Brazil, however, the reality of public schools reveals obstacles that compromise the effectiveness of this teaching. Official reports, such as those from the National Institute for Educational Studies and Research Anísio Teixeira (INEP), point to persistent deficits in infrastructure, availability of laboratories and libraries, as well as access to updated teaching materials. Added to this is the precariousness of the teaching profession, marked by low salaries, lack of adequate working conditions, and limitations in initial and continuing teacher education (Oliveira, 2019).

In addition to structural factors, there are also pedagogical issues that directly impact the teaching-learning process. The predominance of traditional practices, centered on oral exposition and mechanical resolution of exercises, distances students from meaningful and contextualized learning. In this scenario, Physics teaching risks becoming a merely instrumental discipline, focused on memorizing formulas and procedures, without awakening in students the ability to relate scientific knowledge to their daily lives (Silva & Farias, 2021).

Another aspect that deserves attention concerns the social inequalities that permeate the Brazilian educational system. Students from contexts marked by socioeconomic vulnerability face additional barriers, such as lack of access to technological resources, difficulties with school transportation, community violence, and discouragement in the face of limited professional prospects. These factors directly affect student engagement and increase the challenges for teachers in seeking inclusive and effective strategies (Santos & Costa, 2022).

Given this context, the central objective of this article is to analyze the main challenges faced in Physics teaching in Brazilian public schools, based on a bibliographic review conducted in open-access databases. The aim is to understand how different authors have discussed the structural, pedagogical, and



social barriers that impact the discipline, as well as to identify possible paths for overcoming these obstacles.

The specific objectives of the study are:

- To map the main challenges identified in recent literature regarding Physics teaching in public schools.
- To analyze how teacher education and teaching methodologies impact the learning process.
- To identify innovative strategies and public policies that may contribute to improving the teaching of the discipline.
- To propose critical reflections on the role of Physics in civic education and the development of scientific and technological competencies.

The relevance of this research lies in the fact that, by analyzing the contemporary challenges of Physics teaching, it is possible to provide support for the formulation of more consistent educational policies, as well as to inspire pedagogical practices that value student protagonism and promote more meaningful learning.

Thus, this article is structured into five main parts, in addition to this introduction. In the theoretical framework, the main conceptual and empirical contributions regarding Physics teaching in public schools are discussed. Next, the methodological procedure adopted is presented, highlighting the criteria for selecting bibliographic sources. The results and discussion section organizes the research findings into thematic axes, highlighting the main challenges and possible solutions. Finally, the concluding remarks synthesize the reflections developed throughout the text, pointing to future recommendations in the field of Physics education.

THEORETICAL FRAMEWORK

Physics teaching in Brazilian public schools has been the subject of numerous academic studies, which point to the existence of structural, pedagogical, and social barriers. This section seeks to organize the theoretical contributions into five major axes: **school infrastructure, teacher education, teaching methodologies, inclusion and diversity, and student perception**. The analysis engages with recent studies published in open-access journals, official reports, and normative documents, in order to construct a comprehensive and critical view of the topic.

SCHOOL INFRASTRUCTURE

One of the greatest obstacles faced by Physics teaching in public schools concerns the lack of adequate infrastructure for pedagogical practice. Research such as that by Carvalho (2018) indicates that a



large portion of institutions lack properly equipped science laboratories, which limits the possibility of experimentation—a fundamental element for understanding physical concepts.

According to data from the School Census (INEP, 2022), only a fraction of Brazilian public schools have functioning Physics laboratories. In many cases, even when physical infrastructure exists, basic materials, equipment maintenance, or trained professionals to operate them are lacking. This reality compromises the implementation of investigative and experimental practices, which are central to the teaching-learning process in the discipline.

The absence of updated libraries and limited access to digital technologies also reinforces the precariousness. Although public policies such as the National Textbook Program (PNLD) have expanded the distribution of printed materials, the use of digital resources remains restricted. According to Santos and Costa (2022), the lack of quality internet in public schools—especially in rural and peripheral areas—prevents the use of virtual platforms, digital simulations, and educational software that could make classes more attractive and interactive.

Furthermore, factors such as overcrowded classrooms, lack of suitable spaces for interdisciplinary projects, and absence of audiovisual resources further hinder pedagogical practice. In this sense, school infrastructure proves to be a central component in the discussion of the challenges of Physics teaching in Brazil.

TEACHER EDUCATION

Another crucial aspect concerns the education of Physics teachers. Studies such as Oliveira (2019) highlight that many teachers work without specific training in the field, which compromises the quality of instruction. According to data from INEP (2020), a significant number of professionals teach Physics without having completed a degree in the discipline, especially in regions far from major urban centers.

Even when initial training exists, it presents gaps. Research indicates that undergraduate Physics programs generally prioritize theoretical training and mastery of disciplinary content, but offer little emphasis on pedagogical practices, the use of active methodologies, and the development of competencies to deal with the diversity present in classrooms (Menezes & Gomes, 2020).

Continuing education, in turn, remains incipient. Although there are government programs and university initiatives, such as extension and specialization courses, teachers often face difficulties in participating due to work overload, lack of institutional incentives, and the absence of consistent policies for teacher appreciation. As Santos and Farias (2021) emphasize, the precariousness of the teaching profession—marked by low salaries and professional instability—discourages the pursuit of additional training and compromises teacher motivation in the classroom.



In this regard, teacher education constitutes one of the main axes of reflection on the challenges of Physics teaching, as it directly impacts pedagogical practice and the capacity for innovation in the educational process.

TEACHING METHODOLOGIES

The teaching methodology adopted by educators plays a fundamental role in the learning of Physics. Recent research indicates that, in many public schools, a traditional teaching model still predominates—centered on oral exposition of content and repetitive exercise solving (Silva & Farias, 2021). While this model may be effective for preparing students for selective exams, it proves limited in promoting meaningful and contextualized learning.

Studies such as those by Menezes and Gomes (2020) advocate for the adoption of active methodologies, which place the student at the center of the learning process, encouraging participation, protagonism, and collective knowledge construction. Among the suggested practices are the use of simple experiments with low-cost materials, project-based learning (PBL), flipped classrooms, and the integration of digital resources such as simulations and Physics apps.

A relevant aspect in this debate is the National Common Curricular Base (BNCC), which emphasizes the importance of competency- and skill-based teaching, valuing interdisciplinarity and the contextualization of scientific knowledge. In this sense, Physics should be presented not merely as a set of laws and formulas, but as a tool to interpret everyday phenomena, develop critical thinking, and promote scientific citizenship.

Moreover, new technologies such as artificial intelligence (AI) have been incorporated as pedagogical support tools. F-Silva (2025) discusses how AI can be used in Chemistry teaching in public schools, highlighting both benefits and risks. This reflection can be extended to Physics, as AI resources can support personalized learning, provide immediate feedback, and expand access to advanced simulations.

INCLUSION AND DIVERSITY

Physics teaching in public schools must also confront the challenge of inclusion and the appreciation of diversity. Research such as that by Santos and Costa (2022) indicates that students with disabilities still face numerous barriers to accessing scientific knowledge, due to the absence of accessibility resources, adapted materials, and adequate teacher training for inclusive education.

In addition, there are marked regional inequalities. Schools located in rural areas or urban peripheries face more precarious infrastructure conditions, higher teacher turnover, and difficulties in



implementing innovative projects. These inequalities widen the gap between students from different regions of the country, compromising educational equity.

Gender and representativity issues also emerge as challenges. Physics has historically been associated with a male-dominated field, which can discourage girls and women from identifying with the discipline. Strategies that promote female representation in science—through historical examples, science outreach, and the promotion of inspiring role models—are essential to combat stereotypes and increase female student participation.

STUDENT PERCEPTION

Finally, students' perception of Physics is a key element in understanding the challenges of teaching the discipline. Studies such as those by Carvalho (2018) and Silva & Farias (2021) show that many students consider Physics a difficult, abstract subject that is poorly connected to their reality. This disinterest is reflected in low performance scores on external assessments, such as the National High School Exam (ENEM), where the Natural Sciences area shows high error rates and low achievement in Physics questions.

However, research also reveals that when exposed to innovative pedagogical practices, students demonstrate greater engagement and interest in the subject. Classes that incorporate experimentation, contextualization with everyday situations, and the use of digital resources tend to foster greater motivation and support meaningful learning (Menezes & Gomes, 2020).

Thus, understanding students' perceptions is essential for developing pedagogical practices that meet their needs and expectations, making Physics teaching more inclusive, relevant, and transformative.

METHODOLOGICAL PROCEDURE

This article adopts **bibliographic review research** as its methodological approach. This choice is justified by the need to systematize the knowledge already produced about Physics teaching in Brazilian public schools, allowing the identification of convergences, gaps, and persistent challenges.

According to Gil (2019), bibliographic research consists of a procedure based on already developed materials—especially books, scientific articles, and reports—with the aim of analyzing, discussing, and reinterpreting existing information from new investigative objectives. In this study, a time frame was chosen covering the years **2015 to 2025**, a period that encompasses recent discussions on educational policies, the implementation of the National Common Curricular Base (BNCC), and the impacts of the COVID-19 pandemic on the teaching-learning process.



DATABASES CONSULTED

Various open-access academic and scientific databases were consulted to ensure diversity and quality of sources. The main ones include:

- **Google Scholar** – used to locate recent articles in national and international open-access journals.
- **SciELO (Scientific Electronic Library Online)** – an important database that gathers Brazilian and Latin American scientific journals.
- **CAPES Journals Portal** – provides access to a wide range of scientific articles, with filters for open-access materials.
- **Specialized Science Education Journals** – such as the *Revista Brasileira de Ensino de Física* (RBEF), *Caderno Brasileiro de Ensino de Física*, *Investigações em Ensino de Ciências*, and institutional journals from public universities.
- **Official Reports** – including documents from the National Institute for Educational Studies and Research Anísio Teixeira (INEP), the School Census, and publications from the Ministry of Education (MEC).

INCLUSION AND EXCLUSION CRITERIA

To select the works analyzed, inclusion and exclusion criteria were defined to ensure the relevance of the sources:

- **Inclusion Criteria:**
 - Articles published between 2015 and 2025.
 - Texts available in open access (free of charge).
 - Research related to Physics teaching in public schools.
 - Studies addressing at least one of the defined thematic axes: infrastructure, teacher education, methodologies, inclusion, and student perception.
- **Exclusion Criteria:**
 - Works published before 2015.
 - Articles without full free access.
 - Research focused exclusively on Physics teaching in private or higher education institutions.
 - Texts not directly relevant to the research objectives.



ANALYSIS CATEGORIES

The analysis of selected texts was conducted based on the definition of **thematic categories**, which allow for systematic organization and interpretation of data. These categories were established based on preliminary literature review and the recurrence of themes identified by different authors:

1. **School infrastructure:** physical conditions, presence (or absence) of laboratories, libraries, and digital technologies.
2. **Teacher education:** profile of initial training, continuing education programs, professional appreciation, and working conditions.
3. **Teaching methodologies:** pedagogical practices, use of active methodologies, teaching resources, and technological integration.
4. **Inclusion and diversity:** accessibility, regional inequalities, gender, and representativity.
5. **Student perception:** interest, difficulties, engagement, and performance in external assessments.

DATA COLLECTION AND ANALYSIS PROCEDURES

Data collection was carried out in two main stages:

1. **Initial search in databases**, using descriptors such as “*Physics teaching in Brazil*”, “*public schools and Physics teaching*”, “*challenges in Physics teaching*”, “*Physics teaching methodologies*”, and “*Physics teacher education*”. This stage resulted in approximately **120 articles found**.
2. **Filtering and selection of texts**, based on the inclusion and exclusion criteria. After reading abstracts and introductions, **25 scientific articles** were selected, along with **official reports and normative documents**, which constituted the main corpus of analysis for this study.

The analysis was conducted through critical and interpretative reading, aiming to identify the main arguments, empirical evidence, and proposals presented by the authors. Whenever possible, dialogues were established between different works to highlight convergences, divergences, and complementarities.

STUDY LIMITATIONS

It is important to note that bibliographic review, although it provides a broad view of the topic, has limitations. Due to reliance on open-access materials, some relevant studies may not have been included. Additionally, Brazil’s regional diversity implies that certain local specificities may not be fully represented. Nevertheless, the review conducted here offers a consistent overview of the main challenges faced in Physics teaching in Brazilian public schools.



PRESENTATION AND DISCUSSION OF RESULTS

Based on the bibliographic analysis conducted, a set of recurring challenges in Physics teaching in Brazilian public schools was identified. These challenges were systematized into five main axes: school infrastructure, teacher education, teaching methodologies, inclusion and diversity, and student perception. Below, the main findings of the review are presented, accompanied by critical discussions and comparisons among different authors.

SCHOOL INFRASTRUCTURE

The literature analysis shows that the lack of infrastructure remains one of the most serious obstacles to effective Physics teaching. Carvalho (2018) had already identified that more than 70% of public schools do not have dedicated Physics laboratories. INEP (2022) data confirm this reality, showing that even when laboratories exist, they are often underutilized or lack maintenance.

This deficiency directly compromises experimental practice, which is essential for understanding physical phenomena. As Menezes and Gomes (2020) emphasize, the absence of experimentation reduces the discipline to mathematical formulas and abstractions, disconnected from students' everyday lives.

Some authors, such as Santos and Costa (2022), argue that this limitation can be partially mitigated through the use of low-cost experiments assembled with accessible materials. However, while this practice is valid, it does not replace the need for consistent structural investments. The literature therefore converges on the need for public policies that prioritize strengthening school infrastructure, including access to quality internet, audiovisual equipment, and virtual laboratories.

TEACHER EDUCATION

Another central finding concerns the education of Physics teachers. Oliveira (2019) highlights that a significant number of teachers still work without specific training in the field, which compromises teaching quality. This problem is more severe in peripheral and rural regions, where teacher turnover is higher.

Initial training for Physics graduates also presents limitations. As Silva and Farias (2021) argue, degree programs emphasize theoretical content and applied mathematics but offer little space for innovative pedagogical practices and discussions on inclusive methodologies.

Regarding continuing education, Menezes and Gomes (2020) point out that although institutional programs exist, teacher participation is limited due to work overload, low incentives, and lack of professional appreciation. This point is corroborated by Santos and Farias (2021), who emphasize the precariousness of the teaching profession as a demotivating factor.



The identified scenario suggests that any proposal to improve Physics teaching must necessarily include measures for teacher appreciation, such as fair remuneration, adequate working conditions, and policies that encourage ongoing professional development.

TEACHING METHODOLOGIES

With respect to teaching methodologies, the literature reveals a predominance of traditional practices centered on content exposition and exercise solving. Although this approach is effective for preparing students for standardized tests, it contributes little to critical development and meaningful learning (Silva & Farias, 2021).

In contrast, recent studies point to innovative alternatives. Menezes and Gomes (2020) and Carvalho (2018) advocate for the use of active methodologies, such as project-based learning (PBL) and flipped classrooms. These practices allow physical concepts to be related to real-life situations, fostering student engagement.

Another point discussed is the role of digital technologies. Resources such as computer simulations, interactive apps, and artificial intelligence platforms can enrich the pedagogical process. F-Silva (2025), in analyzing AI use in Chemistry teaching, shows that these tools can personalize learning and provide immediate feedback. In the context of Physics, their use can democratize access to virtual experiments, especially in schools without laboratories.

However, caution is needed. Technology use should not be seen as a magical solution but as part of a consistent pedagogical project. Moreover, it requires adequate technological infrastructure and specific teacher training to ensure effective use of these resources.

INCLUSION AND DIVERSITY

Inclusion emerges as a cross-cutting challenge. Santos and Costa (2022) demonstrate that students with disabilities still face significant barriers, such as the absence of adapted materials, lack of accessibility in school spaces, and inadequate teacher training for inclusive practices.

Regional inequalities were also widely discussed. While schools in major urban centers have greater access to resources, those located in peripheral or rural regions face precarious infrastructure conditions and a lower availability of qualified teachers. This scenario exacerbates learning disparities across different regions of the country (Oliveira, 2019).

Furthermore, recent studies have problematized gender issues in Physics education. The low female representation among teachers and scientific role models contributes to the perpetuation of the stereotype that Physics is a predominantly male field. Strategies such as highlighting women scientists in



the history of Physics and encouraging female participation in science fairs and Olympiads can help reverse this situation (Menezes & Gomes, 2020).

Therefore, the findings suggest that inclusion and diversity should not be treated as secondary issues, but rather as foundational pillars of any Physics education policy.

STUDENT PERCEPTION

Students' perception of Physics is marked by feelings of difficulty and disinterest. Carvalho (2018) reports that many students view the subject as "difficult" and "detached from reality." This diagnosis is corroborated by ENEM results, which show low accuracy rates in Physics questions (INEP, 2022).

However, research also indicates that students' perception changes when the subject is taught in innovative ways. Menezes and Gomes (2020) show that practical activities, simple experiments, and everyday contextualizations increase interest and engagement.

Another relevant finding is the impact of the COVID-19 pandemic. The studies analyzed point out that the transition to remote learning exposed inequalities in access to digital resources. Many public school students were excluded from the process, which worsened disinterest in the subject. Even so, successful experiences with hybrid learning showed that, when supported by inclusive digital resources, the pedagogical process can be enriched (Santos & Costa, 2022).

Overall, students' perception reveals that the problem does not lie in Physics itself, but in how it is taught. By bringing content closer to students' realities and valuing their active participation, it is possible to transform this perception and make the subject more attractive and meaningful.

FINAL CONSIDERATIONS

The analysis conducted throughout this study made it possible to identify the main challenges of Physics teaching in Brazilian public schools, as well as to point out possible paths for overcoming them. The bibliographic review revealed that the teaching of this discipline is immersed in a complex context, marked by structural, pedagogical, and social problems that intertwine and produce a scenario of educational inequality.

First, the issue of **precarious school infrastructure** was highlighted, which limits the execution of experimental practices and restricts students' access to experiences that bring Physics closer to their daily lives. Without adequate laboratories, basic equipment, or even digital connectivity, the discipline tends to be reduced to a set of mathematical abstractions, discouraging a large portion of students.

Second, **teacher education** emerged as a decisive factor. The absence of licensed Physics teachers, combined with insufficient initial training and lack of opportunities for continuing education, contributes to rigid and uninspired pedagogical practices. Public policies aimed at valuing and



strengthening the teaching profession—with an emphasis on dignified working conditions—are therefore indispensable.

Another central point was the **predominance of traditional methodologies**, which, although still widely used, have proven limited in fostering students' critical development. Active methodologies and the use of digital technologies were identified as promising alternatives, but they require planning, infrastructure, and teacher preparation. The integration of resources such as virtual simulations and artificial intelligence—already explored by F-Silva (2025) in Chemistry teaching—can be incorporated into Physics as a way to democratize access to experimentation and enrich learning.

It was also observed that issues of **inclusion and diversity** must not be treated as secondary. The inequality of access between urban and rural schools, the lack of resources for students with disabilities, and gender challenges in Physics reveal the need for an educational policy that is sensitive to differences. Initiatives that promote equity—such as adapted materials, the recognition of women scientists, and greater attention to peripheral schools—are fundamental to making teaching more just and inclusive.

Finally, **students' perception** of the discipline proved to be directly linked to the pedagogical practices adopted. When Physics is taught in a decontextualized manner, disinterest prevails; however, when concepts are connected to everyday life, accessible experimental practices are introduced, and students' active participation is valued, the discipline gains new meaning and fosters greater engagement.

Therefore, overcoming the challenges of Physics teaching in Brazilian public schools requires a systemic approach that involves:

- investment in school and technological infrastructure;
- appreciation and continuous training of teachers;
- encouragement of active methodologies and digital technologies;
- strengthening of inclusion and diversity policies;
- constant dialogue between teachers and students to reframe the discipline.

These points do not represent merely isolated solutions, but a **collective project of educational transformation**. Physics teaching, when critically rethought, can become a powerful instrument for scientific, civic, and emancipatory education, capable of preparing young people to face the challenges of the 21st century.

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