

THE IMPLEMENTATION OF BNCC COMPUTING IN SCHOOLS: TEACHER TRAINING, INFRASTRUCTURE, AND PEDAGOGICAL PRACTICES

**A IMPLEMENTAÇÃO DA BNCC COMPUTING NAS ESCOLAS: FORMAÇÃO
DOCENTE, INFRAESTRUTURA E PRÁTICAS PEDAGÓGICAS**

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ABSTRACT

Implementing the National Common Curricular Base (BNCC) for Computing is a challenge for Basic Education in Brazil, particularly because it requires the integration of curricular guidelines, teacher training, school infrastructure, and educational practices. Therefore, this study aimed to investigate the main obstacles to implementing the BNCC for Computing in Brazilian schools, with particular emphasis on the three latter aspects. The research adopted a qualitative approach and employed two complementary procedures: a literature review based on the analysis of theses, monographs, scientific articles, book chapters, and books, and documentary research grounded in CNE/CEB Resolution No. 1/2022 and CNE/CEB Opinion No. 2/2022. The integration of these procedures made it possible to establish a comparison between the scientific literature and the regulatory guidelines governing the implementation of the BNCC for Computing. The findings indicated that the consolidation of computational competencies in Basic Education is directly related to teacher training, the availability of appropriate resources, and the incorporation of computational thinking, the digital environment, and digital culture into pedagogical planning. It is concluded that implementation requires coordinated actions tailored to the diverse realities of schools to promote the development of the prescribed learning outcomes and the critical, creative, ethical, and responsible use of digital technologies.

Keywords: BNCC for Computing; Teacher training; School infrastructure; Pedagogical practices.

RESUMO

Implementar a Base Nacional Comum Curricular (BNCC) Computing é um desafio para a Educação Básica no Brasil, especialmente

porque é preciso articular orientações curriculares, formação de professores, infraestrutura escolar e práticas educativas. Portanto, este estudo se propôs a investigar quais são os principais obstáculos à implementação da BNCC Computing nas escolas brasileiras, com foco especial nos três últimos pontos mencionados. A pesquisa é de natureza qualitativa e foi elaborada através de dois métodos que se complementam: uma revisão bibliográfica, que se baseou na análise de teses, monografias, artigos científicos, capítulos de livros e livros, e uma pesquisa documental, que se fundamentou na Resolução CNE/CEB nº 1/2022 e no Parecer CNE/CEB nº 2/2022. A articulação dos referidos procedimentos possibilitou traçar um paralelo entre a produção científica e as orientações normativas que pautam a implementação da BNCC Computing. A pesquisa apontou que a consolidação das competências computacionais na Educação Básica está diretamente relacionada à formação docente, à oferta de recursos apropriados e à incorporação do pensamento computacional, do ambiente digital e da cultura digital ao planejamento pedagógico. Chega-se à conclusão de que a implementação exige ações coordenadas e ajustadas às diversas realidades das escolas, para promover o desenvolvimento das aprendizagens estabelecidas e um uso crítico, criativo, ético e responsável das tecnologias digitais.

Palavras-chave: BNCC Computing; Formação docente; Infraestrutura escolar; Práticas pedagógicas.

1. INTRODUCTION

The National Common Curricular Base for Computing (BNCC Computing) introduced a structured framework for Computing education in Brazilian Basic Education, addressing a previously unorganized area of learning. This development represents a

significant step forward, particularly in a context in which digital technologies permeate everyday life, from routine activities to increasingly complex tasks. In this regard, providing students with opportunities to understand the fundamental principles of Computing and their applications across different contexts is important, enabling them to move beyond simply using digital systems toward understanding how they work.

The BNCC Computing advances this goal by establishing competencies and skills related to computational thinking, the digital world, and digital culture, thereby creating opportunities for these areas of knowledge to become effectively integrated into teaching and learning processes.

However, a regulatory document alone cannot ensure the implementation of its guidelines. Translating these provisions into educational practice depends on adequately prepared teachers, schools equipped with the necessary technological infrastructure, and pedagogical practices aligned with the competencies established in the curriculum.

These conditions are not uniformly available throughout Brazil. School systems differ considerably, material resources vary among institutions, and teacher preparation for teaching Computing still requires further development. Understanding how these dimensions interact in specific contexts is therefore important for identifying not only the barriers to integrating the BNCC Computing into the Basic Education curriculum but also the conditions that may facilitate its effective implementation.

Against this background, the following research question was formulated: What are the main challenges related to teacher training, school infrastructure, and pedagogical practices in implementing the BNCC Computing in Brazilian schools? Investigating this question guides the analysis of the conditions required to translate curricular guidelines into practice, considering both the regulatory foundations of Computing in Basic Education and the educational, structural, and methodological factors involved in its implementation.

The general objective is to analyze the main challenges related to teacher training, school infrastructure, and pedagogical practices in implementing the BNCC Computing in Brazilian schools.

To achieve this objective, three specific objectives were established: to analyze the foundations of the BNCC Computing and the competencies prescribed for Basic Education, considering their implications for implementing Computing in Brazilian school contexts; to examine the challenges associated with teacher training and school infrastructure in implementing the BNCC Computing in Brazilian schools; and to discuss the possibilities and challenges of integrating computational thinking, the digital world, and digital culture into pedagogical practices in Basic Education.

Regarding the methodological procedures, this study adopts a qualitative approach and combines two complementary research procedures. The first consists of a literature review of theses, monographs, scientific articles published in conference proceedings and academic journals, book chapters, and books related to the subject. The second involves documentary research based on an analysis of CNE/CEB Resolution No. 1/2022 and CNE/CEB Opinion No.

2/2022, which establish regulatory guidelines for Computing in Basic Education. This combination makes it possible to relate contributions from the scientific literature to official guidelines, supporting the analysis of challenges associated with teacher training, school infrastructure, and pedagogical practices.

In addition to this introduction, the article is organized into three further sections. The second presents the theoretical framework, divided into three subsections addressing the foundations of the BNCC Computing and the competencies established for Basic Education, teacher training and school infrastructure, and the relationships among computational thinking, the digital world, digital culture, and pedagogical practices. The third section describes the methodology adopted, detailing the research approach and procedures. Finally, the fourth section presents the concluding remarks, revisiting the research objectives, synthesizing the main issues discussed, and identifying directions for future research.

2. THEORETICAL FRAMEWORK

2.1. BNCC Computing And Competencies For Basic Education

The introduction of Computing into Brazilian Basic Education responds to a concrete demand: organizing knowledge and competencies that enable students to understand the society in which they live, shaped by digital technologies, and to participate actively in it. CNE/CEB Opinion No. 2/2022 establishes guidelines for Computing in Basic Education as a complement to the National Common Curricular Base (BNCC). This means that it does not operate independently but relies on the curricular framework

already established by the BNCC to be effectively implemented across educational systems, providing guidance for incorporating Computing into school curricula. However, national guidelines do not translate into practice on their own. Educational systems are responsible for translating them into curricula, pedagogical planning, and learning experiences appropriate to each stage of schooling (CNE, 2022).

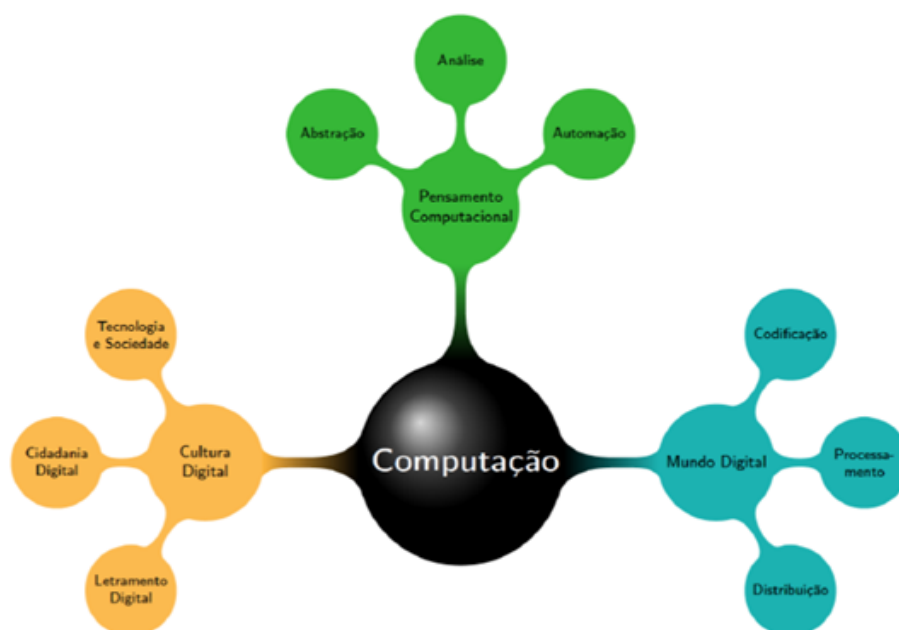
The BNCC Computing organizes learning in this field around three interconnected strands: computational thinking, the digital world, and digital culture. Brackmann et al. (2024, p. 06) state:

The BNCC Computing, published in November 2022, seeks to address the need for a dedicated standard that systematically covers the concepts and skills in this field. This supplement to the BNCC outlines specific competencies and skills to be developed at each stage and grade level of Basic Education, ensuring logical and coherent progression in Computing learning. It also adopts an integrated approach, connecting Computing education to real-life contexts and encouraging the practical application of knowledge. This includes everything from digital literacy in the early years of schooling, through algorithms and programming in Elementary Education, to more advanced topics, such as artificial intelligence and data analysis, in Secondary Education.

This organization highlights the progression of learning and the relationship between computational concepts and real-world situations. Figure 1 presents the three strands that structure Computing in Basic Education and their conceptual components,

illustrating the relationships among the dimensions established in the supplement to the BNCC.

Figure 1. Strands of Computing according to CNE/CEB Opinion No. 2/2022



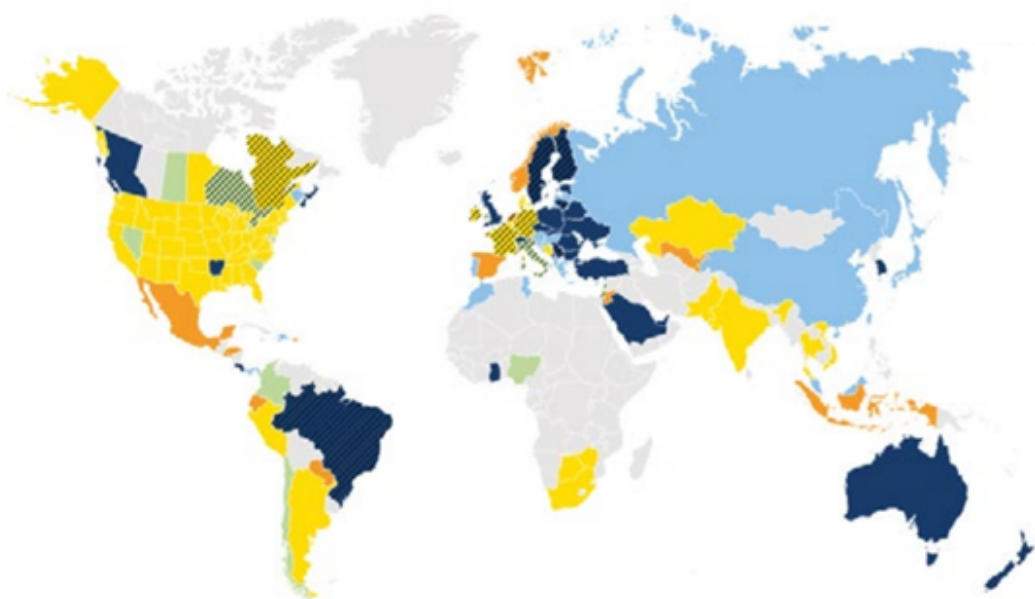
Source: CNE/CEB Opinion No. 2/2022

The curricular organization of Computing must also take into account the implementation conditions within each educational system. In their review of the literature on the BNCC Computing in Brazilian Basic Education, Silva et al. (2025) identify implementation as a research topic that requires attention to both curricular guidelines and their actual enactment in schools. Melo and Oliveira Junior (2025) address the BNCC Computing in their discussion of the National Conference on Education (Conae 2024), adopting a convergent perspective in which curricular decisions are linked to political disputes and competing visions of society. Therefore, implementation involves more than publishing a regulation and expecting its guidelines to be adopted. It also requires political, pedagogical, and institutional decisions.

The analysis of international experiences provides context for understanding the choices made in Brazil, without assuming that curricular models can be transferred directly from one country to another. Eloy et al. (2024) compare the BNCC Computing with documents from other countries, enabling an examination of similarities and differences in the organization of Computing education. Such an analysis must consider the specific characteristics of educational systems, the different stages of schooling, and the social and material conditions that affect educational provision. Figure 2 presents a map illustrating the different ways Computing is incorporated into national curricula, according to the image's legend and categories.

Figure 2 provides an international comparison of policies for incorporating Computing into education, using colors and hatching patterns to represent different levels of mandatory provision and distinct approaches to curricular delivery.

Figure 2. Presence of Computing in School Curricula in Different Countries.



Source: Brackmann et al. (2024)

The distribution shown on the map indicates that countries marked in dark blue have made Computing compulsory throughout Basic Education, whereas light blue represents compulsory provision restricted to either Elementary or Secondary Education. Light green denotes elective provision, while yellow identifies locations where Computing education is available in specific schools or districts. Orange indicates pilot projects or programs under implementation, whereas gray represents areas for which data are unavailable. The hatched areas represent cross-curricular approaches. Within this framework, Brazil appears in dark blue with hatching, indicating that Computing is compulsory and may be organized as a separate curricular subject or addressed through cross-curricular integration, as indicated by the image.

Implementing these guidelines requires teacher training that combines technological knowledge, curricular understanding, and critical reflection on teaching practices.

Cruz et al. (2023, p. 29) emphasize:

Ultimately, strengthening digital safety and positively enhancing the digital competencies of teachers and students will necessarily require the creation of training opportunities that encourage reflection on practices experienced in school settings, actively involving the main participants in the educational process, namely teachers and their students.

Teacher training must therefore engage with real classroom situations and support teachers in selecting strategies appropriate to the prescribed competencies, rather than being limited to the instrumental use of digital tools.

However, teacher training alone is insufficient. For Computing to become effectively integrated into school planning and pedagogical practices, institutional conditions must be in place to sustain this process. Santos and Coelho (2026) address this issue by discussing challenges and proposals for pedagogical practice in light of the relationship between schools and the digital world. Their discussion highlights a point that is easily overlooked: technological transformations also affect educational contexts and must therefore be taken into consideration. Regulatory guidelines, academic research, and international frameworks converge, each in its own way, on the same principle: curriculum, professional development, and the conditions for educational provision must be considered jointly rather than addressed in isolation. From this perspective, analyzing the foundations of the BNCC Computing and the competencies established for Basic Education is meaningful because it makes it possible to identify both what should be taught and the challenges Brazilian schools face in translating these guidelines into consistent educational experiences.

2.2. Teacher Training And School Infrastructure

Computing in Basic Education is regulated by CNE/CEB Resolution No. 1 of October 4, 2022, which supplements the National Common Curricular Base (BNCC) and provides guidelines for incorporating specific competencies and skills into teaching and learning processes (Brasil, 2022). Educational systems must provide teachers with the conditions necessary to understand the foundations of Computing and integrate them into pedagogical planning, taking into account the specific characteristics of each stage of schooling.

Teacher training is an important dimension of this process, as teachers need conceptual, technological, and pedagogical knowledge to implement curricular guidelines effectively. Velho et al. (2026) discuss the challenges of teacher training for incorporating computational thinking into Basic Education, while Mikuska, Prado, and Valente (2024) analyze Brazilian scientific literature on teacher education in Computing. These studies support an understanding of professional preparation as a process that extends beyond knowledge of computational concepts to include the ability to transform them into meaningful learning experiences aligned with educational objectives.

Pedagogical practice is not limited to mastering subject content, since learning also depends on how knowledge is presented and connected to students' experiences. Sperandio et al. (2019, p. 108) also emphasize that:

[...] teachers must not only demonstrate mastery of the subject matter but also understand the most effective ways to present content to students. These include analogies, illustrations, examples, explanations, and demonstrations. When teachers refer to practical activities, they may be using demonstrations and examples, whereas the use of virtual materials involves developing analogies and illustrations for content that may be distant from students' everyday experiences.

This perspective reinforces the need to prepare teachers to select resources and strategies that facilitate understanding of computational concepts by integrating explanations, practical activities, and digital materials.

Continuing professional development must also keep pace with advances in Computing-related knowledge and practices, including the possibilities and limitations of artificial intelligence in education. Duarte (2024, p. 22) states:

[...] the institutions responsible for training teachers who will teach or are already teaching mathematics, across different educational modalities and levels, must provide opportunities to learn computational thinking, not only at the basic level, as established by Brasil (2019), but also in ways that enable the development of digital competencies in the pedagogical area associated with the Fundamentals of AI category and its thematic areas, given that UNESCO (2022) indicates that this category accounts for 41% of the total time allocation.

This quotation highlights the responsibility of teacher education institutions to provide learning opportunities that go beyond initial familiarity with concepts and foster the development of pedagogical competencies related to emerging technologies.

In addition to individual or isolated institutional initiatives, professional development can be strengthened through learning communities and collaborative activities among teachers. Ni, Bausch, and Benjamin (2023), in their review of studies on professional development and learning communities for Computer Science teachers, provide a basis for discussing the importance of continuing education and the exchange of professional experiences among educators. In the Brazilian context, Padua and Azevedo (2026) address the estimation of teacher demand for implementing the BNCC Computing, raising a practical question: whether a sufficient number of qualified professionals is available to meet

implementation requirements. Teacher training, workforce availability, and pedagogical support are interconnected issues, and the ways in which they align, or fail to do so, have significant implications for educational planning.

School infrastructure represents the other major dimension of this challenge. Computers, devices, internet connectivity, software, teaching materials, and technical support determine which activities are feasible in practice and whether they can be sustained throughout the school year or are interrupted by technical failures. However, the mere availability of equipment does not guarantee curricular integration. Resources must be operational and aligned with learning objectives, a condition that is not always met. Moreover, disparities between educational systems and among schools within the same system are sufficiently pronounced that any implementation strategy based on uniform technological access is likely to produce unequal outcomes. Although this concern is not new, it remains a major obstacle encountered by implementation proposals in practice.

Teacher training and infrastructure do not operate independently. Teachers with adequate preparation need institutional conditions that allow them to apply what they have learned, while technological resources can only contribute effectively to learning when educators know how to integrate them into pedagogical practice. This relationship brings the discussion back to teacher training. Neves and Duarte (2024), in a review focused on the use of artificial intelligence, examine the relationship between computational thinking and teacher education, helping to contextualize professional preparation in light of rapidly changing educational demands. From this perspective, implementing the

BNCC Computing requires planning that integrates continuing professional development, the resources actually available in schools, and the monitoring of teaching practices, without allowing any of these areas to advance in isolation.

To organize these issues, Table 1 below brings together the two dimensions discussed throughout this section, teacher training and school infrastructure, relating each to the conditions that may facilitate or constrain the implementation of the BNCC Computing.

Table 1. Teacher training and school infrastructure in the implementation of the BNCC Computing.

Dimension	Aspects to consider	Implementation challenges
Initial teacher education	Fundamentals of Computing, computational thinking, and pedagogical content knowledge.	Integration of computational content into undergraduate teacher education curricula.
Continuing teacher education	Professional development, digital competencies, artificial intelligence, and teaching methodologies.	Regular provision of training aligned with teachers' specific needs.
Collaborative professional development	Learning communities, experience sharing, and joint planning.	Availability of time, institutional support, and continuity of professional development activities.
Technological resources	Computers, digital devices, software, and educational materials.	Availability, maintenance, updating, and suitability of resources for the proposed activities.
Connectivity and technical	Internet access, system functionality, and technical	Unequal access and difficulties in ensuring

support	assistance.	the continuity of activities.
Institutional coordination	Curriculum planning, management support, and integration of training and material resources.	Coordination of actions, pedagogical monitoring, and adaptation to each school's conditions.

Source: Prepared based on Brasil (2022), Sperandio et al. (2019), Duarte (2024), Mikuska, Prado, and Valente (2024), Neves and Duarte (2024), Ni, Bausch, and Benjamin (2023), Padua and Azevedo (2026), and Velho et al. (2026).

Table 1 shows that teacher training and school infrastructure do not operate independently in the implementation of the BNCC Computing. Rather, these dimensions are interdependent. Providing training courses or purchasing equipment achieves limited results when such initiatives are not accompanied by continuous professional development, institutional support, curriculum planning, and resources suited to each school's pedagogical objectives. It is also important to recognize that these challenges vary across educational contexts, depending on the characteristics of each educational system and the specific circumstances of individual schools. This variation requires consideration of both inequalities in access to technological resources and teachers' actual professional needs. Examining these dimensions jointly, particularly the relationship between teacher training and infrastructure, as well as between educational policy and school practice, helps identify the obstacles to implementing Computing in Basic Education and assess the extent to which curricular guidelines are effectively translated into practice in Brazilian schools.

2.3. Computational Thinking, The Digital World, Digital Culture, And Pedagogical Practices

Computational thinking is the ability to understand a problem, organize the available information, and develop a procedure leading to a solution. Its inclusion in Basic Education does not aim to transform schools into programming courses, since the cognitive processes involved are applicable across different fields of knowledge. Berto, Sakata, and Zaina (2017, p. 25) define this competency as follows:

Computational Thinking (CT) is defined as a set of skills focused on the fundamentals of Computer Science that help interpret and solve problems across all fields of knowledge [...]. This ability to “think computationally” is considered as important as other fields, such as Mathematics, Languages, and Science. Exposure to Computational Thinking concepts provides experiences that can encourage children to develop different skills, such as logical reasoning, problem-solving, pattern recognition, decomposition, and generalization, among others.

From this perspective, computational thinking becomes more than an additional curricular subject and instead emerges as a competency that can be developed across existing subject areas. This approach nevertheless requires careful consideration, since its integration at each stage of schooling depends on students' characteristics and the learning objectives established for that stage. Decomposing tasks, recognizing patterns, and solving problems are not exclusive to a single discipline. Their applicability across different subject areas supports the development of reasoning strategies and the use of knowledge in diverse situations.

Integrating computational thinking into pedagogical practices requires deliberate action, including instructional planning, purposeful teaching, and coordination across curricular components. André (2018, p. 103) emphasizes:

We can therefore deduce that the development of computational perspectives, practices, concepts, and competencies does not occur within a single learning situation but requires an integrated set of actions involving planned activities, the teacher's deliberate intervention, careful content selection, diversified disciplinary methodologies, and active student participation. Thus, a curriculum that promotes computational thinking is committed to connecting school subjects and activities with the learning outcomes expected throughout students' educational development.

This understanding highlights that the development of computational competencies depends on sustained educational experiences in which students participate in problem-solving, strategy development, and the evaluation of the procedures employed. In this process, teachers guide knowledge construction and connect computational concepts to learning situations, preventing activities from being reduced to the mechanical execution of instructions.

The digital world strand encompasses devices, systems, networks, and technological processes that enable digital environments to function and information to circulate. Miyamoto, Barreto, and Ajada (2023, p. 19) explain that “When we refer to the Digital World, we think of different artifacts, actions, and advances in Information and Communication Technology (ICT). This entire context becomes

increasingly relevant each day, as its use is no longer secondary but necessary.” In the school context, this dimension involves understanding how technological resources function, how data are represented and transmitted, and under what conditions digital tools are used. Its pedagogical treatment should promote not only the operational use of devices but also an understanding of the processes underlying their operation, while respecting students' age groups and the resources available at each institution.

Digital culture, in turn, encompasses transformations in communication, interaction, knowledge production, and social participation associated with digital technologies. Miyamoto, Barreto, and Ajada (2023, p. 22) emphasize that “Digital Culture is the way technologies influence people's lives, including economic, social, and cultural relationships. It is very important to exercise awareness and care in how they are used.”

Bortolazzo (2020, p. 374) expands this discussion by stating:

Digital Culture does not refer only to the possibilities offered by digital technology but also encompasses other ways of thinking and carrying out activities that have been incorporated through this technology and that, in turn, enable its existence. Referring to Digital Culture evokes a set of elements that includes digital telephony, instant communications, and telepresence. It also encompasses various media formats, including virtual reality, digital cinema and television, electronic music, computer games, and so forth. It also comprises a universe dominated by technology companies such as Microsoft, Apple, and Sony, as well as online retailers such as Amazon, AliExpress, Alibaba, and eBay, which appear to represent a new business model for the twenty-first century.

In Basic Education, this dimension translates into activities in which students critically analyze information, understand social relationships mediated by digital platforms, and act responsibly when sharing content. Digital education also calls for reflection on participation, authorship, privacy, and ethical conduct, consistently connected to technological knowledge and students' everyday experiences (Buckingham, 2019).

Integrating the three strands into classroom practice primarily depends on selecting pedagogical strategies aligned with curricular objectives and the learning conditions of each educational context. Games, unplugged activities, problem-solving tasks, sequences of instructions, and pattern-recognition exercises make it possible to address computational concepts without requiring constant access to a computer. When appropriate technological resources are available, programming, digital content creation, and experimentation can further expand learning opportunities. STEAM

approaches and maker culture also support interdisciplinary experiences, with an important qualification: activities must be designed to promote inquiry, creativity, and conceptual understanding rather than merely the manipulation of materials or devices (Costa; Gomes et al., 2025). The selection of methodologies must therefore consider learning objectives, resource accessibility, and students' active participation.

These practices do not emerge in isolation. They respond to cultural and educational transformations associated with the growing presence of technology in society. Malta et al. (2026) examine digital culture and pedagogical practice in light of the challenges and reconfigurations of contemporary education, while Santos and Coelho (2026) address challenges and proposals for teaching practice at the intersection of schools and the digital world. Considered together, these discussions help situate the implementation of the BNCC Computing beyond the simple introduction of equipment or applications into the classroom. Integrating Computing into the curriculum requires clearly defined objectives, teacher mediation, assessment aligned with intended learning outcomes, and opportunities for students to apply computational knowledge in diverse contexts.

Table 2 systematically presents the relationships between the Computing strands, teaching strategies, and implementation conditions within the curriculum, bringing together pedagogical approaches and the challenges associated with school organization.

Table 2. BNCC Computing strands, pedagogical possibilities, and conditions for implementation.

Strand or Dimension	Pedagogical Approaches	Implementation Conditions and Challenges
Computational thinking	Problem-solving, decomposition, pattern recognition, algorithm development, and unplugged activities.	Instructional planning, teachers' conceptual knowledge, and coordination with curricular components.
Digital world	Exploration of devices, systems, networks, data, and the operating processes of digital technologies.	Resource availability, connectivity, technical support, and alignment of activities with the educational stage.
Digital culture	Critical analysis of information, content production, digital communication, and reflection on ethics and responsibility.	Teacher mediation, education for the responsible use of technologies, and consideration of students' sociocultural contexts.
Curricular integration	Interdisciplinary projects, problem-solving, maker activities, and STEAM approaches.	Coordination across subject areas, explicit learning objectives, planning time, and learning assessment.
Organization of pedagogical practices	Alternation between plugged and unplugged activities, guided inquiry, and student participation.	Initial and continuing teacher education, infrastructure compatible with proposed activities, and adaptation to each school's conditions.

Source: Prepared based on Berto, Sakata, and Zaina (2017), André (2018), Buckingham (2019), Bortolazzo (2020), Miyamoto, Barreto, and Ajada (2023), Costa and Gomes et al. (2025), Malta et al. (2026), and Santos and Coelho (2026).

According to Table 2, the pedagogical implementation of the BNCC Computing involves curricular, methodological, and institutional dimensions that must be considered in an integrated manner. The availability of digital resources alone does not guarantee the development of the prescribed competencies, just as technology-free activities do not eliminate the need for purposeful planning and teacher mediation. Strategies must be selected according to educational objectives, students' specific characteristics, and the circumstances of each school. Therefore, translating these proposals into practice requires alignment among teachers' knowledge, available infrastructure, and the organization of learning experiences with the Computing strands.

Technological equipment alone is insufficient, just as teachers cannot be expected to overcome implementation barriers through individual effort alone. What distinguishes schools capable of integrating computational thinking, the digital world, and digital culture into classroom practice from those that struggle to do so is how curricular guidelines, teacher training, material resources, and methodological choices are coordinated within each institution. These challenges also vary according to institutional conditions, the sociocultural contexts in which schools operate, and the professional development opportunities available to teachers. Considering these dimensions together helps demonstrate that implementing the BNCC Computing depends not only on the availability of equipment but also cannot be achieved solely through teachers' individual commitment. Without adequate working conditions, planning, and institutional support, curricular guidelines remain regulatory provisions rather than being translated into meaningful learning experiences. It is at the intersection of the foundations of the BNCC Computing, the available infrastructure and teacher training, and

everyday pedagogical practices that this study seeks to identify the factors that most significantly affect Brazilian schools in this process.

3. METHODOLOGY

The implementation of the BNCC Computing in Brazilian schools involves curricular guidelines, teacher training, infrastructure, and pedagogical practices, and this study seeks to understand how these dimensions interact. The investigation draws on the regulatory foundations governing the incorporation of Computing into Basic Education and the conditions required for its implementation across different educational contexts. This dual concern guided the methodological procedures adopted, which combine existing scientific literature on the subject with the regulatory documents establishing implementation guidelines.

The study adopts a qualitative approach, which is appropriate for the interpretive analysis of educational phenomena involving normative, pedagogical, and institutional dimensions simultaneously. Lüdke and André (2021) note that qualitative research is particularly suited to capturing the meanings, relationships, and specific characteristics of phenomena while considering the contexts in which they occur. This capacity to examine complex issues that cannot be fully explained by quantitative indicators alone justifies the choice of approach. It enables the interpretation of concepts, guidelines, challenges, and relationships among different aspects of the same reality. In this study, the qualitative approach made it possible to critically examine the conditions for implementing the BNCC Computing without reducing the phenomenon to a single dimension.

Two complementary research procedures were employed: a literature review and documentary research. The literature review was based on the examination of theses, monographs, scientific articles published in conference proceedings and academic journals, book chapters, and books addressing the BNCC Computing, teacher training, educational infrastructure, and pedagogical practices. The sources were selected from academic repositories, digital libraries, scientific journal portals, conference proceedings, and other platforms disseminating scientific research, considering their relevance to the research question and established objectives. According to Arantes (2025), attention must be paid to the nature of the sources and the objectives of each procedure to maintain methodological consistency and distinguish among bibliographic research, documentary research, and systematic reviews.

The literature review was important for compiling and connecting theoretical contributions and findings from previous studies, enabling the identification of concepts, analytical perspectives, and issues relevant to implementing Computing in Basic Education. This process contributes to scientific knowledge by situating the investigation within existing research, fostering dialogue among authors, and providing a basis for understanding the subject under study. In this research, the literature review supported the discussion of the computational competencies expected of students, teachers' training needs, and the structural and pedagogical conditions that may either facilitate or constrain the implementation of curricular guidelines.

Documentary research, in turn, focused on two Brazilian regulatory documents: CNE/CEB Resolution No. 1 of October 4, 2022, which establishes standards for Computing in Basic Education as a

supplement to the National Common Curricular Base (Brasil, 2022a), and CNE/CEB Opinion No. 2/2022, approved on February 17, 2022, concerning these same standards and their relationship with the BNCC (Brasil, 2022b). Both documents were examined to understand the official guidelines underpinning the incorporation of Computing into school curricula and the implications of their provisions for the organization of teaching. This analysis drew on the methodological perspective discussed by Cellard (2019), who considers institutional and regulatory records relevant sources of information for investigating policies and social practices.

Direct examination of documents produced in institutional contexts makes it possible to identify their foundations, objectives, guidelines, and implications for the phenomenon under investigation. This is the main reason documentary research is relevant to this study. Cellard (2019) emphasizes that qualitative document analysis must consider the circumstances surrounding document production, as well as the documents' context and content. This principle guided the examination conducted in the present research. A resolution and an opinion issued by the National Education Council describe what should occur in Brazilian schools regarding Computing, but not necessarily what actually occurs. This distinction established the connection between documentary research and the literature review, making it possible to compare the regulatory provisions guiding the BNCC Computing with issues raised in the scientific literature, particularly those concerning teacher training, school infrastructure, and the organization of pedagogical practices.

The combination of these two research procedures proved appropriate for this study. The literature review provided the conceptual and analytical foundations, while documentary research

offered access to the official guidelines governing the implementation of the BNCC Computing. Their combined use supported a broader understanding of the subject, linking regulatory requirements to academic discussions about the conditions necessary for their implementation in Brazilian schools. Neither source, considered independently, would have been sufficient to address the research question or support the type of analysis proposed. The methodological strategy was appropriate precisely because of the complementarity between these distinct sources of evidence, in accordance with the qualitative approach and the established research objectives.

4. FINAL CONSIDERATIONS

The National Common Curricular Base for Computing (BNCC Computing) poses a challenge for Brazilian schools that cannot be resolved through regulatory provisions alone. Its implementation requires curricular guidelines to be aligned with teacher training, the infrastructure available in each school, and everyday classroom practices. This alignment is necessary to prevent Computing education from becoming an isolated curricular component and to fulfill its educational purpose of fostering critical thinking, problem-solving skills, and the conscious use of digital technologies. Accordingly, this study examines the main challenges associated with implementing the BNCC Computing, considering the conditions required to translate its guidelines into practice across diverse school contexts.

The research was guided by the following question: “What are the main challenges related to teacher training, school infrastructure, and pedagogical practices in implementing the BNCC Computing in

Brazilian schools?” The analysis was theoretical and organized around normative, educational, material, and pedagogical dimensions. Consequently, the results reflect the evidence and perspectives presented in the literature and regulatory documents rather than empirical observations of specific school contexts. This limitation must be acknowledged.

The discussion showed that these challenges do not occur independently. They emerge from the interaction among knowledge of Computing, teacher preparation, the technological resources available to each school, and each institution's ability to integrate these elements into its curricular planning. None of these dimensions can independently compensate for the limitations of the others. The analysis also demonstrated that these conditions must be considered jointly, since difficulties in one dimension directly affect the possibilities for progress in the others.

The general objective was achieved by examining the main obstacles related to teacher training, school infrastructure, and teaching methodologies in implementing the BNCC Computing in Brazilian schools. Similarly, the three specific objectives were addressed. The first enabled an analysis of the normative and pedagogical foundations of the BNCC Computing, as well as the competencies expected in Basic Education, positioning Computing as a field of knowledge to be incorporated into students' education. The second supported a discussion of schools' material conditions and the professional development requirements for teachers. The third contributed to understanding the possibilities for integrating computational thinking, the digital world, and digital culture into pedagogical practices.

The first section of the theoretical framework demonstrated that the BNCC Computing provides a foundation for organizing Computing-related learning in Basic Education, supplementing the BNCC and guiding the progressive development of competencies and skills. The discussion showed that implementing this educational framework involves curricular and pedagogical decisions that must account for the different stages of schooling, learning objectives, and the specific characteristics of school contexts. Therefore, making regulatory guidelines effective requires more than incorporating them into institutional documents. They must also be translated into teaching proposals consistent with established educational purposes.

The second subsection of the theoretical framework focused on two dimensions directly related to implementation conditions: initial and continuing teacher education and school infrastructure. Teacher training must encompass knowledge of Computing, digital competencies, and teaching strategies that transform subject content into meaningful learning experiences. Infrastructure, in turn, provides the conditions for organizing and sustaining educational activities, including the availability of equipment, connectivity, software, educational materials, and technical support. These conditions are not uniform. Educational systems and schools do not start from equivalent positions, and implementation strategies can only be effective when designed according to the resources and circumstances actually available in each context.

The third subsection examined the integration of computational thinking, the digital world, and digital culture into pedagogical practices. The analysis indicated that this integration can be pursued through problem-solving, task decomposition, pattern recognition,

algorithm development, unplugged activities, and the critical use of digital resources. These approaches enable Computing to be connected with other fields of knowledge, provided that activities are planned according to learning objectives and students' characteristics. In this respect, the third subsection revisits, from a different perspective, the issue addressed in the second: incorporating these strands into educational practice requires adequate teacher preparation and material conditions that enable educators to select appropriate methodologies and promote learning experiences grounded in the critical, creative, ethical, and responsible use of technologies.

The three dimensions examined in this article, teacher training, infrastructure, and pedagogical practices, do not operate in the same way across all Brazilian schools. Institutional conditions vary among educational systems, available resources differ, and teachers' professional development needs are not identical across contexts. One might therefore argue that discussing three interconnected dimensions merely acknowledges that each context is different, a reality already familiar to public school teachers. However, the value of examining these dimensions together lies less in generalizing their characteristics than in identifying where attention should be directed, even when the conditions encountered differ from one setting to another. Considered jointly, these dimensions help explain why implementing the BNCC Computing requires more than publishing curricular guidelines. It also depends on professional development, material conditions, and methodological choices that must be coordinated. Teacher training guides the pedagogical appropriation of computational knowledge, infrastructure determines whether different activities can actually be carried out, and pedagogical practices ultimately determine whether the

learning outcomes prescribed by the curriculum are realized or remain merely theoretical provisions. The complexity of implementation lies in this contextual variation rather than in a fixed set of challenges repeated identically across schools.

In this regard, the article proposes a systematic examination of the normative, educational, structural, and pedagogical aspects involved in implementing the BNCC Computing and of the relationships among them, an approach that brings together dimensions often addressed separately in the literature. The discussion provides a basis for planning teacher training initiatives, organizing school resources, and developing pedagogical practices consistent with curricular objectives. Rather than merely addressing a theoretical gap, examining these dimensions collectively contributes to academic and educational debates on the place of Computing in Basic Education and identifies issues that require further attention in the planning of policies and institutional initiatives.

Future research could investigate different educational systems empirically, covering multiple stages of Basic Education and diverse regional contexts, to examine how the guidelines of the BNCC Computing are translated into curricula and classroom practices. The provisions of a curricular framework do not necessarily correspond to what is ultimately implemented in schools. Further studies could also examine teachers' initial and continuing professional development needs, the conditions under which technological resources are accessed and used, and the pedagogical strategies employed to develop computational competencies. These are three interconnected areas that this article could address collectively but not investigate in the depth afforded by fieldwork. Longitudinal studies could also follow implementation initiatives

over time and examine their relationship with students' learning experiences. These research directions may broaden the scope of investigation and support the production of knowledge that informs evidence-based pedagogical and institutional decisions.

REFERENCES

ANDRÉ, C. F. O pensamento computacional como estratégia de aprendizagem, autoria digital e construção da cidadania. In: teccogs – *Revista Digital de Tecnologias Cognitivas*, n. 18, jul./dez. 2018, p. 94-109. Disponível em: www.pucsp.br/pos/tidd/teccogs/artigos/2018/edicao_18/teccogs18_artigo05.pdf. Acesso em: 11 set. 2026.

ARANTES, T. R. de R. Documentary research, bibliographic research, and systematic review: defining aspects and brief considerations. *Interdisciplinary Studies Notebooks*, v. 7, n. 2, e722501, 2025. ISSN 2764-394X. <https://doi.org/10.5281/zenodo.15799019>.

BERTO, L. M.; SAKATA, T. C.; ZAINA, L. A. M. Metodologia Para Ensino do Pensamento Computacional para Crianças Baseada na Alternância de Atividades Plugadas e Desplugadas. *Revista Brasileira de Informática na Educação – RBIE Brazilian Journal of Computers in Education* (ISSN online: 2317-6121; print: 1414-5685). Disponível em: https://www.researchgate.net/publication/336420934_Metodologia_Para_Ensino_do_Pensamento_Computacional_para_Crianças_Baseada_na_Alternancia_de_Atividades_Plugadas_e_Desplugadas. Acesso em: 11 out./26.

BORTOLAZZO, S. F. Das conexões entre cultura digital e educação: pensando a condição digital na sociedade contemporânea. *ETD - Educação Temática Digital*, Campinas, SP, v. 22, n. 2, p. 369–388, 2020.

BRACKMANN, C. et al. *Recomendações para implementação da BNCC Computação*. São Paulo: Fundação Telefônica Vivo, 2024. Disponível em: https://www.computacional.com.br/files/Implementacao/FTV_-Recomendacoes_para_Implementacao_da_BNCC_Computacao.pdf. Acesso em: 14 out. 2026.

BRASIL. Resolução CNE/CEB No. 1, de 4 de outubro de 2022: Define normas sobre Computação na Educação Básica, em complemento à Base Nacional Comum Curricular (BNCC). 2022. *Diário Oficial da União*. Acesso em: 21 set. 2026.

BUCKINGHAM, D. *Educação digital: princípios e práticas*. Porto Alegre: Penso, 2019.

CELLARD, A. *A análise documental na pesquisa qualitativa*. São Paulo: Unesp, 2019.

Conselho Nacional de Educação – CNE (2022). *Parecer CNE/CEB nº 2/2022, aprovado em 17 de fevereiro de 2022*. Normas sobre Computação na Educação Básica – Complemento à Base Nacional Comum Curricular (BNCC). Ministério da Educação (MEC), Brasília – DF.

COSTA, O. R. da; GOMES, R. L. R. et al. Cultura Maker e Steam na Educação Básica: Abordagens Inovadoras para a Aprendizagem Ativa. In: *Transformações Pedagógicas e Inovação Educacional*. São José dos Pinhais: Seven Company, 2025.

CRUZ, E.; FRADÃO, S.; VIANA, J.; RODRIGUEZ, C. Formação de professores e promoção da competência digital dos seus aprendentes: uma experiência em tempos de transição digital.

Cadernos CEDES, v. 43, n. 120, p. 19–32.
<https://doi.org/10.1590/CC271228>.

DUARTE, E. M. Formação de professores de Matemática e o Currículo de Inteligência Artificial da Educação Básica –Unesco. *Revista Paranaense de Educação Matemática*, Campo Mourão, PR, Brasil, v.13, n.31, p.1-25, mai.-ago.2024.

ELOY, A.; ALVES, L.; BLIKSTEIN, P.; LOPES, R. de D. Posicionando a BNCC Computação: uma comparação com documentos curriculares internacionais. In: *Simpósio Brasileiro de Educação em Computação (EDUCOMP)*(pp. 273-280). SBC. 2024.

LÜDKE, M. L.; ANDRÉ, M. *Pesquisa em educação: abordagens qualitativas*. São Paulo: EPU, 2021.

MALTA, Y. S. et al. Cultura Digital e Práticas Pedagógicas: Desafios e Ressignificações no Ensino Contemporâneo. *Revista Tópicos*, Rio de Janeiro, v. 4, n. 34, p. 1-26, 2026. ISSN: 2965-6672.
<https://doi.org/10.70773/revistatopicos/780548425>.

MELO, A. A. S. Gestão do conhecimento: Base nacional comum curricular, interesses e projetos de sociedade. In: MACIEL, C. E.; GOMES, M. P.; SIQUEIRA, R. M. (Org.). *Políticas educacionais democráticas em tempos de resistência*. 1ed. Brasília: ANPAE, v. 2, p. 116-130. 2021.

MELO, A. A. S.; OLIVEIRA JUNIOR, R. Base Nacional Comum Curricular de Computação (BNCC Computação) na Conferência Nacional de Educação (CONAE 2024). *Revista Brasileira de Informática na Educação*, vol. 33, 672-691. 2025.
<https://doi.org/10.5753/rbie.2025.4642>.

MIKUSKA, M. I. S.; PRADO, M. E. B. B.; VALENTE, J. A. Formação de Professores no Brasil em Pensamento Computacional: uma revisão sistemática de literatura. *Revista Iberoamericana de Tecnología en Educación y Educación en Tecnología*, (38):40–51. 2024.

MIYAMOTO, E. S.; BARRETO, C. F.; AJADA, J. P. (org.). *Experiências des(conectadas) e divertidas no Programa Escola Inovadora: pensamento computacional, mundo digital e cultura digital*. Livro II: 1º e 2º ano. Jundiaí: Prefeitura Municipal de Jundiaí, Núcleo de Apoio às Tecnologias Educacionais, 2023. 66 p. Disponível em: https://educacao.jundiai.sp.gov.br/wp-content/uploads/2023/11/1o-e-2o-Pensamento-Computacional.pdf_compressed.pdf. Acesso em: 13 out./26.

NEVES, C. P. da C.; DUARTE, E. M. Pensamento Computacional e Formação Docente: Um Estado do Conhecimento Precursor para o uso da Inteligência Artificial. *South American Development Society Journal*, [S. l.], v. 10, n. 30, p. 376, 2024. <https://doi.org/10.24325/issn.2446-5763.v10i30p376-406>.

NI, L.; BAUSCH, G.; BENJAMIN, R. Computer Science Teacher Professional Development and Professional Learning Communities: A Review of the Research Literature. *Computer Science Education*, 33(1):29–60. 2023.

PADUA, Y. S.; AZEVEDO, R. Quem Vai Ensinar Computação? Dimensionando a Demanda Docente para a BNCC Computação no Brasil. In: SIMPÓSIO BRASILEIRO DE INFORMÁTICA NA EDUCAÇÃO (SBIE), 37, 2026, Goiânia/GO. *Anais [...]*. Porto Alegre: Sociedade Brasileira de Computação, 2026. p. 71-86. <https://doi.org/10.5753/sbie.2026.26628>.

SANTOS, S. F dos; COELHO, L. A. A escola e o mundo digital: desafios e proposições para a prática pedagógica na sociedade hodierna. *Reflexão e Ação*, [S. l.], v. 34, 2026. <https://doi.org/10.17058/rea.34.20330>.

SILVA, V. de N. B. da; PRATA, D. N.; TREVISAN, D. M. de Q.; RODRIGUES, D. de C.. BNCC Computing in Brazilian Basic Education: a Systematic Literature Review. *Revista de Gestão Social e Ambiental*, São Paulo (SP), v. 19, n. 11, p. e013427, 2025. <https://doi.org/10.24857/rgsa.v19n11-010>.

SPERANDIO, M. R. et al. *Tecnologias digitais na formação docente: tecnologias da comunicação e informação*. Florianópolis: Universidade Federal de Santa Catarina, 2019. Disponível em: <https://repositorio.ufsc.br/handle/123456789/200627>. Acesso em: 14 out. 2026.

VELHO, V. de L. A. et al. BNCC Computação e Formação Docente: Desafios para a Inserção do Pensamento Computacional na Educação Básica. *Missioneira*. Santo Ângelo. v. 28. n. 9. p. 125-141. 2026. ISSN: 1518-0263. <https://doi.org/10.46550/8d4wav80>.

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