EMP Educação Matemática Pesquisa
ISSN 1983-3156
Qualis A1
http://dx.doi.org/10.23925/1983-3156.2023v25i3p049-078

Computational thinking in new high schools: An analysis of didactic works in mathematics and its technologies

El pensamiento computacional en la nueva escuela secundaria: Un análisis de trabajos didácticos en el área de las matemáticas y sus tecnologías

La pensée computationnelle dans le nouveau lycée : Une analyse des travaux didactiques dans le domaine des mathématiques et de ses technologies

O pensamento computacional no novo ensino médio: Uma análise das obras didáticas da área de matemática e suas tecnologias

Leandro Mário Lucas[1]
Universidade Estadual da Paraíba (UEPB)
Doutorando em Ensino da Rede Nordeste de Ensino (RENOEN/UEPB)
https://orcid.org/0000-0001-9627-4951

Filomena Maria Gonçalves da Silva Cordeiro Moita[2]
Universidade Estadual da Paraíba (UEPB)
Doutora em Educação (UFPB)
https://orcid.org/0000-0003-0184-6879

Lucas Henrique Viana[3]
Universidade Estadual da Paraíba (UEPB)
Doutorando em Ensino da Rede Nordeste de Ensino (RENOEN/UEPB)
https://orcid.org/0000-0003-4320-6888

Abstract

The inclusion of computational thinking (CT) in the National Common Curricular Base (Base Nacional Comum Curricular - BNCC), especially as it is associated with mathematics and its consequences in reformed Brazilian high schools, also caused changes in the didactic materials produced with potential reflections on teaching practices. Aware of this, in this article, we seek to answer the following question: How does the insertion of the CT impact the content of didactic works in mathematics and its technologies of the new high school? From this perspective, we aimed to analyze the impact of the insertion of the CT in the content of didactic works in the area of Mathematics and its technologies in the new high school. Our research, with a qualitative approach, is of the documentary type, and its methodological outline was built based on the assumptions of content analysis. To this end, we use as axes of analysis the frequency of the references made to CT, its position in the structure of works and collections and the importance given to mathematical learning. The data were analyzed in light of investigations on CT and the new high school system. The results showed that CT significantly impacted the contents of most of the works we analyzed due to the frequency with which it is mentioned, the position it occupies in its structure, and the importance it is given for mathematical learning, with potential implications for the practice and education of the teacher of this subject in the new high school.

Keywords: Computational thinking, New high school, Didactic works, Mathematics and its technologies.

Resumen

La inclusión del pensamiento computacional (PC) en la Base Curricular Común Nacional (BNCC), especialmente asociado a las matemáticas, y sus consecuencias en la educación secundaria brasileña reformada también provocó cambios en los materiales didácticos producidos a partir de entonces, con potenciales reflexiones sobre la práctica docente. Conscientes de ello, en este artículo buscamos responder a la siguiente interrogante: ¿Cuál es el impacto de la inserción del PC en el contenido de las obras didácticas del área de las matemáticas y sus tecnologías en la nueva escuela secundaria? Desde esta perspectiva, nos propusimos analizar el impacto de la inserción de lo PC en el contenido de los trabajos didácticos en el área de Matemáticas y sus tecnologías en la nueva escuela secundaria. Nuestra investigación tiene un enfoque cualitativo, es de tipo documental, y su esquema metodológico se construyó a partir de los presupuestos del análisis de contenido. Para ello, tomamos como ejes de análisis la frecuencia con que se menciona el PC, su posición en la estructura de obras y colecciones y la importancia que se le otorga para el aprendizaje matemático. Los datos fueron analizados a la luz de investigaciones sobre el PC y la nueva educación secundaria. Los resultados mostraron que el PC impactó significativamente los contenidos de la mayoría de los trabajos analizados, debido a la frecuencia con la que se menciona, el lugar que ocupa en su estructura y la importancia que se le otorga para el aprendizaje matemático, con posibles implicaciones en la práctica y en la formación de profesores de esta disciplina en la nueva escuela secundaria.

Palabras clave: Pensamiento computacional, Nueva educación secundaria, Obras didácticas, Matemáticas y sus tecnologías.

Résumé

L'inclusion de la pensée computationnelle (PC) dans le socle commun des programmes nationaux (BNCC), associée en particulier aux mathématiques et à ses développements dans le lycée brésilien réformé, a également provoqué des changements dans le matériel didactique produit, avec des réflexions potentielles sur la pratique de l'enseignement. Conscients de cela, dans cet article, nous cherchons à répondre à la question suivante: Quel est l'impact de l'insertion de la PC dans le contenu des manuels du domaine des mathématiques et de ses technologies dans le nouveau lycée ? Dans cette perspective, nous avons cherché à analyser l'impact de l'insertion du PC dans le contenu des travaux didactiques dans le domaine des Mathématiques et de ses technologies dans le nouveau lycée. Notre recherche, d'approche qualitative, est de type documentaire, et sa conception méthodologique a été construite sur la base des hypothèses de l'analyse de contenu. Pour cela, nous utilisons comme axe d'analyse la fréquence avec laquelle sont faites des mentions au PC, sa position dans la structure des ouvrages et des collections et l'importance qui lui est donnée pour l'apprentissage mathématique. Les données ont été analysées à la lumière des recherches sur la PC et le nouvel enseignement secondaire. Les résultats ont montré que la CP avait un impact significatif sur le contenu de la plupart des ouvrages que nous avons analysés en raison de la fréquence avec laquelle elle est mentionnée, de la position qu'elle occupe dans leur structure et de l'importance qui lui est accordée pour l'apprentissage des mathématiques, avec des implications potentielles pour la pratique et la formation de l'enseignant de cette matière dans le nouvel enseignement secondaire.

Mots-clés : Pensée informatique, Nouveau lycée, Manuels scolaires, Mathématiques et ses technologies.

Resumo

A inclusão do pensamento computacional (PC) na Base Nacional Comum Curricular (BNCC), sobretudo associado à matemática e seus desdobramentos no ensino médio brasileiro reformado, provocaram mudanças também nos materiais didáticos produzidos com potenciais reflexos na prática docente. Cientes disso, neste artigo, buscamos responder a seguinte pergunta: Qual o impacto da inserção do PC no conteúdo das obras didáticas da área de matemática e suas tecnologias do novo ensino médio? Nessa perspectiva, objetivamos analisar o impacto da inserção do PC no conteúdo das obras didáticas da área de Matemática e suas tecnologias do novo ensino médio. Nossa pesquisa, de abordagem qualitativa, é do tipo documental, e seu traçado metodológico foi construído com base nos pressupostos da análise de conteúdo. Para tanto, utilizamos como eixos de análise a frequência com que são feitas menções ao PC, sua posição na estrutura das obras e das coleções e a importância que lhe é dada para a aprendizagem matemática. Os dados foram analisados à luz de investigações sobre o PC e o novo ensino médio. Os resultados mostraram que o PC impactou significativamente os conteúdos da maioria das obras que analisamos devido à frequência com que é mencionado, à posição que ocupa em sua estrutura e à importância que lhe é dada para a aprendizagem matemática, com potenciais implicações na prática e na formação do professor dessa disciplina no novo ensino médio.

Palavras-chave: Pensamento computacional, Novo ensino médio, Obras didáticas, Matemática e suas tecnologias.

Computational thinking in new high schools: An analysis of didactic works in mathematics and its technologies

The inclusion of CT in the BNCC (Brasil, 2018) resulted in the insertion of this theme in documents and curricular guidelines that succeeded it, with many developments in the didactic materials produced, which also sought to adapt to this new context, giving rise to debates and discussions of a conceptual and didactic-pedagogical nature to improve their teaching in the classroom.

In the particular case of Brazilian high schools, these discussions are also important because of the reform implemented (MEC, 2018), which gave it the status of "new high school" and caused significant changes in the didactic material offered by the National Book and Didactic Resource Program (Programa Nacional do Livro e do Material Didático - PNLD).

In addition, with the associated BNCC recommendations on CT's approach, especially in mathematics and its technologies, it is necessary to understand the developments of these guidelines in the didactic material offered and adjusted to the guidelines of the reform above.

Aware of this, in this article, we seek to answer the following question: How does the insertion of the CT impact the content of didactic works in mathematics and its technologies of the new high school? From this perspective, we aimed to analyze the impact of the insertion of the CT in the content of didactic works in the area of Mathematics and its technologies in the new high school.

For this, we define as axes of analysis the frequency with which references are made to CT, its position in the structure of works and collections, and the importance given to it for mathematical learning by using the qualitative methodological approach (Bogdan & Biklen, 1994), of the documentary type (Ludke & André, 1986), relying on assumptions of content analysis (Bardin, 1977).

In structural terms, this article has been divided into five sections in addition to this introduction. The following section addresses CT as a curricular thematic trend in basic education. Then we discussed 'the new high school' and its changes and controversies. Next, we present the methodology used for the research development, the analyses and the final considerations.

CT: a curricular thematic trend in basic education

The current ubiquity of digital technologies (DT), their impacts on people's lives, and their potential to enable access to information and store it have put even more in check the teaching that transmits knowledge, demanding skills and abilities to solve problems in the complexity of the data that have become available.

In this new perspective, there are understanding that it is necessary to master the principles of computer science, regardless of the area of activity, either to use such technologies better or to improve the quality of life (França & Tedesco, 2019) because today, computers are forcing digital literacy as an essential skill to succeed in the 21st century (Shute et al., 2017).

Within the discussions that took place in this context, aspects related to the concepts of computing and its implications on the intellectual structure of people became of interest in the investigative and educational spheres. In this scenario, CT has become a relevant theme in research and educational practice, reviving the term already mentioned by Seymour Papert, when he presented the basis for computer-mediated learning. However, there was no deepening of CT, perhaps because of the limitations of computers back then, which did not allow their integration into everyday life (Papert, 1980).

In the mid-2000s, and therefore in another technological reality, Janette Wing (2006) resumed this term, brought a new vision of the relationship between computers and humans and presented it as a fundamental skill for everyone, not only for computer scientists, as well as the importance of knowing how to read, write and calculate. Thus, thinking computationally does not mean thinking like a machine. It means that one has acquired an intellectual structure or a set of mental tools to solve problems effectively, as computer scientists do.

Shute et al. (2017), starting from Wing (2006), present the following cognitive processes underlying CT: the reformulation of the problem, which consists of making it solvable; recursion, which involves the incremental treatment of the problem, based on previous information; decomposition, which consists of dividing the problem into smaller and manageable parts; abstraction, which is the ability to focus on the relevant information of the problem; and systematic tests, which consists of verifying the solutions found.

Of all these processes, the most relevant is abstraction because it is present in the others and makes it possible to capture the properties of objects at different levels of generalization and deal with complexity from the emphasis on the variables essential for understanding and solving problems (Wing, 2008, 2014, 2017). However, Wing (2006) does not present a focal definition of CT. The researcher's writings reveal that this was one of her concerns since, in her studies, it is possible to find more than one definition for this way of thinking.

Of the definitions presented, one of the most cited was developed in partnership with other researchers, who define computational thinking as "the thought process involved in the formulation of problems and their solutions, so that solutions are represented in a way that can be effectively carried out by an information processing agent" (Wing, 2010, p.1)[1].

Wing (2014), however, presents a slightly different definition from that, which was later reused, and conceptualizes CT as the "thought process involved in the formulation of a problem and in the expression of its solution or solutions in such a way that a computer — human or machine — can carry it out effectively" (Wing, 2017, p. 8). However, these conceptual modifications keep CT not limited to using computers, understanding it as a problem-solving approach in different contexts (Wing, 2008).

Other researchers, organizations, and entities have also dedicated themselves to defining CT, but there is still no consensus on its concept nor on the skills, competencies or pillars that support it (da Silva et al., 2022; Valente, 2016; 2019).

This fact has led to attempts to conceptualize CT collectively or from other definitions, such as the International Society for Technology in Education (ISTE) and the Computer Science Teachers Association (CSTA), which released an operational definition from the approval of computer science teachers. Kalelioglu et al. (2016) verified the definitions of CT in 125 articles and found that the most recurrent words are abstraction, algorithm thinking, problem solving, and pattern recognition.

Brackmann (2017) considers CT as a distinctly human capacity based on four pillars: decomposition and abstraction, as described by Shute et al. (2017), and pattern and algorithm recognition, respectively associated with the ability to use solutions already carried out in similar problems and create a sequence of steps that allows them to be solved efficiently.

As defined, such pillars also do not represent a consensus, and it is possible to find researchers who use others or more than four concepts or base elements associated with CT. This gap is intrinsically associated with the topicality of CT as an investigative field and its evolution. However, the speed with which this theme has been inserted into the curricula has highlighted other deficiencies from the didactic-pedagogical point of view.

Therefore, the issue of the evaluation of the CT (da Silva et al., 2022; Mühling et al., 2015; Santos et al., 2021) and the absence of a complete report of its correlations with other psychological constructs, with the force of compromising its insertion in the curricula to its full potential (Román-González et al., 2017) are pointed out.

[1] In the text by Wing (2010), reference is made to this definition as being from a work still in progress , entitled "Demystifying Computational Thinking for Non-Computer Scientists" (Cuny et al., 2010). However, we did not find this work published.

If we consider that we solve problems conditioned by reality (D'Ambrósio, 1998), we understand that we need to do more research on the implications of the sociocultural context as a condition for the development of CT. However, we realize that there is a predominantly cognitive approach that aims to understand and develop CT skills and abilities (da Silva et al., 2022).

In line with this approach, we observed that the integration of CT in the curricula has occurred through the inclusion of computer science themes, disciplines that explore it with the use of technologies and as cross-cutting content (Valente, 2016), with a predominance of computational tools (Barcelos et al., 2015) and, therefore, the plugged approach in studies and educational practices, even if investigations and unplugged practices have been perceived, using only "offline activities (without the use of machines or electronic devices)" (Brackmann, 2017, p. 21).

This fact brings us to the problem of educating teachers to use digital and computer resources, which persists "even after 40 years of digital insertion in Brazilian education" (Cardoso & Figueira-Sampaio, 2019, p. 44). This lag has direct implications for the insertion of CT in the classroom since it is an integral part of these resources, without being limited to them.

In addition, also because of the contemporaneity of CT as a research field, there is still a lag and little systematization of investigations associated with teacher education and teaching, which makes good pedagogical practices unfeasible (da Silva et al., 2022; Silva et al., 2017).

Despite these gaps, some data indicate the importance, presence, and applicability of CT on several fronts, such as in people's daily and professional lives, in various areas of knowledge, in employability, in areas of computing, in increasing productivity and in learning other disciplines.

Wing (2014) states that CT is one of the bases of digital literacy of the 21st century and enhances intellectual skills that enable the exercise of citizenship and criticality, as well as problem solving in any domain. In addition, Wing (2008) states that CT is a type of analytical thinking that shares the general ways of solving a problem with mathematical thinking.

A particular case of the intersections between CT and mathematics is the connection between CT and algebra, mainly because they have close languages based on variables, pattern recognition, and abstractions. However, it is possible to identify approximations of this knowledge through modeling, data analysis, and interpretation, statistics and probability, among other mathematical contents.

Therefore, it is reasonable to think that the development of CT skills contributes to mathematical learning and vice versa. This fact has aroused the interest of researchers worldwide, who seek to understand how to integrate it into basic education, especially since 2010 (de Jesus Garcia & Borges, 2022; França & Tedesco, 2019; Wing, 2017).

Nonetheless, non-governmental technology and computing organizations and institutes, such as the Massachusetts Institute of Technology (MIT) and, in Brazil, the Lemann Foundation, have also implemented actions to stimulate CT in schools.

As a government initiative, one milestone is Computer Science for All, announced by Barack Obama as President of the United States, to develop students' skills required by the economy of the digital age. In addition, countries such as the United Kingdom, Denmark, Australia, China, New Zealand, Finland, Germany, Argentina, South Korea and France have inserted CT in the basic education curriculum.

Thus, we can infer that the importance, applicability and ubiquity of CT today in various areas of knowledge, in people's daily lives, in sciences, among many other contexts, has given it notoriety in such a way that official education cannot ignore it, in a movement that characterizes it as a **curricular thematic trend in basic education.**

In Brazil, this movement echoed in the BNCC (Brasil, 2018), according to which elementary school mathematics should focus on understanding and developing CT. In high school, this development must continue, considering the ubiquity of digital information and communication technologies (DICT), their influences on today's society and an integrated and integrative view of mathematics applied to reality.

We emphasize that the protagonism of mathematics as knowledge that incorporated CT may suffer modifications with the inclusion of computing as a subject in basic education (MEC, 2022), an initiative of the Brazilian Computing Society (Sociedade Brasileira de Computação - SBC). However, as pointed out by the New High School Guidelines [Novas Diretrizes do Ensino Médio] (MEC, 2018), Art. 8, the curricular proposals of this stage of basic education must guarantee actions that promote it, not mentioning a specific discipline and, therefore, conceiving such actions in any area of knowledge. This is among many other changes that have occurred in the new high school, which we will deal with below.

New high school: changes, controversies and implications for PNLD

Law n. 13.415, of February 16, 2017, amended other Brazilian education laws and guidelines, establishing a new pedagogical model for high school. These changes have implications in the articulation between professional education and propaedeutics, in the workload and the type of knowledge necessary to be a teacher, with the institutionalization of the professional of notorious knowledge.

There was also a dilution of the disciplines in the areas of BNCC - Languages and their technologies; Mathematics and their technologies; Natural Sciences and their technologies, and Applied Human and Social Sciences - and the addition of educational itineraries, free choice of the student, which include, in addition to these areas, technical and professional formation.

The idea that permeates these transformations is the search for an integral and integrated formation, which considers the physical, cognitive and socio-emotional dimensions of the student and collaborates to carry out his life project (Costa & Silva, 2019; de Souza Corrêa et al., 2022), which, from the perspective of its creators, was not possible because of the various problems presented by the "old" high school.

From this perspective, the reform of high school was officially justified based on problems such as the low performance of students in external and internal evaluations, non-compliance with the goals established by the Brazilian Education Guidelines and Bases Law (Lei de Diretrizes e Bases da Educação Brasileira - LDB), the rigidity and uniqueness of its curriculum, the excess of subjects, and the ineffectiveness in promoting youth protagonism. They also pointed out as justification the lack of dialogue with young people and the productive sector, the numerous public outside the right age, and the lack of compliance with the guidelines of international organizations (Bezerra Filho, 2016; Ferreira & Ramos, 2018; Gonçalves, 2017).

However, despite not denying the problems that high school presents, many researchers, educators, and organizations have spared no criticism of the implemented reform. In this sense, the Brazilian Curriculum Association (Associação Brasileira de Currículo - ABdC), the National Association of Postgraduate Studies and Research in Education (Associação Nacional de Pós-Graduação e Pesquisa em Educação - ANPEd), and the National Association for the Training of Education Professionals (Associação Nacional pela Formação dos Profissionais da Educação - ANFOPE) address the authoritarian way in which high school was reformed through a provisional measure, without dialoguing with the academic community and with educators.

Another point of contention is the adoption of the discourse of the curriculum internationalization movement, mobilized by transnational organizations such as the World Bank, which advocate the alignment of education with the current world economic system, discursively presented as an alternative for updating, innovation, efficiency and modernization (Thiesen, 2019). Hence, the report of the *International Commission on Education for the*

Twenty-first Century (Delors et al., 1996) is cited, which reproduced the famous motto: "Learning to learn", alluding to the need for learning not only during schooling.

The implementation of a competency pedagogy, associated with a reformist vision of education and society (da Silva & Boutin, 2018; Saviani, 2013), assessed nationally and internationally by large-scale tests, has been accused of wanting to adjust individuals to the conditions of society. There are also criticisms of the formative itineraries, associating them with the formative options of the military dictatorship and making reservations about its insufficiently varied offer, which undoes the discourse of protagonism and flexibility underlying its proposal (Branco et al., 2018; da Silva & Boutin, 2018; Gonçalves, 2017).

The promotion of a full-time school, without a vision of integral education and technical-professional formation articulated with propaedeutics, is also placed within the discussions that repudiate the new high school on the grounds that, in practice, the historical vocation of the disadvantaged for the labor market is institutionalized. About this, Süssekind (2019) states that the "new" high school is arrogant, indolent, and malevolent; it causes injustices, invisibilities and nonexistences; it objectifies knowledge, wounds autonomy, dehumanizes the teaching vocation, and de-characterizes the student as different and legitimate, transforming him into an object of the right to learn.

Thus, in several spheres, the status of innovation officially given to the new high school is questioned, through the identification of vices historically present in the processes of curriculum construction. These questions seem to have gained strength with the inauguration of the new Brazilian government in 2023, which has been discussing with union organizations and other spheres of society about the necessary adjustments, without, however, considering it pertinent to revoke it at this time, as recently reported in the press[2].

In this scenario, the implementation of the new high school, which began in 2022, expected to be fully effective in 2024, apparently will not have its path totally interdicted, even under the tutelage of a new government, which has a different ideology than the one that idealized it. Thus, changes that were prerequisites for such implementation have not yet suffered a significant impact and continue with the same format established or demanded by the reform, as in the case of didactic materials approved by the National Program for the Distribution of Teaching Resources (Programa Nacional de Distribuição de Material Didático - PNLD).

---

[2] Available at:<https://g1.globo.com/economia/blog/ana-flor/post/2023/04/06/nao-vamos-revogar-suspendemos-e-vamos-discutir-diz-lula-sobre-novo-ensino-medio.ghtml >. Accessed on May 7, 2023.

This program, whose emergence brings us back to the creation of the National Book Institute (Instituto Nacional do Livro – INL) in 1937, underwent several changes, which were essential to reach the scope acquired today.

Through this lens, we highlight the transformations in the Textbook Program for Elementary Education (Programa do Livro Didático para o Ensino Fundamental - PLIDEF) and its proposal to extend the supply to the 1st and 2nd grades of public and community schools in 1985; in 1996, the materials produced began to be analyzed and pedagogically evaluated by researchers and teachers to obtain greater quality and nationalization; and, in 2010, there was an expansion to all high school, with the name of the National Textbook Program for High School Education (Programa Nacional do Livro Didático para o Ensino Médio - PNLEM), definitively consolidating itself as Brazilian educational policy (Albuquerque & Ferreira, 2019; da Silva Fernandes et al., 2021).

With the construction of the new high school, one of the most significant changes in history at the PNLD occurred. The regulatory framework of these modifications is Decree N. 9099, of July 18, 2017, which changed the name of said program to National Textbook and Teaching Resources Program (Programa Nacional do Livro e do Material Didático) from the absorption of the actions of the National Program Library at School (Programa Nacional Biblioteca na Escola - PNBE).

In its new format, PNLD began to evaluate the books produced, having as axes the competencies and skills of the BNCC. In this new format, the program expanded its objective to improve teaching, learning and education, guaranteeing material to support educational practice, democratizing sources of information and culture, and fostering reading and the student’s investigative attitude. The PNLD also aims at teachers’ updating, autonomy, and professional development and the implementation of the BNCC.

Carried out periodically and contemplating all stages of basic education, the PNLD also began to cover literary and pedagogical works, educational software and games, reinforcement materials, teacher training and school management. However, higher education institutions were excluded from the evaluation of teaching resources, whose choice, previously made by schools, was delegated to education networks.

In the case of the new high school, textbooks seek to contemplate the areas of knowledge and address the same subject in different areas, aiming to stimulate interdisciplinarity, the challenges of current society, youth protagonism and, through contextualization, dialogue with the student reality (da Silva Fernandes et al., 2021). For this, they are organized into five objects of knowledge: ‘Works of integrative projects and Life Project’, ’Didactic works by area of knowledge and specific', 'Works of continuing education', 'Digital educational resources' and 'Literary works'.

The didactic works by area of knowledge, as described on the PNLD-Digital website, are composed of students' printed books and digital materials (only for languages and their technologies), teachers' printed manuals, a collection of audios and, optionally, video tutorials. Each work consists of six volumes that, in general, address, in an articulated way, the general and specific competencies, the skills of the area of knowledge to which it belongs, contemporary themes and youth cultures, according to what the BNCC indicates.

Encouraging interdisciplinarity, transversal content, autonomy, creativity, innovation, youth protagonism, development of research competence and resolution of real-world problems in all areas, not only in mathematics, are also at the heart of the works by area of knowledge.

In the case of mathematics and its technologies, it is oriented to the non-use of artificial contexts, produced only to exemplify a false application of concepts and a content approach that contemplates current and relevant themes, especially the CT, whose impact of its inclusion in the didactic works of the area mentioned above is analyzed in articulation with the following methodology.

Methodology

This article used a qualitative approach (Bogdan & Biklen, 1994), considering only the conceptions of the authors of didactic works in mathematics and their technologies as data sources. These works, which are written archives and, therefore, documents, assume requirements that characterize them as primary sources, which typifies our research as documentary (Ludke & André, 1986).

To construct the methodological outline, we rely on assumptions of content analysis, which Bardin (1977) defines as

> [...] A set of communication analysis techniques aiming to obtain through systematic procedures and description objectives of the content of indicator messages (quantitative or not), the inference of knowledge related to the production/reception conditions (inferred variables) of these messages (BARDIN, 2009, p. 44).

With this, Bardin (1977) provides a set of techniques capable of generating indicators that enable us to understand, in depth, the content studied and its production context. For this, it defines three phases of the analysis, organized into three chronological moments, whose main functions are described in Table 1.

Table 1.

Chronological moments of content analysis (Bardin, 1977)

Chronological moments	Role
Pre-Analysis	Production of the research corpus/ selection of the initial material; floating reading; constitution of the sample.
Material exploration	Coding or enumeration of the material according to previously established rules.
Treatment of results, inference and interpretation	Choice of record or context units; counting rules; classification/aggregation or choice of analysis categories.

In our research, the pre-analysis consisted of selecting the didactic works in mathematics and their technologies, in the[3] Digital Guide-PNLD, which formed the corpus, initially composed of ten collections and 60 volumes from seven different publishers, approved in 2021. We chose these works because they were approved in the first evaluation process and adjusted to the norms of high school reform.

Also, in this first moment, we read the available reviews and cataloged the names of the publishers and the collections approved in an electronic spreadsheet, through a code formed by the letters "E" (publisher) and a number referring to the order in which we accessed it in the Digital Guide, and C (collection), along with a number indicative of the number of approved collections of the same publisher. Thus, the E4C2 code indicates a second approved collection from the fourth publisher we accessed in the digital guide.

As Bardin (1977) points out, not everything that constitutes a corpus of research is necessarily the object of analysis. The extraction of what will be analyzed and constitute a sample depends on criteria that must align with the rules of completeness, representativeness, homogeneity, and pertinence[4].

From this perspective, the objective of our research, the unavailability of the complete works in the digital guide and the practicality of the search to be carried out made us explore

[3] Available at: < https://pnld.nees.ufal.br/>. Acess in: August 14th. 2022.

[4] According to Bardin (1977), the sample must be constructed taking into account all elements of its corpus (rule of completeness), representative in relation to the set of elements initially selected (rule of representativeness); it must be chosen based on clear and precise criteria, which make it impossible to have elements with too much uniqueness (rule of homogeneity), and consist of documents that are adequate sources of information and correspond to the objective that raises the analysis (rule of relevance).

the material made available on the publishers' websites observing the exclusion criteria shown in Table 2.

Table 2.

Exclusion criteria for the constitution of the analysis sample (Constructed by the authors)

Exclusion criteria	**Association with Bardin's rules (1977)**
Internet unavailability in PDF	Relevance, because we would have no way to analyze the content in a practical way and achieve our goal.
It is not the teacher's book.	Homogeneity, because mixing teacher's books with students' books would make the sample heterogeneous.
Blocked for smart search	Relevance, because it would make our search less practical, making it difficult to achieve our goal.

After applying these criteria, the analysis sample consisted of eight collections from five different publishers, which resulted in a total of 48 volumes, indicated in this article by the codes E1C1, E2C1, E2C2, E3C1, E4C1, E4C2, E5C1, and E5C2. This sample allowed us to comply with the rule of representativeness since it corresponds to 80% of the corpus of documents initially produced.

We then downloaded all volumes from the selected collections, and saved them in folders on our personal computer, cataloguing them with the codes above, followed by the characters V1-V6. Thus, the code E2C1V3 indicates the third volume of the first approved collection from the second publisher we accessed in the 2021 PNLD.

Then, using the shortcut CTRL + F and typing the term "computational thinking", we counted the frequency with which the term was mentioned and read the texts in which it was found, thus complying with the rule of exhaustiveness.

The analysis and counting rules we used are shown in Table 3 below.

Table 3.

Counting/Analysis Rules (Constructed by Authors)

Axis of analysis	**Counting/analysis rule**
Frequency with which the term "computational thinking" was mentioned	Sum of the absolute values of the times when the term "computational thinking" appeared in the selected collections, according to the search shortcut CTRL + F.

Position of CT in the structure of didactic works	Location of texts that address CT in the guidelines for teachers and in the contents for students through the shortcut CTRL + F, reading and identification of the most recurring contents.
Importance of CT for mathematical learning	Location through the shortcut CTRL + F of the texts with explicit mentions about the importance of CT for mathematical learning and identification of the most recurrent contents.

We defined the axes as mentioned above of analysis a priori because, in general, a theme that causes impact tends to be more cited, to occupy relevant spaces in the form of themes of volumes and/or chapters, in the summaries, in the form of objectives, justifications, among other prominent positions, and to be relevant to the learning of the contents in which it is inserted.

In addition, the large number of data we dedicated ourselves to analyzing required a focus and, at the same time, flexibility so as not to miss other important topics. For this reason, we organized the most recurring contents in spreadsheets, using coding of the volumes of the collections above. After this step, we organized the page on which the text was removed for later cataloguing, categorization and analysis, which corresponds to the moment of treatment of the results, inference and interpretation (Bardin, 1977) presented below.

Analyses

The works we analyzed referred us to the conditions of their production context (Bardin, 1977), which involves the need to meet the guidelines of the BNCC (Brazil, 2018) and the norms of high school reform (Law No. 13,415, of February 16, 2017), as well as the understanding of their relations with the social moment that our country lives in recent years.

In this perspective, our comparative sense with the 2018 PNLD was activated, and we found that in eight collections of mathematics approved that year, still in the mold of the "old" high school, there are no records of the term "computational thinking". On the other hand, in 2021, we obtained the following result, recorded in Figure 1:

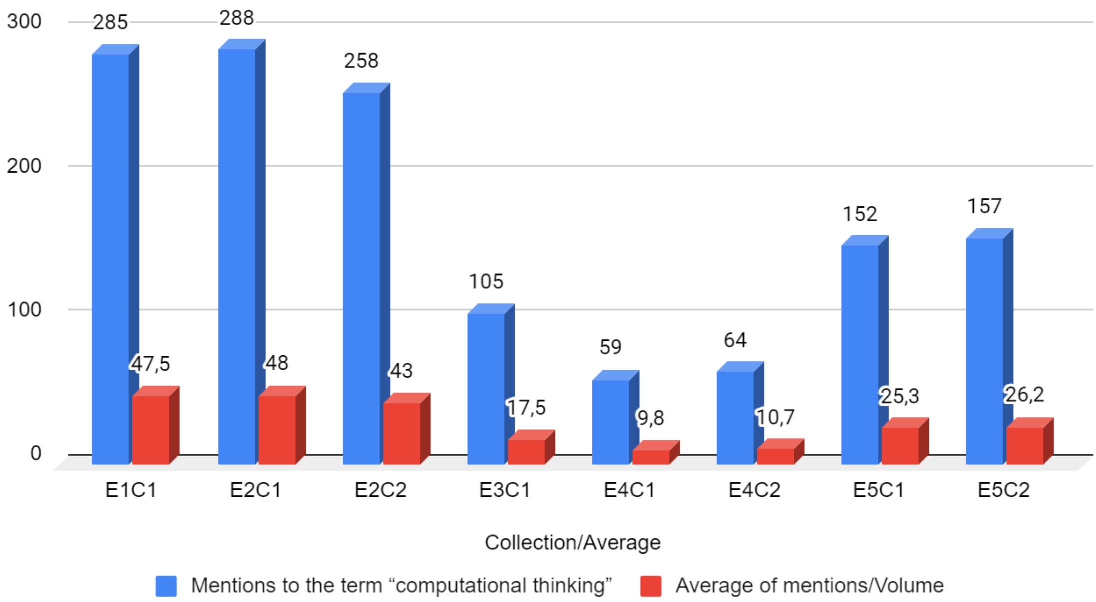

Figure 1.

Mentions made to the term 'computational thinking' and average mentions by volumes of didactic works in mathematics and its technologies (Analysis sample)

So, CT is mentioned in all the collections we searched. In three of them (E1C1, E2C1, and E2C2), the number of mentions per collection is greater than 250, and the average by volume is greater than 40. In two others (E5C1, E5C2), these numbers are respectively greater than 150 and close to 25 and, for the rest (E3C1, E4C1, E4C2), they are below 150, with an average of less than 20 mentions per volume.

The contrast in relation to the absence of CT in the 2018 books is related to the short time of publication of the final version of the BNCC in relation to the PNLD of that year, the deadline given for adjustments to the new high school or even the topicality of CT as a field of research and the gaps of this resulting fact, such as those associated with evaluation, teacher education or little understanding of the relationship it maintains with other psychological constructs (da Silva et al., 2022; Mühling et al., 2015; Román-González et al., 2017; Silva et al., 2017).

Thus, the 2021 data indicate that the inclusion of CT alone in the works we analyzed impacts the traditional structure of knowledge to be taught in mathematics, with potential implications for teachers, who, until then, did not have it in the list of contents to be taught to students. In addition, the high frequency of mentions of CT reveals that it was not included only as complementary or illustrative content, as suggested by the distribution of these mentions in the structure of the works and collections, shown in Table 4.

Table 4.

Distribution of CT in the structure of didactic works and collections in the area of mathematics and its technologies (Analysis sample)

Structure	Frequency in collections
In [orientações gerais] general guidelines (OG) [e/ou específicas] and/or specific (OE) guidelines for teachers	100%
In the summary of OGs	75%
As main volume content of the collection and/or volume chapter	12.5%
In the form of objectives, justification or presentation of volumes and/or chapters	50%
In the form of sections and boxes	100%
Such as activities, exercises or problems	100%

As explained, all the collections we analyzed address CT in the OG and OE for teachers, in the form of contents, activities, exercises and problems and/or sections and boxes for students. The numbers related to its presence in the summaries of OGs, as the main theme of volume and/or chapter or in the form of objectives, justification or presentation, indicate that, in many cases, it is the main content to be studied. The following excerpts corroborate our assertions.

> Collection E1C1: "But it is worth mentioning that **computational thinking** (emphasis added) is developed throughout the six volumes of this collection, not only in these sections, which provides an opportunity for outstanding work with the cognitive processes involved but also in other activities and proposals throughout the chapters".
>
> Collection E2C1: "In this work, there are several activities that allow exploring this content, and also boxes entitled **Computational Thinking** (emphasis added), in which there are suggestions for work to stimulate computational thinking".
>
> Collection E5C1: "One of the purposes of this section is to develop **computational thinking** (emphasis added) by proposing ways to reason, represent, communicate and argue when solving a problem situation".
>
> E5C2 Collection: "This collection intentionally assumes didactic experiences so that **computational thinking** (emphasis added) can increasingly integrate the training of high school students, making them able to intervene in a citizenship way in the environment in which they live".

From the above, we can infer that the impact caused by the insertion of CT in the content of most of the didactic works we analyzed is significant enough not to be simply ignored by the teacher. Perhaps, therefore, its authors have destined several texts for teachers, whose titles and topics of the summary in which they were inserted formed the following cloud of words.

Figure 2.

Most recurring words in the titles of the texts that mentioned CT and/or the topics of the summaries in which they were inserted (Constructed by the authors)

The most relevant words and others with close meanings suggest that CT is treated in teacher guidelines in a theoretical-didactic-methodological perspective for mathematics teaching.

Reading these texts allowed us to identify four other underlying themes: CT as a problem-solving methodology; CT in DTs; educational resources to practice and develop CT; and BNCC skills and competencies. As a whole, these themes relate to each other and outline what is most substantial in the content that addresses CT for teachers because, from them, we were able to identify subthemes, as shown in Figure 3 below.

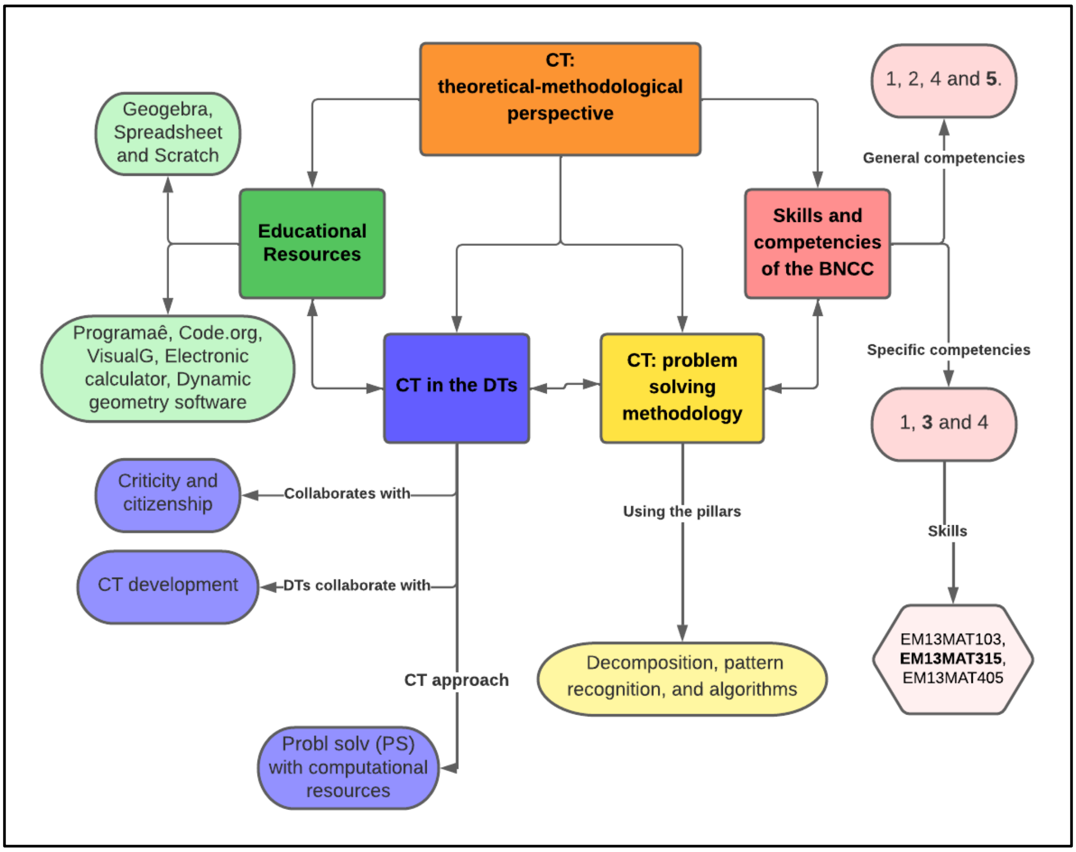

Figure 3.

Themes and sub-themes of the content that mentions CT in the guidelines for teachers (Built by the authors)

Computational thinking, as a problem-solving methodology, is effective with guidelines for the use of the pillars proposed by Brackmann (2017) –decomposition, pattern recognition, abstraction and, more often, algorithm– and approaches the understanding of CT as a problem-solving approach in general contexts (Wing, 2008).

However, the emphasis given to algorithms is incongruous with Wing's (2008; 2014; 2017) view. She considers abstraction as the most critical cognitive process underlying CT. Factors such as the presence of abstraction in all CT elements, the historical exploitation of algorithms in mathematics and the explicit recommendations of the BNCC for using algorithms and flowcharts may have contributed to this emphasis.

Associated with the CT, three discourses drew our attention: the use of these technologies in solving mathematical problems contributes to the development of CT; problem solving with computational resources is an approach of CT; and, by being present in them and contributing to their domain, CT enables the development of criticality and the exercise of citizenship, aligning with authors who consider it essential for digital literacy and literacy (Shute et al., 2017; Valente, 2019; Wing, 2010; 2014).

The reflections of these discourses are given in the indication of resources to practice and develop CT. Despite the mentions of the unplugged approach (Brackmann, 2017), we notice indications of computational resources that corroborate studies such as those by Barcelos et al. (2015), Jesus Garcia and Borges (2022), and Valente (2016). Indications for using Geogebra, spreadsheets, and scratch stand out in this regard. In turn, references to resources of non-governmental organizations, such as the Programaê platform, may be related to the market interests of the private initiative in education fostered by the reform of high school education (Gonçalves, 2017).

In line with the pedagogy of competencies mentioned above (da Silva & Boutin, 2018; Saviani, 2013), the theme of the CT in the BNCC is configured with the presentation of what this curricular reference speaks of CT and of ostensible associations with its competencies and skills, especially General Competence 5, which associates CT with the creation of TD, in a critical and ethical, authorial and protagonist way.

For this to occur, it is necessary to use, even at elementary levels, programming languages, computers and/or computational tools. Besides, teachers must have pedagogical mastery of the necessary DTs for that creative process, which, according to Cardoso and Figueira-Sampaio (2019), has not yet occurred, even 40 years after the digital insertion in Brazilian education.

The other general competencies related to the CT in the didactic works we analyzed associate it with problem solving in different contexts; with understanding and explaining reality; with lifelong learning; with building a just, democratic and inclusive society; with the production of meanings and understandings; with the world of work; with the exercise of citizenship, criticality and autonomy; with argumentation and decision-making, considering human, social, ethical and environmental values.

The lines of the content above (Bardin, 1977) reveal to us again the appropriation of academic discourses on the importance of CT and the internationalization movement of the curriculum (Thiesen, 2019), in its association with the labor market and in the expression "learning throughout life", which brings us to the motto "learning to learn".

Concerning specific skills, the third one stands out, which refers us to the intersections of CT with mathematics via model building, problem solving, analysis, interpretation, and evaluation of results and argumentation processes, as indicated by several studies (Barcelos et al., 2015; Sneider et al., 2014).

The other specific competencies associate CT with mathematics due to the proximity of its records, languages, strategies and ways of interpreting situations, which aim at the ability to use algorithms in flowchart language to solve problems (EM13MAT315 Skill), from the current language or mathematics (EM13MAT405 Skill), with or without the use of programming languages.

The unfolding of the content that mentions CT, on the part of the teachers to the students, occurs as shown in Figure 4:

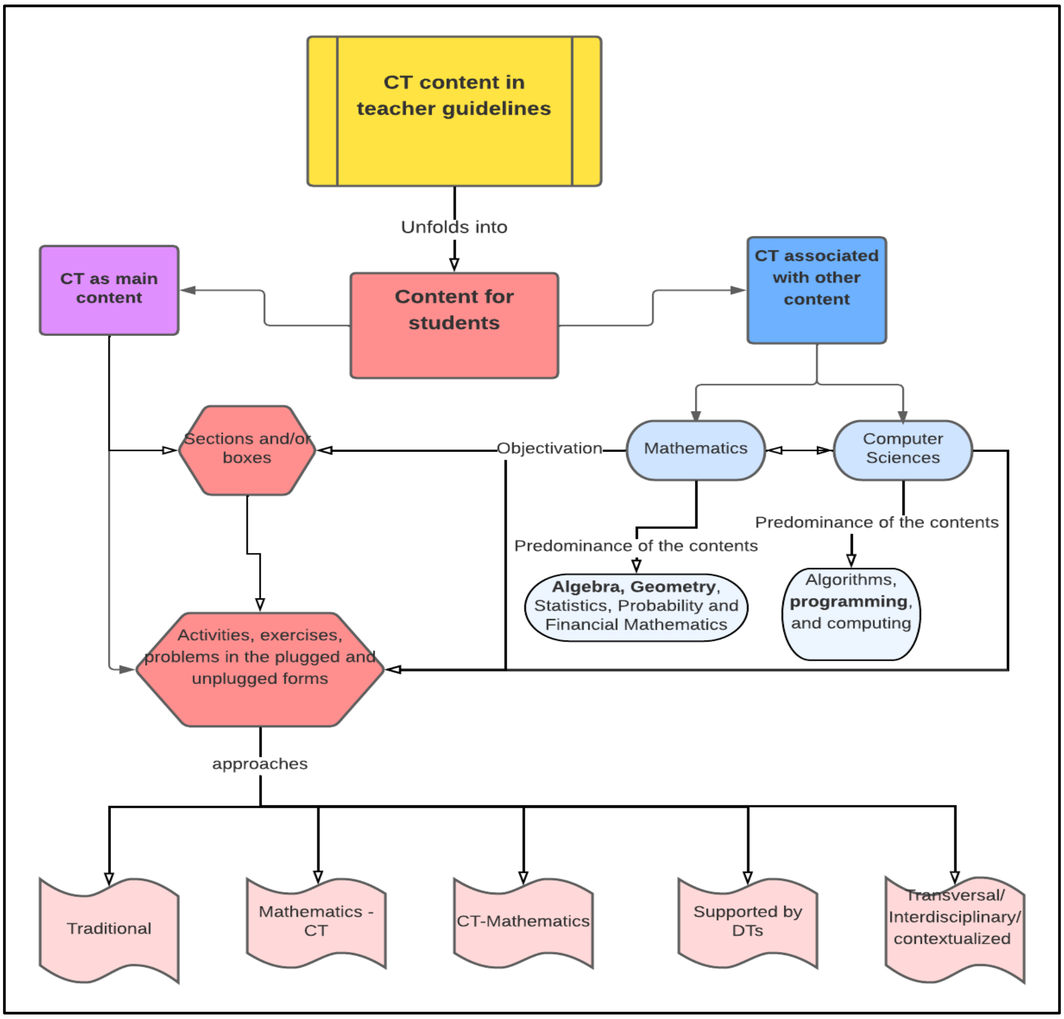

Figure 4.

Developments of the content of the guidelines for teachers that mention CT for students (Built by the authors)

Therefore, the content that addresses CT in the teacher guidelines unfolds to students in two ways: treating it as the main content to be learned or associated with other content, especially mathematics and computer science. In both forms, it is required of students in the form of sections, boxes, activities, exercises and problems. As the main content, it comes to be the subject of a volume and a chapter, entitled, respectively, 'Computational thinking and flowcharts' and 'Computational thinking'.

In typical computer science content, CT is predominantly associated with programming, computing and algorithms, which must be studied in some collections in parallel with mathematical knowledge traditionally inserted in curricula.

This change brings us to one of the strategies for integrating CT into education mentioned by Valente (2016), which is associated with more curricular flexibility caused by the high school reform. This strategy can potentially significantly impact the mathematics teacher's practice, considering formation issues and how the reform was conducted, without in-depth debate and therefore without stimulating teachers' understanding of the required changes. Therefore, it is reasonable to think that, on the one hand, there will be resistance to the teaching of these contents and, on the other hand, some frustration since they are very motivating for students.

When associated with mathematical contents, CT is predominantly inserted in contents of algebraic and geometric nature. However, we have identified its presence in all mathematical themes of basic education, such as statistics, probability and financial mathematics.

Numerous factors may be related to this predominance, such as the explicit guidelines of the BNCC for the teaching of CT associated with algebra and geometry and the very relationships that exist between them, due to the sharing of elements such as algorithms, variables, pattern recognition and abstraction (Brasil, 2018).

The materialization of these contents into sections and/or boxes occurs through an approach to CT in the problem solving process, with or without the use of DTs, contextualized with such technologies, practical situations and/or daily life and other areas of knowledge.

As activities, exercises and problems, CT is explored plugged and unplugged (Brackmann, 2017), as illustrated in Figure 5.

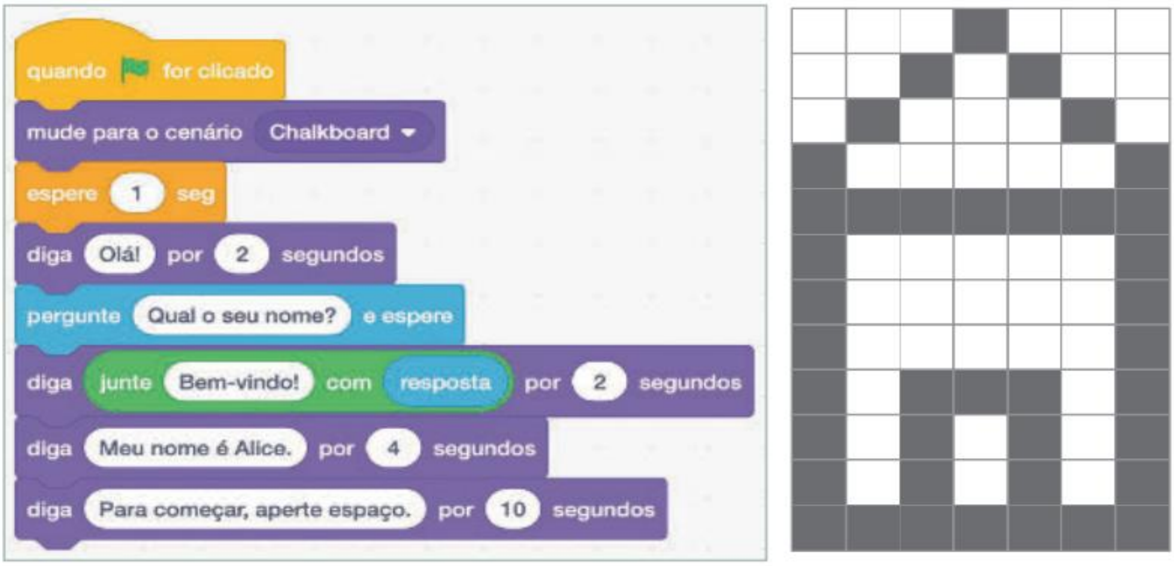

Figure 5.

Example of plugged and unplugged activities in didactic works in mathematics and its technologies (Analysis sample)

On the left, we have a scratch interface, used in an activity of construction of a game of questions and answers, representing others in which the use of CT is necessary, in particular, the resources that we present in Figure 3, in a plugged form. On the right, there is the representation indicated in one of the collections to be made and enlarged on checkerboard paper, using lines of code in the usual language, in unplugged form.

In these two forms, we identified four types of approaches to CT in activities, exercises and problems, shown in Table 5.

Table 5.

Approaches to CT in activities, exercises and problems in didactic works in mathematics and its technologies

Approach	**Activity, problem/exercise or guidance for teachers**
1 - traditional;	An algorithm can be represented, for example, in everyday language, as in the solved exercise [. . .]R1 Write the steps to measure any object with the jaws of the caliper **based on the solved exercise R1** (emphasis added)**.**
2. Mathematics - CT	[. . .]Now, they learn that this term names one of the pillars of computational thinking and understand some early concepts of algorithm structures.
3. CT-mathematics	In activity 36, students develop the cognitive process of decomposition[. . .] whose objective is to divide a problem into smaller and solvable parts so that

	[...]it is possible to solve each of these parts and, in the end, obtain the general proposed answer.
4. Transversal/ Interdisciplinary contextualized	Creating a newscast is a complex task[...]. The recognition of components and stages, as well as the organization of the newscast, put students in contact with the pillars of computational thinking: pattern recognition, decomposition and abstraction.

The traditional approach is characterized by the exposition of an exercise, problem or activity solved as a model, followed by the presentation of another(s) to be solved similarly to what was done previously.

The second approach is one in which one starts from elements underlying mathematical content to approach these same elements from a CT perspective. At the same time, the third uses CT skills and abilities as a problem-solving approach/methodology (Wing, 2008).

The transversal/interdisciplinary/contextualized approach brings applications and the presence of CT in daily life, new technologies and the areas of knowledge. Its pillars are the means to accomplish the task or the ends of the intended learning.

The analysis of the importance given to CT for mathematical learning –our third axis of analysis– motivated us to identify and extract excerpts from the content in this sense.

> E2C1 Collection: “The work with computational thinking is a great ally in the development of the approximation between mother tongue and mathematics”.
>
> E3C1 collection: “computational thinking [...] can contribute to problem solving, as well as make students skilled at making a geometric representation or even solve systems by correctly applying digital information and communication technologies (DICTs)”.
>
> E4C1: “Promoting the development of computational thinking is also a rich opportunity for students to develop mathematical reasoning.”
>
> The development of computational thinking is fundamental to mathematical learning because it [...] involves a form of thinking that is linked to any type of tool and situation in which it is necessary to create and assimilate results from experiences and sequential and recursive thinking.
>
> E5C2 Collection: “The development of computational thinking contributes significantly to the students [...] being able to solve different problems that may occur in the personal, professional or even collective trajectory”.

These excerpts, together with the others that we catalogued of the same nature, allow us to infer that the authors of the works we analyzed consider CT important for mathematical learning because: it brings the mother tongue closer to the mathematical language; it has applications in DTs; it contributes to problem solving in different contexts, with or without DTs; it contributes to the development of skills and forms of thinking essential to reasoning, argumentation and mathematical representation; and it is present in any situation that involves sequential and recursive thinking.

These contributions of CT to mathematical learning collected from the statements of the authors of the didactic works we analyzed to meet the methodology we adopted (Ludke & André, 1986) reflect appropriations of positions of the BNCC and researchers on CT and start, above all, from the intersections of CT with mathematics, many of which have already been mentioned in our theoretical framework.

This fact potentially impacts the teacher's practice, who needs to understand the intersections between CT and mathematics and know how to use them didactic-pedagogically to mediate teaching processes in which the development of CT skills and abilities contributes to mathematical learning and vice versa.

The data analyzed in this article point to a significant impact of the insertion of CT in the content of didactic works in mathematics and its technologies with potential implications for the practice of the teacher of this subject. Therefore, the teacher needs to master the new content, conceptually and didactic-pedagogically, under penalty of denying students necessary knowledge for their personal and professional formation or even to enter higher education, since the tendency is that the selection processes that give access to it start to charge this new content.

These implications require teacher education to fulfill its function of preparing teachers to teach, in this case, CT. The challenges in this sense are many and reveal a little mismatch between the public policies of curricular reformulation and the real-world conditions of CT implementation in the mathematics classroom.

Final considerations

The findings of this study allow us to infer that the insertion of CT as content of the didactic works in the area of mathematics and its technologies had significant impacts on the structure of knowledge historically taught in the referred school discipline.

Through this, we show that the previous works, approved in the 2021 PNLD, inaugurated CT as a mathematics content of the final stage of our basic education, which, in itself, already changes the traditional list of mathematical knowledge established as mandatory even before the high school reform is fully implemented.

The data we collected and analyzed regarding the frequency with which CT is mentioned, the position it occupies in the collections and volumes' structure, and the importance it is given for mathematical learning indicate numerically and qualitatively that it was not included only as complementary or illustrative content in most of the works analyzed, but as a relevant knowledge in itself, from the didactic-methodological point of view, in the problem solving process and for the development of mathematical skills and abilities.

This impact, in our view, has potential implications for teaching practice and teacher education since teachers will need to master CT conceptually and didactic-pedagogically to be able to teach it in the classroom and explore its connections with mathematics, favoring the teaching-learning process of both knowledges, collaboratively.

Thus, we conclude that the implications of the inclusion of CT in the contents of mathematics of the new high school and its possible consequences for teaching practice and teacher education highlight the need for studies in other areas of knowledge and the other stages of basic education since computational thinking is not limited to a subject or grade of school education. Thus, we hope that the results of this investigation awaken new research that will collaborate with this discussion.

References

Barcelos, T., Muñoz, R., Acevedo, R., & Silveira, I. (2015). Relações entre o Pensamento Computacional e a Matemática: uma Revisão Sistemática da Literatura. *Anais dos Workshops do Congresso Brasileiro de Informática na Educação*, 4(1), 1369. doi:http://dx.doi.org/10.5753/cbie.wcbie.2015.1369

Bardin, L. (1977). *Análise de conteúdo*. Lisboa: edições.

Bezerra Filho, J. M. (2016). *Exposição de Motivos nº 00084/2016/MEC*. http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2016/exm/exm-mp-746-16.pdf

Bogdan, R., & Biklen, S. (1994). *Investigação qualitativa em educação: uma introdução à teoria e aos métodos*. Porto editora.

Brackmann, C. P. (2017). Desenvolvimento do pensamento computacional através de atividades desplugadas na educação básica. [Tese de Doutorado em Informática na Educação, Universidade Federal do Rio Grande do Sul]. https://www.lume.ufrgs.br/handle/10183/172208

Branco, E. P., de Godoi Branco, A. B., Iwasse, L. F. A., & Zanatta, S. C. (2018). Uma visão crítica sobre a implantação da Base Nacional Comum Curricular em consonância com a reforma do Ensino Médio. [TESTE] *Debates em Educação*, 10(21), 47-70. https://doi.org/10.28998/2175-6600.2018v10n21p47-70

Brasil. (2018). *Base nacional comum curricular*. Ministério da Educação. http://fila.mec.gov.br/manutgeral.htm

Cardoso, M. C. S. D. A., & Figueira-Sampaio, A. D. S. (2019). Dificuldades para o uso da informática no ensino: percepção dos professores de matemática após 40 anos da inserção digital no contexto educacional brasileiro. *Educação Matemática Pesquisa*, 21(2), 44-84. https://doi.org/10.23925/1983-3156.2018v21i2p044-084

Corrêa, S. de S., Ferri, C., & Garcia, S. R. de O. (2022). O que esperar do Novo Ensino Médio?. *Retratos Da Escola*, 16(34), 15–21. Recuperado de https://retratosdaescola.emnuvens.com.br/rde/article/view/1543

Costa, M. D. O., & Silva, L. A. D. (2019). Educação e democracia: Base Nacional Comum Curricular e novo ensino médio sob a ótica de entidades acadêmicas da área educacional. *Revista Brasileira de Educação,* 24. https://doi.org/10.1590/S1413-24782019240047

D'Ambrosio, U. (1998). *Etnomatemática: Arte ou técnica de explicar e conhecer*. Editora Ática.

da Silva Fernandes, N., Vasconcelos, F. H. L., & de Carvalho, W. V. (2021). Programa nacional do livro e do material didático (pnld): um estudo de seu funcionamento e apresentação das mudanças nos materiais à luz do novo ensino médio a partir de 2021. *Conexões-Ciência e Tecnologia*, 15, 021023. https://doi.org/10.21439/conexoes.v15i0.2099

da Silva, I. S. F., Junior, J. D. A., & Falcão, T. P. (2022, April). Panorama Sobre Iniciativas para Promover o Pensamento Computacional no Ensino Superior Brasileiro. In A*nais do II Simpósio Brasileiro de Educação em Computação* (pp. 88-98). SBC. https://sol.sbc.org.br/index.php/educomp/article/view/19202

da Silva, K. C. J. R., & Boutin, A. C. (2018). Novo ensino médio e educação integral: contextos, conceitos e polêmicas sobre a reforma. *Educação,* 43(3), 521-534. https://doi.org/10.5902/1984644430458

de Jesus Garcia, S. R., & Borges, M. A. F. (2022, November). Mapeamento e classificação de grupos de incentivo ao Pensamento Computacional no Brasil e no mundo. In Anais do XXXIII Simpósio Brasileiro de Informática na Educação (pp. 1425-1433). SBC. https://sol.sbc.org.br/index.php/sbie/article/view/22513

Decreto n° 9099, de 18 de julho de 2017. (20170. Dispõe sobre o Programa Nacional do Livro e do Material Didático.

Delors, J., Chung, F., Geremek, B., Gorham, W., Kornhauser, A., Manley, M. & Nanzhao, Z. (1996). Relatório para a UNESCO da Comissão Internacional sobre Educação para o século XXI. *Educação um tesouro a descobrir,* 6.

Ferreira, R. A., & Ramos, L. O. L. (2018). O projeto da MP nº 746: entre o discurso e o percurso de um novo ensino médio. *Ensaio: Avaliação e Políticas Públicas em Educação,* 26(101), 1176-1196. https://doi.org/10.1590/S0104-4036201800260129

França, R., & Tedesco, P. (2019, November). Pensamento computacional: Panorama dos grupos de pesquisa no brasil. In *Brazilian Symposium on Computers in Education (Simpósio Brasileiro de Informática na Educação-SBIE*) (Vol. 30, No. 1, p. 409). http://ojs.sector3.com.br/index.php/sbie/article/view/8745

Gonçalves, S. D. R. V. (2017). Interesses mercadológicos e o" novo" ensino médio. *Retratos da Escola*, 11(20), 131-145. https://doi.org/10.22420/rde.v11i20.753

Kalelioglu, F., Gulbahar, Y., & Kukul, V. (2016). A framework for computational thinking based on a systematic research review. *Baltic J. Modern Computing.* Vol. 4 (2016), No. 3, 583-596

Lei nº 13.415, de 16 de fevereiro de 2017. (2017). Altera as Leis n º 9.394, de 20 de dezembro de 1996, que estabelece as diretrizes e bases da educação nacional, e 11.494, de 20 de junho 2007, que regulamenta o Fundo de Manutenção e Desenvolvimento da Educação Básica e de Valorização dos Profissionais da Educação, a Consolidação das Leis do Trabalho - CLT, aprovada pelo Decreto-Lei nº 5.452, de 1º de maio de 1943, e o

Decreto-Lei nº 236, de 28 de fevereiro de 1967; revoga a Lei nº 11.161, de 5 de agosto de 2005; e institui a Política de Fomento à Implementação de Escolas de Ensino Médio em Tempo Integral.

Ludke, M., & André, M. (1986). *Pesquisa em educação: abordagens qualitativas*. EPU.

Ministério da Educação (MEC). (2018). *Resolução CNE/CEB 3/2018*. Atualiza as Diretrizes Curriculares Nacionais para o Ensino Médio. Diário Oficial da União, Brasília.

Ministério da Educação (MEC). (2022). *Resolução nº 1, de 4 de outubro de 2022*. Normas sobre Computação na Educação Básica- Complemento à BNCC. Diário Oficial República Federativa do Brasil, Brasília.

Mühling, A., Ruf, A., & Hubwieser, P. (2015, November). Design and first results of a psychometric test for measuring basic programming abilities. In Proceedings of the workshop in primary and secondary computing education (pp. 2-10). https://doi.org/10.1145/2818314.2818320

Papert, S. (1980). *Children, computers, and powerful ideas*. Harvester.

Román-González, M., Pérez-González, J. C., & Jiménez-Fernández, C. (2017). Which cognitive abilities underlie computational thinking? Criterion validity of the Computational Thinking Test. Computers in human behavior, 72, 678-691.https://doi.org/10.1016/j.chb.2016.08.047

Santos, A. D. S., Pereira, W. G., & de França, R. S. (2021, July). Como Ensinar Ciência da Computação para Crianças? Tendências e Lacunas de Pesquisa na Área. In *Anais do XXIX Workshop sobre Educação em Computação* (pp. 298-307). SBC. https://sol.sbc.org.br/index.php/wei/article/view/15921

Saviani, D. (2013). *História das ideias pedagógicas no Brasil*. Autores Associados.

Shute, V. J., Sun, C., & Asbell-Clarke, J. (2017). Demystifying computational thinking. Educational research review, 22, 142-158. https://doi.org/10.1016/j.edurev.2017.09.003

Silva, V., Silva, K., & França, R. (2017, October). Pensamento computacional na formação de professores: experiências e desafios encontrados no ensino da computação em escolas públicas. *In Anais do Workshop de Informática na Escola* (Vol. 23, No. 1, pp. 805-814). http://ojs.sector3.com.br/index.php/wie/article/view/7299

Sneider, C., Stephenson, C., Schafer, B. & Flick, L. (2014). Computational Thinking in High School Science Classrooms: Exploring the Science "Framework" and "NGSS". *Science Teacher*, 81(5), 53-59. Retrieved March 19, 2023 from https://www.learntechlib.org/p/155904/.

Süssekind, M. L. (2019). A BNCC e o "novo" Ensino Médio: reformas arrogantes, indolentes e malévolas. Retratos da escola, 13(25), 91-107. https://doi.org/10.22420/rde.v13i25.980

Thiesen, J. D. S. (2019). Políticas curriculares, Educação Básica brasileira, internacionalização: aproximações e convergências discursivas. *Educação e Pesquisa*, 45. https://doi.org/10.1590/S1678-4634201945190038

Valente, J. A. (2016). Integração do pensamento computacional no currículo da educação básica: diferentes estratégias usadas e questões de formação de professores e avaliação do aluno. *Revista E-curriculum*, 14(3), 864-897. https://doi.org/10.23925/1809-3876.2016v14i3p0864.

Valente, J. A. (2019). Pensamento computacional, letramento computacional ou competência digital? Novos desafios da educação. *Revista educação e cultura contemporânea*, 16(43), 147-168. http://dx.doi.org/ 10.5935/2238-1279.20190008

Wing, J. (2010). " Computational Thinking What and Why, Phil. Trans. R. Soc. A. vol. 366. pp. 3717-3725. Wing, Jeannette, 2010. *Computational Thinking What and Why, Phil. Trans. R. Soc. A*, 366, 3717-3725.

Wing, J. (2017). Computational thinking's influence on research and education for all. Italian Journal of Educational Technology, 25(2), 7-14. https://doi.org/10.17471/2499-4324/922

Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, 49(3), 33-35.

Wing, J. M. (2008). Computational thinking and thinking about computing. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 366(1881), 3717-3725. https://doi.org/10.1098/rsta.2008.0118

Wing, J. M. (2014). Computational thinking benefits society. 40th anniversary blog of social issues in: *Computin*g. Recuperado de: http://socialissues. cs. toronto. edu/2014/01/computational-thinking.