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LESS SCREENS, MORE CONNECTIONS: unplugged computational thinking in the early years

MENOS TELAS, MAIS VÍNCULOS: pensamento computacional desplugado nos anos iniciais

MENOS PANTALLAS, MÁS VÍNCULOS: pensamiento computacional desconectado en los primeros años

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Abstract
This paper examines the integration of unplugged Computational Thinking in the early years of Basic Education, articulating theoretical foundations and the development of teaching materials designed to support teachers' digital literacy. It first presents core concepts of Computational Thinking in dialogue with Papert, Wing, and the BNCC, addressing the pillars of abstraction, decomposition, pattern recognition, and algorithm design, as well as complementary competencies such as testing, debugging, collaboration, and metacognition. It then describes the development process of the e-book "Error is My Friend," structured according to Design-Based Research and organized into five iterative cycles that included paper prototyping, storyline revision, the introduction of challenges using educational robots, creation of the digital version, and publication. The article also presents examples of unplugged activities derived from the e-book, combining narrative, movement, and symbolic representation to support the understanding of commands and paths. It underscores the transversal integration of Computational Thinking, which permeates various aspects of education, enhancing digital literacy and promoting meaningful learning experiences that strengthen relationships, autonomy, and student authorship within the school environment.

Keywords: Unplugged computational thinking. Educational practices. DBR. Teacher education.

Resumo

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Este artigo discute a inserção do Pensamento Computacional Desplugado nos anos iniciais da Educação Básica, articulando fundamentos teóricos e a criação de materiais didáticos voltados ao letramento digital docente. Inicialmente, apresenta conceitos centrais de Pensamento Computacional em diálogo com Papert, Wing e a BNCC, abordando os pilares de abstração, decomposição, reconhecimento de padrões e algoritmização, além de competências complementares como teste, depuração, colaboração e metacognição. Em seguida, descreve o processo de desenvolvimento do e-book "O erro é meu amigo," estruturado a partir da Pesquisa Baseada em Design e organizado em cinco ciclos, que incluíram prototipação em papel, revisão do enredo, inserção de desafios com robôs educacionais, criação da versão digital e publicação. O artigo também apresenta exemplos de atividades desplugadas derivadas do e-book, que combinam narrativa, movimento e registro simbólico para favorecer a compreensão de comandos e trajetos. Por fim, discute o papel do professor empreendedor na transversalização do Pensamento Computacional, destacando que práticas desplugadas ampliam o letramento digital docente e promovem experiências de aprendizagem significativas, reforçando vínculos, autonomia e autoria no cotidiano escolar.

Palavras-chave: Pensamento Computacional Desplugado. Práticas educativas. DBR. Formação docente.

Resumen
Este artículo analiza la inserción del Pensamiento Computacional desconectado en los primeros años de la Educación Básica, articulando fundamentos teóricos y la creación de materiales didácticos destinados a la alfabetización digital docente. En primer lugar, presenta conceptos centrales del Pensamiento Computacional en diálogo con Papert, Wing y la BNCC, abarcando los pilares de abstracción, descomposición, reconocimiento de patrones y algoritmización, además de competencias complementarias como evaluación, depuración, colaboración y metacognición. A continuación, describe el proceso de desarrollo del e-book "El error es mi amigo", estructurado a partir de la Investigación Basada en el Diseño y organizado en cinco ciclos que comprendieron la prototipación en papel, la revisión del relato, la inserción de desafíos con robots educativos, la creación de la versión digital y la publicación. El artículo también presenta ejemplos de actividades desconectadas derivadas del e-book, que combinan narrativa, movimiento y registro simbólico para favorecer la comprensión de comandos y trayectorias. Por último, discute el papel del profesor emprendedor en la transversalización del Pensamiento Computacional, señalando que las prácticas desconectadas amplían la alfabetización digital docente y promueven experiencias de aprendizaje significativas que fortalecen vínculos, autonomía y autoría en el contexto escolar.

Palabras clave: Pensamiento computacional Desconectado. Prácticas educativas. DBR. Formación docente.

Introduction

This paper aims to present the teaching materials developed to support the digital literacy of teachers working in basic education, particularly in early childhood education and the early grades. It also outlines key concepts related to

Computational Thinking (CT) in both plugged and unplugged approaches. It presents the creation process of the e-book *"Error Is My Friend!"* as a central element in structuring the learning process. The paper concludes with reflections and theoretical insights derived from the development of these materials, the methodological approach, and additional examples of activities beyond those included in the e-books collection.

2. Computational Thinking: foundational concepts

To position our reflection on the inclusion of Computational Thinking (CT), as established in the BNCC Computing (2020), we rely on two premises. First, the concept underlying Computational Thinking is not new. It was established before the 21st century. One of the early contributors to the concept was Seymour Papert (1980), the creator of Constructionism, which is grounded in Piaget's Constructivism. For Papert, CT can be a pedagogical practice included as part of a teaching strategy. Wing (2006) later popularized the concept of CT, framing it as a strategy for organizing problem solving, system design, and understanding human behavior through the extraction of fundamental concepts from computer science. Subsequently, Wing (2011) emphasized that CT is a set of processes for formulating and solving problems in ways that an information-processing agent would processes, inspired by traditional programming used in computing.

Thus, the development of Computational Thinking may occur through three distinct approaches:

- Plugged CT: using digital artifacts (computers, tablets, smartphones, and others);
- Unplugged CT: without the use of digital devices, working with concrete materials;
- Hybrid Computational Thinking: combined use of plugged and unplugged practices, depending on pedagogical intent (Giraffa, Rodrigues and Santos, 2023).

Even in contexts where technological conditions in schools are unfavorable, it is possible to work on CT-related competencies both conceptually and in practice. In this sense, we introduced the hybridized CT format, which combines both forms, as a means to strengthen the development of CT competencies. Our experience shows that working with children in the early grades benefits significantly from this combination.

According to Raabe, Zorzo and Blikstein (2020), initiatives for the inclusion of Computing education in Basic Education have four approaches:

- Constructionism and computational literacy: based on the ideas of Constructionism developed by Papert, grounded in Piaget's Constructivism. In this approach, the computer is treated as a learning tool, emphasizing that "you need to program to learn" (Raabe, Couto and Blikstein, 2020, p. 13), enabling students to become fluent in "creating innovation and technology through computing" (p. 13). Learning may also occur through the construction of artifacts enriched with technology. Constructionists argue for greater emphasis on concrete experiences to support theory and for empowering students to create technology-enriched artifacts.
- Computing education: emphasizes Computer Science elements starting in Basic Education, considering Computing as a foundational science for contemporary education. This curricular organization proposes that students will only learn problem-solving and programming through a specific subject focused on the theme. According to the authors, "schools that privilege a more traditional disciplinary curriculum will find it easier to adopt a specific Computing subject" (Raabe, Couto and Blikstein, 2020, p. 13).
- Market demand & Code.org: focused on training professionals for the job market, identifying and encouraging talent from early schooling, systematized by the software industry and by Code.org. This market-driven culture is based on economic advancement and workforce development in the technology sector. The authors caution that this set of ideas and beliefs does not align with the educational goals of young people and prioritizes the development of problem-solving skills (Raabe, Couto and Blikstein, 2020).

- Equity & Inclusion: seeks to promote the integration of individuals who may be at the margins of this process, since in a world permeated by Computing, they may gradually be excluded from participation. Its central theme is equity of opportunities, assuming that "all people should have access to Computing knowledge" (Raabe, Couto and Blikstein, 2020, p. 13), including minorities and students historically excluded from Computing, in order to "adopt inclusive formats that respond well to differences" (p. 13).

Our decision to focus on teachers' digital literacy in connection with CT is grounded in Constructionist theory (Papert, 2008), which advocates placing greater emphasis on concrete experiences to support theoretical understanding and on empowering students to create technology-enhanced artifacts. The organization of the process for solving a problem, according to Brackmann (2017), is structured around four pillars:

- Abstraction: understanding the problem to be solved, separating information that is relevant to construct the solution from information that merely contextualizes the problem.
- Decomposition: enabling more complex problems to be solved more simply by dividing them into smaller parts and addressing them individually.
- Pattern recognition: allowing the person to use solutions from similar problems or previous knowledge already applied to other situations.
- Algorithm design: organizing the solution through algorithmization, that is, creating an algorithm that specifies the sequence of steps necessary to solve the problem. Algorithms must contain precise, unambiguous instructions that are defined in a way that their execution will lead to a solution.

In the context of Early Childhood Education and the early grades of elementary school, the cross-cutting incorporation of CT requires a deeper understanding of existing pedagogical practices and of children's cognitive development. In the professional development activities we have conducted, we observed that teachers initially struggle to identify and apply the core pillars of CT, often interpreting them as linear and separate stages. Abstraction comes first,

involving the selection of relevant information from complementary data. Pattern identification follows, focusing on recognizing properties that support the construction of a solution. Decomposition then reduces complexity by breaking the problem into smaller parts, preferably segments for which solutions are already known and can be reused. Finally, algorithmization involves organizing the steps that systematize the proposed solution, enabling someone else to replicate it.

In practice, this process is not linear. These pillars are foundational, and their use unfolds dynamically. As one gains a better understanding of the problem, pattern identification begins to emerge, often informed by decomposition, and the algorithm starts to take shape incrementally, forming a sequence of well-defined and unambiguous steps. Beyond the central CT pillars, various authors expand this framework by incorporating complementary competencies. Wing (2006) emphasizes the importance of logical reasoning and metacognition in organizing ideas and reflecting on one's own problem-solving process. Brennan and Resnick (2012) present testing, debugging, and evaluating solutions as practices involving verifying results, identifying errors, and comparing alternatives. The CSTA (2017) and ISTE (2016) include reuse and modularity, allowing parts of a solution to be applied in new contexts, as well as representing information through diagrams, flowcharts, and tables. These frameworks also emphasize the importance of clearly communicating processes and collaborating with others. Perseverance and revision are treated as essential competencies for maintaining progress despite difficulties, contributing to the gradual refinement of the solution.

3. Development of the e-book *Error Is My Friend*

The organization of this collection of teaching materials grew out of needs identified during in-person teacher training sessions conducted by our research group in 2018 and 2019, as well as in the online workshops held during the pandemic period of 2020 and 2021. To structure these activities, we used materials from the website https://www.computacional.com.br/, organized by Christian Brackmann, and materials by Linda Luikas available at https://www.helloruby.com/.

At that time, these repositories were still in an early stage, and nowadays they offer a higher-quality and variety of materials and activities. However, participants in the workshops reported a lack of materials written in direct language that could be used with their children, considering their culture, examples, and pedagogical approaches, and the transversal integration of these competencies in Early Childhood Education and the early grades of Elementary School.

Based on these findings, we developed free teaching materials aligned with the BNCC (2018) and the Computing Supplement (2022) to support teachers in implementing innovative pedagogical practices. Among them are the e-books *O erro é meu amigo!* (Giraffa and Santos, 2021, translated into Spanish and English), which discusses the role of error in the learning process; *Dora, a programadora* (Giraffa & Santos, 2021); *Algo e Ritmo: uma aventura na programação* (Giraffa & Santos, 2023); and, following the sequence of CT-related content, the e-book *Conectando Experiências*, which reinforces the integration of Computational Thinking into school practices (Giraffa, Santos, and Rodrigues, 2023), presenting proposals for unplugged activities that strengthen teacher autonomy and connections. The most recent work, *O Erro é meu amigo: Guia do Professor* by Giraffa and Santos (2024), describes the methodology proposed for working with Error in the learning process.

3.1 Methodology

To develop these e-books, we organized a research project that adopted the principles of Design-Based Research (DBR). This methodological approach involves the creation, implementation, and analysis of educational interventions in real teaching environments. According to Brown (1998) and Barab and Squire (2004), DBR establishes active collaboration among all participants, who assume the role of co-participants in designing and analyzing interventions. The research is developed iteratively, in cycles of design, experimentation, evaluation, and ongoing refinement, always guided by participant interactions and feedback. This dynamic requires flexibility, allowing for adjustments throughout the research to respond to emerging

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needs and transformations within the educational context itself. The active participation is crucial in this collective effort.

Another fundamental aspect is its capacity to articulate theoretical and practical development. DBR does not focus solely on solving practical problems; it also seeks to produce theoretical insights that illuminate how interventions function and contribute to advances in the educational field. It is, by nature, an interventionist approach: the researcher acts directly in the environment by proposing and implementing changes, which requires methodological rigor to ensure the credibility and validity of the results. Several authors consider DBR both a methodology and a research approach. As a methodology, it refers to the methods and processes used to develop and test interventions. As an approach, it encompasses the philosophy and principles guiding the research, emphasizing collaborative practice and the generation of applicable theoretical knowledge. In the ARGOS group, we adopted DBR as our methodological approach, ensuring the practical application of our findings in real teaching environments.

The production of the e-book The Mistake Is My Friend!, which later served as a model for the other books mentioned earlier, involved five cycles and was carried out over one academic trimester. Each cycle included conjectures that were confirmed, reformulated, or expanded based on the partial results obtained at that stage. The context of investigation consisted of five third-grade classes in which the second author served as the classroom teacher. The work had the approval of the school leadership and pedagogical coordination, and the school obtained formal authorization from parents for their children to participate in pedagogical experiments associated with routine classroom activities. Thus, the creation process became part of the students' regular school experience. The research was structured into five cycles, as shown in Figure 1.

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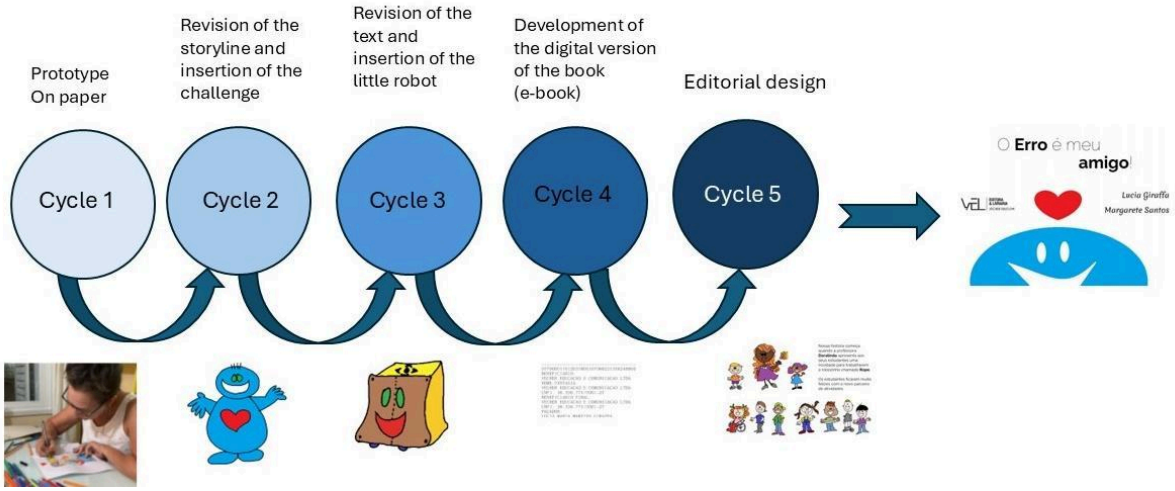
Figure 1- Production cycles of the e-book *"Erro é meu amigo"*



Source: Authors (2025)

First cycle. Prototype testing of the e-book aimed to verify the language, illustrations, and storyline. The conjecture for this stage included the following premises: the text should use short sentences and simplified language, and the illustrations should have outlines that enable children to reproduce the characters, especially the main character, Error. The inspiration for the text came from books used at the school to support reading and storytelling activities. In this first version, the book was produced on paper and included storytelling tasks. The reading circle provided evidence that validated the premises related to text style and illustrations. These premises were confirmed, and the results indicated that the storyline required further revision to better engage the students.

Second cycle. Revision of the storyline and insertion of the challenge. The conjecture for this stage included the following premises: the narrative should incorporate a playful character and present a problem to be solved, encouraging children to reflect, and the problem should be something they had already experienced. The school had purchased programmable robots to support CT activities, and when observing students using them, issues already described in the literature became evident, such as relative laterality, since the robot's left side did not always correspond to the student's left side depending on its orientation. A

conversation circle conducted by the teacher introduced the idea of the challenge of helping the robot perform tasks. These premises were validated, and the results indicated that the storyline required revision and that incorporating the challenge of programming the robot would support the learning process.

Third cycle. Revision of the e-book text and insertion of the small robot. The conjecture for this stage included the following premises: when solving concrete problems involving robot movement exercises, children would make mistakes that might lead to frustration or discouragement. If the e-book addressed this issue, the connection between the story and real-life situations would create a positive link. Another conversation circle was held, and we observed behavioral difficulties related to completing the robot's movement challenges.

Fourth cycle. Digital version of the book. The conjecture for this stage was grounded in the following guidelines: the format should be digital, with minimal text per page, colored images, simplified language with the intention of telling a story about overcoming the fear of making mistakes, using situations observed in the teacher's practical activities as a basis.

Fifth cycle. After these four phases of planning, organization, and prototyping, the authors decided to produce a digital version and contacted a publisher. The publisher carried out the linguistic review and made the book available for free download on its website, with financial support from CNPq, since the creation of this teaching material was part of a broader project linked to the first author's productivity grant.

4. Results and activity suggestions

The e-book "The Mistake Is My Friend" is, at its core, a storytelling book that introduces error as a character and an ally in the learning process through a playful narrative. Written in accessible language for children in Early Childhood Education and the early grades, the text seeks to demystify the association between error and failure, presenting it as a natural and necessary part of learning. In each episode, the story reinforces that experimenting, making mistakes, and trying again are essential

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steps in the construction of knowledge. A teacher's guide accompanies this narrative work, supporting educators as they reflect on and facilitate the proposed activities. More than an instruction manual, the guide presents possibilities for integrating Computational Thinking with creative pedagogical practices, based on the idea that educators should view error not as something to avoid, but rather as an opportunity for discovery and growth.

This conception aligns directly with Paulo Freire's pedagogy, which views error as an inherent part of the learning process. As the author writes: "What I mean is that error is not something to be avoided at all costs. Error must be assumed as a necessary dimension of the process of knowing. There is no act of knowing without the risk of error" (Freire and Faundez, 2021, p. 44). By adopting this Freirean perspective, the "Error Is My Friend" methodology encourages teachers and students to treat error as an opportunity for correction, reflection, and progress in the educational process. In this sense, the connection between the children's book and the pedagogical guide shapes a methodological proposal that integrates narrative, imagination, and critical reflection. While the story engages children and normalizes error as part of life, the guide offers teachers ways to transform this experience into reflective, critical, and inclusive pedagogical practice.

It is worth noting that the collection of books mentioned in this paper has already surpassed ten thousand downloads, and we, the authors, are pleased to see how this material has contributed to the field and how its creation grew out of the collaboration between a researcher and a classroom teacher working together and sharing complementary experiences. The classroom teacher is also a researcher.

To complement the activities described in the e-books, particularly in the teacher's guide, we present two examples of possibilities for creating unplugged activities. The first activity, titled "Tabuleiro da Turma do Erro" ("Error's Crew Board Game"), consists of building a large-scale board on the classroom floor using EVA mats. The characters from the story, hand-painted and attached to MDF supports, are placed on the board. When students enter the classroom, they find the "Error's Crew Carpet," which presents different paths to the characters. Behind each

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character, we placed envelopes containing reading comprehension cards related to the book. Working in groups, students should:

- Choose a character;
- Decide who will "program" a classmate to reach the chosen character;
- Select who will execute the path by following directional arrows (forward, right, left);
- Record the "code" on the board before executing it;
- Retrieve the envelope upon arriving at the character and read the question and select a classmate to answer.

The activity encourages sequential logic, cooperation, and reading comprehension. Mistakes, whether in movement or response, were welcomed as part of the process, reinforcing the message that making mistakes is a natural part of learning.

Another suggested activity is the game "Descubra o caminho com a Turma do Erro" ("Find the Path with Error's Crew"). This physical game, made of MDF, features thirty-two hollow squares that form the base of the board. We produced seven sets so that all groups could participate simultaneously. The movable character pieces were printed, laminated, and mounted to ensure durability. The objective of the game is to create paths between characters by defining a starting point and an end point. Students then record the route on a mini-board using directional arrows (forward, right, left, up, down). The group verified whether the proposed route aligned with the actual path on the board, facilitating reflection and discussion.

This dynamic encouraged collaboration among peers and collective problem solving, moving away from a competitive logic and emphasizing the idea of "all for all."

5. Final Considerations

In Martins and Giraffa (2020a; 2020b), we emphasized that, to develop the concept of remixed pedagogical practices, it is necessary to consider the alignment

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between pedagogical strategies and the opportunities generated by digital culture. Experimentation plays a central role in this process. When referring to experimentation, we argue for the possibility of error as an essential element of learning, not only for students but also for teachers. Unfortunately, the tradition of applying widely consolidated pedagogical strategies, justified by the intention to avoid possible harmful effects on learning, together with the adoption of rigid systems and strict planning, is one of the factors that inhibits a culture of experimentation as a practice oriented toward innovation.

On the other hand, the experience during the COVID-19 pandemic further reinforced the need to undertake pedagogy. In Nascimento and Giraffa (2019), we argued that the entrepreneurial teacher's classroom is a space where the teacher presents the idea that students should be the authority of their own lives. In this sense, the entrepreneurial teacher takes ownership of the right to learn and to dare, transforming paradigms. This teacher experiences innovation as the sum of ideas, actions, and results, shares knowledge, thinks differently, collaborates, and faces challenges. From this perspective, the entrepreneurial teacher has a passion, a dream, a cause, but does not abandon method or concreteness. Entrepreneurship is therefore a process of becoming, a continuous movement of innovation in which the teacher constitutes themselves as a subject of knowledge.

This classroom of the entrepreneurial teacher is a place where images and ideas from a fast-paced culture shape emotional identities, and where the possibilities for teaching invention and experimentation are numerous. It is also in this space that virtual life, driven by recent technological, digital, mobile, and ubiquitous developments, provides fertile ground for recreating and redefining human spaces and institutions, as well as for articulating and connecting content in interdisciplinary and even non-disciplinary ways, from small schools to large universities. In this sense, as Nascimento and Giraffa (2021) note, entrepreneurship must be understood as an attitude built through formative processes that produce multiple meanings, without a single prescriptions or homogeneous entry points. It takes shape through the participation of teachers who construct, propose

methodological reversals, invest in the experimentation of thought, and develop and reinterpret knowledge, gradually gaining recognition in their fields of activity.

These elements, remixing, experimentation, and entrepreneurship form the framework that supports and projects pedagogical innovation expressed in the constructions teachers create from their experiences. For this movement of re-signification and creativity to have an impact on the quality of education, it is essential to invest in ongoing teacher training and curricular revision, a topic debated for decades but increasingly urgent in light of contemporary challenges. In the early years of Basic Education, the role of the entrepreneurial teacher became even more relevant. This teacher dares to experiment and recognizes error as an essential part of the formative process, both for themselves and for students. By adopting this stance, they create creative and innovative strategies that allow Computational Thinking to become cross-cutting in everyday school life.

The entrepreneurial teacher in the early years does not limit themselves to applying ready-made methodologies or reproducing established practices. They reinvent their classroom as a space for experimentation. They use simple and concrete resources, often recyclable, to create unplugged activities that relate to children's reality and enable meaningful learning. In this process, they connect computational concepts such as abstraction, decomposition, pattern recognition, and algorithms to real and interdisciplinary situations, exploring the potential of Computational Thinking as both a language and a pedagogical strategy.

Thus, teacher entrepreneurship in the early years appears in the courage to innovate, to cross disciplinary boundaries, and to propose practices that break with the centrality of content-focused teaching. By experimenting and remixing, this teacher creates conditions for Computational Thinking to become a cross-cutting axis, re-signifying the curriculum and contributing to the development of children who are critical, creative, and active in their learning.

Entrepreneurship in the context of implementing the unplugged approach, as a counterpoint to the idea that screen use and digital technologies are synonymous with innovation, needs to be carefully revisited. Although Desmurget, in his book "Faça-os ler!: para não criar cretinos digitais" (Desmurget, 2023), does not directly

address the use of concrete materials such as toys or physical objects in teaching, since his focus is on the value of reading as a tangible practice anchored in printed books, he does highlight the importance of returning to real and concrete contact rather than relying solely on digital mediation. Reading, in this sense, is an embodied activity with proven benefits that distinguish it from screen-based media consumption.

In this scenario, the entrepreneurial teacher in the early years emerges as a central figure. This teacher dares to experiment, does not fear error as part of the process, and creates innovative strategies for integrating unplugged Computational Thinking across the curriculum. By proposing activities that use printed books, games, play, and concrete materials, preferably recyclable ones, this teacher promotes meaningful learning that integrates logical reasoning, creativity, and cooperation. Teacher entrepreneurship finds in the unplugged perspective a turning point. It shifts away from the logic of innovation associated only with the digital and adopts practices that, while dialoguing with technological culture, respect childhood needs, support sustainability, and enhance the quality of Basic Education.

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