


DIDACTIC MATERIALS FOR K-12 EDUCATION TEACHER TRAINING IN COMPUTATIONAL THINKING

MATERIAIS DIDÁTICOS PARA FORMAÇÃO DE PROFESSORES DA EDUCAÇÃO BÁSICA EM PENSAMENTO COMPUTACIONAL
MATERIALES DIDÁCTICOS PARA FORMACIÓN DE PROFESORES DE LA ENSEÑANZA BÁSICA EN PENSAMIENTO COMPUTACIONAL


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ABSTRACT:

Brazil has notably advanced in the formulation of public policies regarding the integration of Computing in K-12 Education. With the approval of Resolution no. 1, which provides for the Rules on Computing in K-12 Education, a

complement to the BNCC, it is up to the states, municipalities and the Federal District to initiate implementation. In this direction, there is undefinitions about how to carry out this implementation, especially in relation to the absence of teacher training and teaching materials that make it possible to carry out the didactic transposition. With a quantitative methodology, the present study presents a set of teaching materials to promote continuing education courses for elementary school teachers, the works were validated by 312 teachers, statistical data were collected via survey forms. The results showed that the target audience considered the works accessible and would recommend them to friends. They also considered using the proposed activities in their classrooms and stated that they found it possible to create new activities that are very positive results.

KEYWORDS: Computational Thinking; Teaching materials; Continuing Teacher Training.

Introduction

Technologies surround us in different aspects of our lives. In the area of education, every year, innovations appear that seek to improve techniques that aim to facilitate the teaching-learning processes. From this perspective, studies show that Computational Thinking (CT) has gradually grown in the educational environment (Medeiros et al., 2021). The approach was proposed by (Wing, 2006) and consists of solving problems in different areas of knowledge using fundamentals of Computer Science.

In this perspective, it is notorious that Brazil has advanced in approaching the new teaching standards already consolidated in other countries. As a more recent consequence, we have the approval of Resolution No. 1, of October 4, 2022, which provides for the Norms on Computing in K-12 Education, a complement to the BNCC (Brasil B, 2022), which comes into force on 11/01/2022. With the approval of the

Resolution, it is up to the states, municipalities and the Federal District to start implementation within one year

From this, a great concern arises: How Computational Thinking will be implemented in Brazil. As a discipline (being a new component of the BNCC) or transversally? Regardless of this, another issue comes up: the lack of continued teacher training in CT and, consequently, their lack of preparation to develop the topic in the classroom. In this direction, the growth in the number of materials that are produced for students, mainly in Basic Education, to work with the CT in the classroom stands out (Medeiros et al., 2020; Schulz and Schmachtenberg, 2017; Bell et al., 2011) however, it cannot be said that the same occurs for teachers (Medeiros et al., 2021).

On this topic, there is still much to be discussed. Still according to the study by (Medeiros et al., 2021), this occurs for a number of reasons: i) because the incidence of articles published in the scope of CT is still incipient in the scientific literature; ii) because studies that point to teacher training to work with CT are still rare; iii) because it is primarily concerned with training students; and iv) because when training takes place, it boils down to training reproducers of practices, manipulators of tools, which does not allow teacher autonomy and the formation of critical thinking. Among these four points, iii) and iv) are worrying.

Thus, objective of the study was to present a set of didactic materials to promote continuing education courses for Elementary School teachers, with the aim of training them in terms of the concepts and practical applications of CT, enabling teachers to carry out the transposition didactic.

The paper is organized as follows: Section 2 describes a background about Computational Thinking; Section 3 explains the methodology used; Section 4 describes the experiments carried out and presents the results; and, Section 5 gives some the final conclusions and proposals for future work.

Background

In 1980, Seymour Papert already saw the computer as a stimulator of ideas and visualized the possibilities of using it to innovate the educational system. In his work, (Papert, 1985) stated that the interaction was guided by the children teaching the computer to perform the tasks, and never the other way around. Thus, the computer becomes an ally in the construction of knowledge and an influencer of human thought.

Decades later, ideas such as Papert's are reintroduced under the term Computational Thinking. In 2006, Wing defines it as a set of skills used to solve problems efficiently, providing mental tools found in the field of Computer Science. Therefore,

thinking computationally means viewing the same problem at different levels, and finding strategies to reformulate a difficult problem into smaller, easier-to-solve problems – reflecting on the solution in a logical, algorithmic, abstract, recursive and parallel way. This approach includes exploring different aspects of the problem, considering its complexity and designing solutions with available resources (Wing, 2008). Still, it is considered a universal thought because it can be applied in other fields of human interest.

In a more practical perspective, (Guarda and Pinto, 2020) define that Computational Thinking can be understood as an approach aimed at solving problems by exploring cognitive processes, as it discusses the ability to understand proposed situations and create solutions through mathematical models, scientific or social to increase our productivity, inventiveness and creativity.

Abstraction, decomposition, pattern recognition and algorithms are the four pillars of Computational Thinking, abstraction being considered as the essence of this type of thinking. According to (Wing, 2008), an algorithm is the abstraction of a sequence of steps to process inputs and produce the desired outputs. Consequently, it is the abstraction process that establishes which details are important and which can be ignored, and allows identifying which will be the best tool to be used among those available to solve a specific problem.

In practical terms, the CT can be implemented with the support of digital technologies or not. The implementation without the use of digital technologies is called the Unplugged Approach and it was created with the aim of enabling individuals without access to the computer to have the opportunity to understand its operation and its fundamentals (Bell et al., 2009; Bell et al., 2011). According to (Vieira et al., 2013 and Barbosa et al., 2015), because it is easy to understand, teachers and researchers have used this technique as a way to streamline the learning of computing concepts, as well as using it as a strategy for approaching the teaching of more specific contents in the area of Computing (Costa et al., 2017).

Therefore, this study intends to explore the exposed gaps as an opportunity to expand and develop the theme by answering the following question: **How to work with continuing education on the four pillars of Computational Thinking with Elementary School teachers, in an unplugged approach?**

Method

According to (Gil, 2010), the research is developed based on existing knowledge and with the careful use of methods and techniques of scientific investigation. The methodological approach used in this study was quantitative according to (Limena and Cavalcanti, 2006) and exploratory in nature (Gil, 1999; Severino, 2007), adopting the survey research method (Pinsonneault and Kraemer, 1993).

The study's target audience was 312 teachers or people interested in the subject who do not work as teachers who participated in the validation process of teaching materials. However, only 192 (62% of the sample) actually started the validations and 60 (28% of the sample) finished.

Also, the target included people with prior knowledge in Computational Thinking in order to have more technical analyzes and people with only pedagogical experience. The compiled data refer to the period between November 2021 and July 2022 and included teachers from different school segments.

The sampling adopted was non-probabilistic and for convenience (Gil, 1999). Table 1 below presents the general profile of the teachers - the data were extracted from the profile mapping and previous knowledge survey form. More specifically, the table presents gender, age, type of school (public, private or both), length of experience in years.

Table 1 General profile of the target

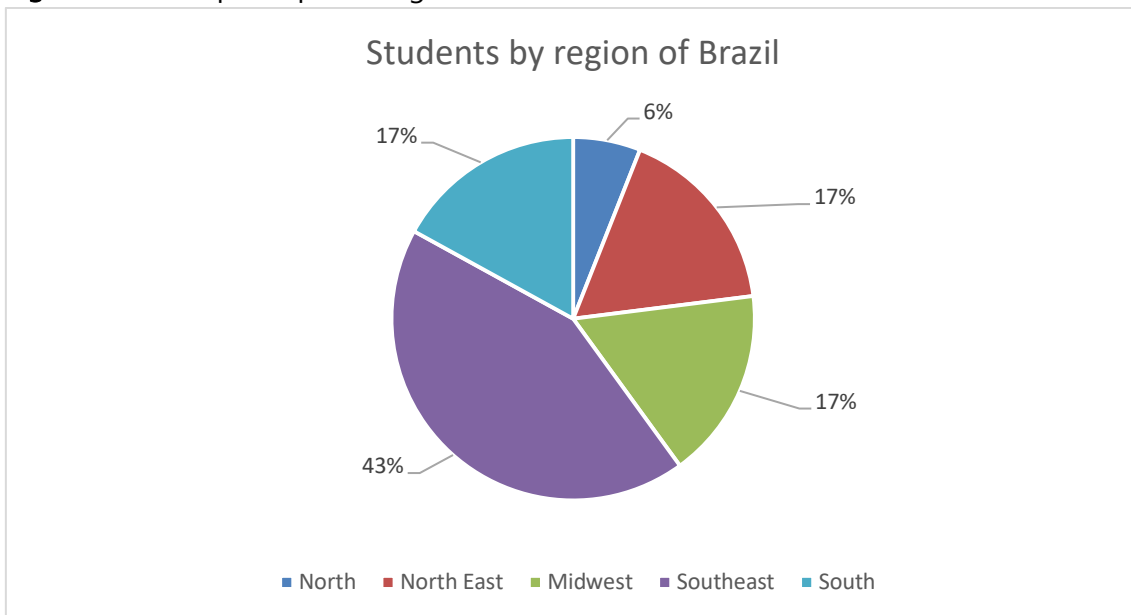
Gender:	Age:	Type of school:	Experience (in years):
Female 52%	21 to 30 13.1%	Public 76.6%	Until 5 21,9%
Male 48%	31 to 40 28.6%	Private 18.7%	Between 6 and 10 17,7%
	41 to 50 38.5%	Both 4.7%	Between 11 and 15 9.1%
	Above 50 19.8%		Between 16 and 20 22,9%
			Above 20 37.6%

Source: Prepared by the authors. Data collected from the profile mapping survey form and prior knowledge.

Regarding the profile of the teachers, it is important to highlight that more than half of the teachers interested in participating in the validation have more than 16 years of experience in the classroom, which represents 60.5% of the sample. This result suggests an interest in learning and innovating pedagogical practices, even for those who are closer to the end of their careers. Another important data was the great interest of public-school teachers (76.6% of the sample) and this data increases as we have 4.7% of the sample signaling that they work in both public and private schools.

In addition, the regions of Brazil where the evaluators reside were also mapped. The data reveal that the north region had the lowest rate of participants (6% of the sample), the 'north east', Midwest' and 'south' regions represent 17% of the sample each and the region that had the most course participants belong to 'southeast' region with 43% of the sample. Finally, from the Federation Units AC, AP, PI, RR and TO we had no course participants (of these, 80% from the northern region of Brazil). Figure 1 below illustrates the findings in detail.

Figure 1 Course participants' regions of Brazil.



Source: Prepared by the authors.

Finally, regarding preliminary knowledge about Computational Thinking. The results showed that 24.6% of the teachers claimed not to have knowledge about CT compared to 75.5% who claimed to have knowledge. From this result, during the validation process, the level of knowledge that the teachers effectively had was investigated in more depth and it was observed that they did not, in fact, fully understand the CT and the skills associated with the subject.

It was noticed that the teacher's perception of the subject is associated with elements that allude to: 1) The computer performing tasks or 2) computer programming or finally, 3) the use of technology or computational tool. These results are in agreement and in line with the recent study by (Kubota et al., 2021) on a portrait of the understanding of teachers at Federal Institutes about CP.

The survey form data were compiled using the Likert scale, which is a scale considered suitable for analyzing data from the application of electronic forms that

assess the opinions of a group of people representing the target audience (Oliveira, 2005). Besides, the research received a positive opinion from the Research Ethics Committee (CEP) of the Fluminense Federal University (UFF) under protocol no. 49077121.0.0000.8160.

The collection of textbooks for teacher training

The collection of textbooks presents a proposal for the implementation of Unplugged Computational Thinking in an interdisciplinary way in Elementary School – Early Years and integrated with all BNCC curricular components of this educational stage.

The works were carefully written for educators (and parents) to help them develop more creative and meaningful learning. Learning is not only for today, but with an eye to the future. In the works, stimuli are found to create, develop new ideas, thoughts, knowledge that bring fun and play as part of the learning process.

Still, the works stimulate the development of cognitive, numerical, linguistic, social, motor skills, logical reasoning and introduce programming fundamentals and concepts based on the 4 pillars of Computational Thinking, which include: sequential structures, selection, looping and operators' arithmetic, relational, and logical methods that are commonly used in logic programming.

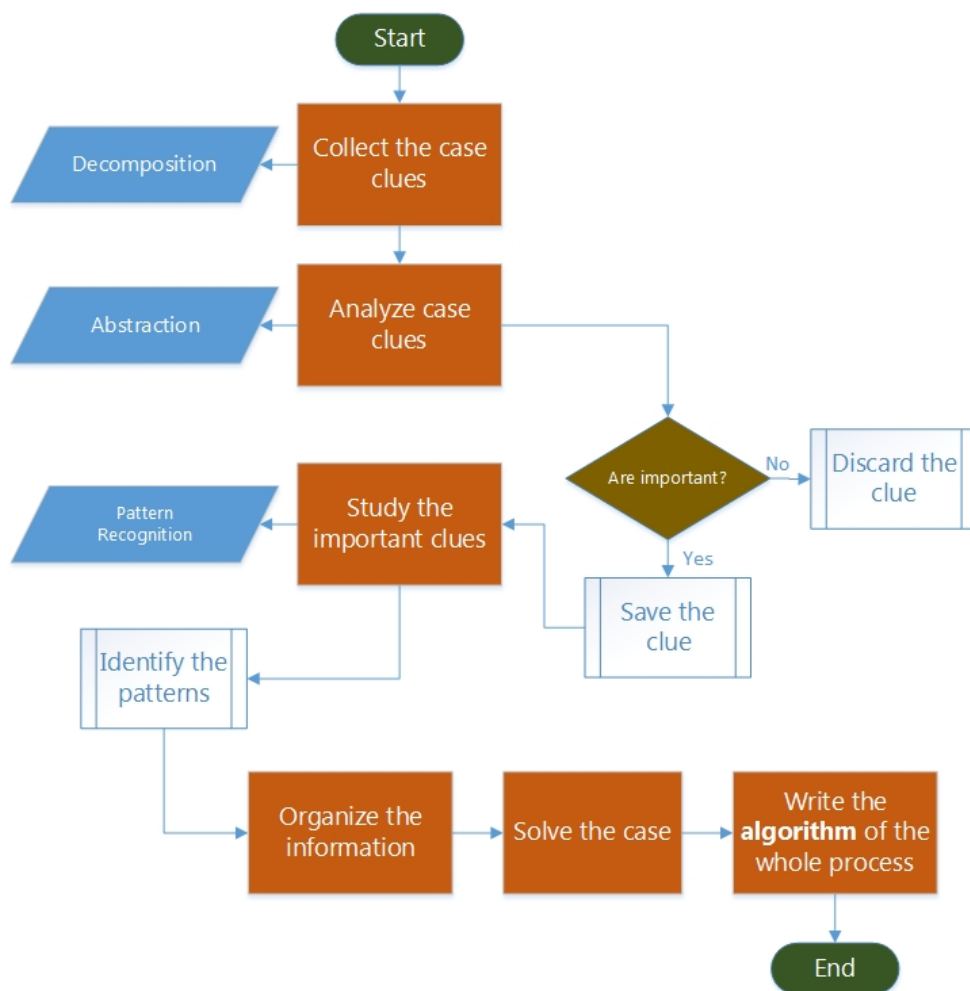
The books were written in two parts. Firstly, a theme was defined so that teachers could understand and appropriate the concepts of CT and the 4 pillars in a real-world perspective (theoretical part) and later a unified model of activities was created, which refers to the activities that aim to enable an implementation of the pillars of the CP in Elementary School (practical part).

The **theoretical** part illustrates and clarifies – for teachers – what Computational Thinking is and the skills of the 4 pillars. The abilities were explored making an analogy with the investigative universe of the public domain character Sherlock Holmes. In this way, the 4 pillars of the CT are not presented to the professors in isolation using independent examples, instead, they are presented in an integrated manner, establishing a single line of reasoning for understanding the concepts.

Thus, the theoretical aspects were constructed from the Scotland Yard board game intertextually related to the work of Sir Arthur Conan Doyle, creator of Sherlock Holmes. The game is inspired by the stories of Sherlock Holmes and has one hundred and twenty cases that take place in London, which players must unravel through clues found in different parts of the city. In such a way, the game involves reasoning and abilities to relate, to cross data, after all the players need to join the clues in a logical way to unravel

the cases. To this end, this theme was explored following the steps in the flowchart below (Figure 2).

Figure 2 Presentation flowchart of the 4 pillars of the CT from the collection of didactic works



Source: Prepared by the authors.

According to Figure 2, the collection of clues for the case under analysis is associated with **decomposition**, since the information is all partitioned; the analysis of the clues is related to **abstraction** because a filter needs to be made in them that will define which clues are important and which are irrelevant; after that, a more detailed study of the important clues that is associated with **pattern recognition** is necessary and finally, the **algorithm** refers to the step-by-step organization of all the information and process steps that lead to the solution of a case. This theme was chosen because it presents an important interdisciplinary potential.

In the **practical** part, the pedagogical proposal was based on two assumptions: 1) digital literacy is the new literacy and 2) allow yourself to make mistakes. The proposal has as inspirations and theoretical bases, the intersection between 4 components:

- a) the document entitled: "Guidelines for Teaching Computing in K-12 Education" (SBC, 2018);
- b) the new BNCC (Brasil A, 2017);
- c) the unplugged approach (Bell, 2009; 2011), Brackmann, 2017);
- d) the active methodology Creative Learning (Resnick, 2006; 2012) which will be detailed below:

a) **The document "Guidelines for Teaching Computing in K-12 Education":** The document presents a set of directions and possibilities for teaching Computing in Brazilian K-12 Education. To this end, several concepts were put in place: what is Computing, as well as other terminologies commonly used in the Computing area to make explicit the interpretation of the vocabulary that was used in the document, which stand out: technology, digital technology, Information Technology and Communication (ICT), digital fluency, educational technology and finally, Computational Thinking (SBC, 2018).

The document defines Computational Thinking as: "The ability to understand, define, model, compare, solve, automate and analyze problems (and solutions) in a methodical and systematic way" (SBC, 2018).

From this, the knowledge of the area of Computing was organized in 3 axes: Computational Thinking, Digital World and Digital Culture, which conceptualized in the introduction of the thesis. Furthermore, the general competences of Computing were defined relating them to BNCC. In the end, these competencies were described and illustrated in conceptual maps considering each school year of Basic Education, ranging from the 1st year of Elementary School to the 3rd year of High School (SBC, 2018).

The collection of textbooks used this document as a starting point and from it, the contents, skills and competencies were customized for the composition of the materials. In this way, the books have a properly organized format, language and design so that teachers can use the works in their classrooms with their students in the format of the National Book and Didactic Material Program (PNLD). Thus, the objects of knowledge and skills to be developed according to each book are described in Table 2 below:

Table 2 Objects and Skills per year of Elementary School of the Customized Computational Thinking Axis.

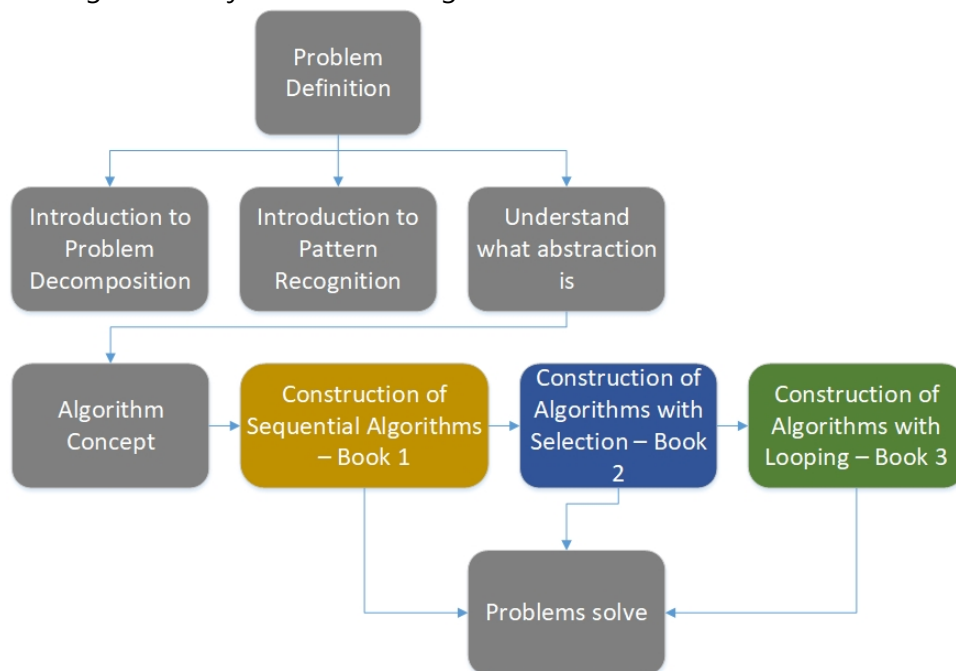
Book:	Grade:	Object of Knowledge:	Skills:

1	1 nd	Organization of Objects	Arrange concrete objects in a logical way using different attributes (for example: color, size, shape, textures, others).
		Identification of Behavior Patterns	Identify patterns of behavior (examples: playing games, everyday routines, gold stuff, others).
		Algorithm: Definition	Understand the need for algorithms and their definition to solve problems step-by-step (examples: construction of origami, spatial orientation, execution of a recipe, others).
		Algorithm: construction and simulation (sequential structures)	Define and simulate algorithms (described in natural or pictographic language) constructed as simple sequences and repetitions of a set of basic instructions (example: go forward, turn right, turn left, others); elaborate and write stories from a set of scenes.
	2 nd	Problem Definition	Identify problems whose solution is a process (algorithm), defining them through their inputs (resources/inputs) and expected outputs.
Objects Model		Create and compare object models by identifying essential patterns and attributes (example vehicles, housing constructions, others).	
2	3 rd	Introduction to Logic	Understand the set of truth values and the basic operations on them (logical operations).
		Algorithms: selection	Define and execute algorithms that include sequences, simple repetitions (defined iteration) and selections (described in natural language and/or pictographic) to accomplish a task, independently and in collaboration.
3	4 nd e 5 nd	Algorithms: looping	Define and run algorithms that include sequences and repetitions (definite and indefinite, simple and nested iterations) to accomplish a task, independently and collaboratively.

Source: Prepared by the authors. Adapted from the document "Guidelines for Teaching Computing" (SBC, 2018).

Furthermore, it is important to understand that the proposal of the books follows an alignment in terms of content, starting in the 1st year of Elementary School and being expanded in the remaining years. This proposal can be better visualized in Figure 3 below. The diagram shows the objects of knowledge of the works, illustrating the dependencies between them:

Figure 3 Diagram of objects of knowledge of didactic works



Source: Prepared by the authors.

b) **The new BNCC:** The document "The new BNCC" (Brazil a, 2017) is also the basis for planning the proposal in relation to the curricular components and contents of Basic Education. To this end, it is clarified that a model entitled 'Unified model of activities' was created, which is an example of an activity that can be implemented in all educational modalities: face-to-face teaching, distance education (DE) and blended learning.

This model was proposed in view of our reflections on the real scope and potential of the CT, considering that studies in the scientific literature show that the CT is basically associated with mathematics and the natural sciences (Brackmann, 2017). In this sense, the creation of a model was idealized - one that was fully adaptable to enable the expansion of the CT to the other components of the curriculum.

Each book has an activity for each component of K-12 Education aligned with the BNCC, namely: 1) Portuguese language, 2) arts and music, 3) geography, 4) history, 5) natural sciences, 6) mathematics and 7) In a complementary way, an optional foreign language activity was included in English (in modules 1 and 2) and Spanish in module 3. The model's activities are adaptable to any BNCC content and the teacher has autonomy to promote changes and adjustments that he/she finds necessary.

The model is organized in two parts: 1) The **planning** that refers to the organization of the activity (or lesson plan) and 2) The **pedagogical action** that refers to the way of applying the activity with the students. The idea is that this model serves as a guideline so that teachers can develop the four pillars of the CT, thus seeking to effectively

contribute to a creative and meaningful learning process, also favoring interdisciplinary activities.

The model was developed using the methodology called gamification. Gamification refers to the use of game techniques in non-game situations. Therefore, it is adapted within a context to motivate, engage or make an activity more pleasurable. With this, the student learns to solve problems and enhances his learning. In addition, gamification awakens the curiosity of those who “play” to solve challenges and obtain rewards (Oliveira et al. 2022).

In this way, gamification in education provides stimuli for learning to occur through games, reinforcing both theory and practice. In this sense, the teacher will act as a kind of game designer, finding ways for students to want to play more, as well as interact with the knowledge provided in the classroom (Oliveira et al. 2022).

Gamification in learning emerges as a solution to stimulate collective and collaborative action. In a practical way, we work with the idea of reward, in this way, students feel encouraged to overcome the proposed challenges and, for that, it is recommended to develop work in groups (P “pairs” of Creative Learning).

The characteristics that define gamification in the unified model of this thesis are:

- a) Curiosity or Mystery: Curiosity can encourage engagement with learning, it is an element to make students want to know more about the topic addressed, know the answer to a question or find out how to do something;
- b) Progress and Feedback: It is important for teachers to monitor the development of students so that they can see their progress. It gives them something to be proud of. Feedback from that journey helps them stay engaged;
- c) Competition: Competition can turn activities into something more fun and social;
- d) Teams: Competition between teams is a great tool to balance different levels of competence, work on cooperation and build teamwork skills;
- e) Exploration: This element allows students to explore specific topics or subjects in greater depth; It is
- f) Challenges: Challenges motivate students to apply their knowledge by encouraging them to complete objectives, even when they have some level of difficulty in achieving the goals.

c) **The unplugged approach:** The implementation (practical) approach of Unplugged Computational Thinking used in the books was inspired by the activities of Bell (2009; 2011), Brackmann (2017), the PNLD books and the Scratch development environment.

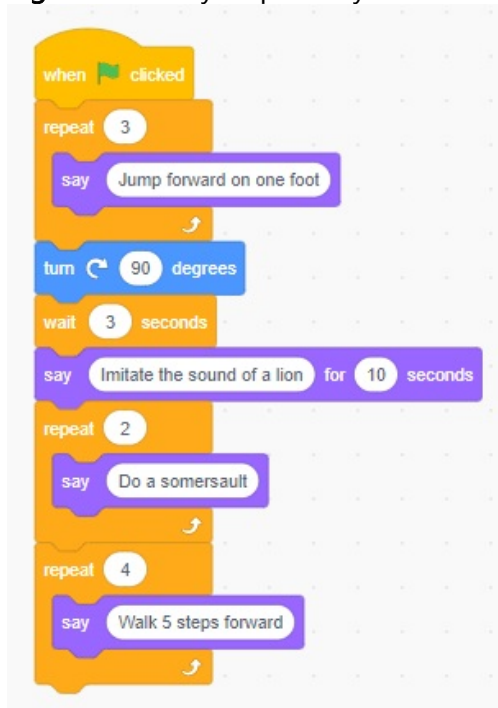
Scratch is a graphical programming language that was created at the Media Lab at the Massachusetts Institute of Technology (MIT), inspired by the Logo and Squeak languages. The language was invented for children to create programs without needing to know coding. Instead, they program through command blocks that are nested within each other, forming a set of instructions (Santos, 2018).

Its purpose is to facilitate the introduction of mathematics and computing concepts, while at the same time inducing creative thinking, systematic reasoning and collaborative work. In this sense, Scratch allows the creation of programs that control and mix images, animation, text, music and sound (Santos, 2018).

Unplugged activities often occur through kinesthetic learning – this learning includes the perception of muscle movements, weight and position of the limbs through proper stimuli. Examples are: moving, cutting, folding, pasting, drawing, painting, solving puzzles, others) – Brackmann (2017). This approach was chosen to enable the works to reach everyone, thus enabling a possible implementation both in public and private schools, this occurs since the implementation cost is low and accessible.

The unplugged CT is contained in all activities proposed in the unified model of activities and in the programming logic of the works, where the gifts were implemented. The gifts are a set of actions that will be organized in logical sequences inspired by the commands of the Scratch block programming development environment. An example can be seen in Figure 4 below:

Figure 4 Activity inspired by Scratch from Module 1 of the collection



Source: Prepared by the authors.

The gift illustrated above gives us a set of instructions that must be executed sequentially by the students as follows:

1. Repeat 3x: jump forward on one foot;
2. Turn 90 degrees;
3. Wait for 10 seconds;
4. Imitate the sound of a lion for 10 seconds;
5. Repeat 2x: Do a somersault;
6. Repeat 4x: Walks 5 steps forward.

The repeat command denotes that the action needs to be repeated the number of times indicated in the command. The say expression (in the purple parts) shows what students should do. As the gifts will be applied by the teachers, unlike if it were being executed by Scratch, who should check if the sequence established in the gift was correctly executed by the students, is the teacher or another person designated for this function.

In this way, the process called compilation is done by a human and not by a machine. Compiling a program or source code written in a programming language can be understood as a source code interpretation process.

d) **The active methodology Creative Learning:** The active methodology for implementing (practice) Unplugged Computational Thinking chosen for the works was Creative Learning (Resnick 2006; 2012). In all works, we use the 4P's of Creative Learning (CL) associated with gamification. CL refers to creating educational opportunities that encourage the development of shareable products in the physical or virtual world, stories, presentations, art installations and more; looking at students' interests and passions; collaboration and mutual respect; ludic exploration, play and the perception of error not as a defect, but as an attempt that is part of the learning process (Carbajal and Baranauskas, 2018).

In this way it is clarified that the books are an exact reflection of this concept. We associate play with the possibility of taking risks, testing new things and testing limits, rescuing students' interest and passion for learning (engagement).

We reduce the complexity of teaching algorithms and programming logic, adapting it to a suitable language for children, using elements such as: curiosity, mystery, playful exploration, challenges (gamification) making interactions between students and teachers can occur in conditions of "equality", deconstructing the idea that the teacher is the protagonist of the pedagogical relationship, since the construction of knowledge (in the view of the CL) occurs through learning by doing, doing together, building together. In this way, the teacher appropriates the knowledge that the students bring and explores with them, new approaches from that.

Finally, the work developed in pairs, in collaboration, was stimulated. In addition, the quiz that are part of the unified model work on understanding that the error (or making mistakes) is not a problem, but rather an attempt that is part of the learning process, which is important for not only academic development, but personal. In quiz, the more the student makes mistakes in the logical sequences that must be developed, the more fun the process becomes and the more they learn the fundamentals of programming, deconstructing the idea that the error is something negative.

For a better understanding of the four components, an example of the unified model of activities is provided, which can be viewed at: <http://bit.ly/3K1t3iV>.

The example refers to one of the activities in the books and relates to the BNCC Geography component. It was proposed to be applied to the 1st and/or 2nd year of Elementary School (Initial Years). In the example, the theme was worked on: means of transport and traffic in the city.

In part 1: **pedagogical planning**, the teacher finds in detail how to organize the activity and some complementary guidelines that include:

- The general description of the Problem (objective): what is intended with this activity;
- The skills worked on: what will be worked on in the activity in terms of skills and competences;
- The methodology: steps on how to carry out the activity, here we have the step by step for the execution that can be modified / adapted at the teacher's discretion;
- The materials: the materials needed to carry out the activity that can be adapted to the reality of the school; and
- Expected results: what is expected or what we want with carrying out the activity.

In part 2: **Pedagogical Action**, the teacher finds the practical proposal that refers to the playful part of the activity, which in this case refers to the construction of a crossword puzzle. The crossword contains 7 items and they must be completed according to the resolution of the clues described.

The first clue is described as: 'WE CAN CROSS THE STREET WHEN THE PEDESTRIANS TRAFFIC LIGHT IS ON COLOR', whose answer is the word GREEN – this is the word that must be filled in in the number indicated in the presented diagram that was adapted to the age of the public-target.

However, for students to have access to the clues and to be able to complete the crossword, they must answer a quiz item that must be presented to the students in random or shuffled order.

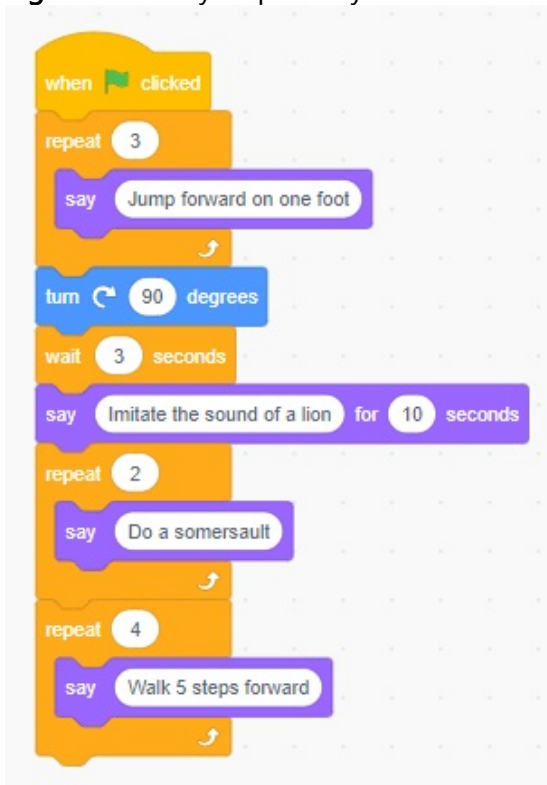
The quiz is a set of true or false questions and answers (or a bank of questions) related to the theme of the activity. The quiz are ready to be printed in card format and

allow the teacher to explore in more depth the themes worked on. In the activity, the teacher also finds all the templates for the questions so that they can be guided or instructed.

When the student gets the correct answer from the quiz card obtained, the same or the group of students receive a crossword clue so that the same or they can fill in the diagram.

When the student or group of students gets the quiz card wrong, they must pay a gift. Gifts, as explained earlier, is a logical sequence inspired by Scratch. To detail one of the gifts illustrated in the Geography activity, let's analyze Figure 5, corresponding to gift number 2 of the activity.

Figure 5 Activity inspired by Scratch from Module 1 of the collection



Source: Prepared by the authors.

The gift illustrated above gives us a set of instructions that must be executed sequentially by the students as follows:

1. Repeat 3x: jump forward on one foot;
2. Turn 90 degrees;
3. Wait for 10 seconds;
4. Imitate the sound of a lion for 10 seconds;
5. Repeat 2x: Do a somersault;
6. Repeat 4x: Walks 5 steps forward.

Students must execute this sequence of commands described above to pay the gift. If it is executed incorrectly, there is no problem because the important thing here is the development of psychomotricity, as well as the appropriation of the executed programming logic commands - the same ones were described previously (repeat commands, say).

In this way, the more students miss the quiz questions, the more they practice programming logic commands.

The activity is finished when a student or group of students completes all items in the crossword correctly. In case the student or group of students receives the clue and gets the answer wrong, they must give way to the other participants in the activity.

Each work in the collection has a set of characteristics that differentiate them. They will be detailed according to the volumes that were named: module 1, module 2 and module 3.

Regarding **Module 1** (Guarda & Pinto, 2021). It is the first book in the collection and is specific for the 1st and 2nd years of Integrated Elementary School, this division was made as a suggestion of the teachers who carried out the validation, because according to them, the contents of the 1st and 2nd year are basically the same, being in the 1st year initiated and in the 2nd year deepened. In this way, the book presents the pillars of CT and the four pillars of the unplugged CT, yet, this module has programming logic activities specifically with a focus on sequential structures;

Regarding **Module 2** (Guarda & Pinto, 2021). It is the second book in the collection and is specific for the 3rd year of Elementary School. In this sense, it is clarified that the 3rd year is a year of school transition, it is a year that represents the end of the literacy cycle. From that perspective, this was the last book written in capital letters (or capital letters).

Module 2 of the collection brings news in relation to module 1, in this module, the number of illustrations was reduced to give greater emphasis to writing and reading skills, adapting to the characteristics of this age group. In addition, a cryptography activity was included, this activity refers to the 'foreign language' component (English), however, the activity can be applied entirely in Portuguese and the cards (quiz) can also be used to carry out a memory game (Portuguese versus English) as the illustrations help in this regard.

Cryptography is a very interesting subject in the area of Computing to start a dialogue with children about the importance of data/information security and the care that we must have with exposure in the media and social networks. In module 2, the gifts also advance in complexity. In this sense, the use of relational operators and conditional

structures (command if – otherwise) was included in the development of algorithms, and gifts also stimulate the arithmetic calculations of addition.

Regarding **Module 3** (Guarda & Pinto, 2022). It is the third book in the collection and is specific for the 4th and 5th years of Integrated Elementary School, again this division was made as a suggestion of the teachers who carried out the validation, because according to them, the contents of the 4th and 5th year are basically the same, starting in the 4th year and deepening in the 5th year. Module 3 of the collection is the last book with news in relation to the other modules:

The texts started to be written in lowercase letters (or lower case) because at this stage, the students have already acquired proficiency in reading and already recognize the characters in that format. In addition, the illustrations have again been reduced to place greater emphasis on reading and writing skills. Also, the quiz questions are longer, so problem solving is an important component of this book.

Also, the foreign language developed was Spanish and not English to bring a greater diversity of languages to the collection. Additionally, in the history activity, the Brazilian Sign Language (Libras) was addressed in order to promote awareness regarding the inclusion of deaf and hearing-impaired children who use Libras, a topic that is so important in the school environment. In module 3, the gifts also advance in complexity. In this way, the use of looping structures was worked through the commands repeat and repeat until. The gifts were classified as simple and complex because the way the controls work is different.

Validation of the textbook collection

In order to validate the teaching materials, in addition to mapping the profile of the evaluators shown in the methodology, it was verified whether there were special education target audience students in the classrooms of these teachers (students with disabilities, global developmental disorders and/or with high abilities/giftedness).

Data showed that 53.6% of teachers reported not having special education target audience students in their classrooms, while 46.4% said they did. They described the profiles as: attention deficit hyperactivity disorder (ADHD), pervasive developmental disorder (PDD), autism spectrum disorder (ASD), intellectual disability (ID), multiple disability (DMU), dyscalculia, dyslexia, deafness or low hearing, blindness or low vision, down syndrome, angelman syndrome, physical disabilities, cerebral palsy, microcephaly, oppositional defiant disorder (ODD) or High Abilities/Giftedness (AH/G).

Regarding how the teacher considers the application of CT in their pedagogical practice, 19.8% thought that it would be a complex and difficult process, while 80.2%

stated that the application could occur in a calm and easy way, since everyone went through changes of conceptions and paradigms in the period of remote classes.

Regarding knowledge of the incorporation of the term CT in the new BNCC and in the PNLD. 24.6% of teachers claimed not to have this knowledge regarding the BNCC while 75.5% claimed to be aware. Regarding the demand of the PNLD, 57.8% of the teachers stated that they did not have knowledge, while 42.2% of the sample stated that they had this knowledge. Again, by better observing the data, it was possible to perceive that this knowledge existed primarily on the part of teachers who were working in school management. This suggests that teachers are out of date with regard to the content of the new PNLD textbooks and the changes promoted in the new BNCC.

Finally, the opinions expressed by the participants were mapped onto a scale with five levels of measurement, where 1 represents the minimum score and 5 the maximum score with the following parameters (1= Strongly disagree; 2= Partially disagree; 3= Neither agree nor disagree; 4= Partially agree; and 5= Fully agree). Our intention was to elaborate an opinion ranking, using a scale with fixed answers format.

To analyze the results, we calculated the average ranking (AR) of the answers, based on the Likert scale method proposed by Oliveira (2005). As previously reported, 60 people completed the validation (28% of the sample).

Different questions were evaluated, namely: 1) content, language and graphic designer project; 2) if the teacher considers it possible to create new activities (or adapt) with reference to the Activity Model; 3) if the professor would consider using / applying the practical activities of the book in his/her classroom and finally; 4) whether the professor would recommend the book to a friend or colleague.

The results revealed that in 1) 78% of the professors totally agreed, 20% partially agreed and 1% neither agreed nor disagreed, demonstrating neutrality in the answer.

In 2) 67% of the professors totally agreed, 27% partially agreed, 5% neither agreed nor disagreed demonstrating neutrality in the answer and 1% partially disagreed.

In 3) 77% of the professors totally agreed, 22% partially agreed and 1% partially disagreed.

In 4) 87% of the teachers totally agreed and 13% partially agreed, which are very positive results and suggest that the books are suitable for a possible implementation of CT in schools in Elementary Education. The calculations of the rankings will be shown below, as well as in Table 3, the results of the questions.

$$\text{AR of question 1} = (1 \cdot 3 + 12 \cdot 4 + 47 \cdot 5) / (1 + 12 + 47) = 4.9.$$

$$\text{AR of question 2} = (1 \cdot 2 + 3 \cdot 3 + 16 \cdot 4 + 40 \cdot 5) / (1 + 3 + 16 + 40) = 4.3.$$

$$\text{AR of question 3} = (1 \cdot 2 + 13 \cdot 4 + 46 \cdot 5) / (1 + 13 + 46) = 4.7.$$

AR of question 4 = $(8 \cdot 4 + 52 \cdot 5) / (8 + 52) = 4.9$.

Table 3 Results of the evaluation questions

Questions:	Frequency of answers:					
	1	2	3	4	5	AR
1. Regarding the textbook. Do you consider the contents, language and graphic design used in the Textbooks accessible?			1	12	47	4.9
2. Would you consider using/applying the Unified Model hands-on activities from the book in your classroom?		1	3	16	40	4.3
3. Do you think it is possible to create new activities (or adapt) with reference to the Activity Model presented in the textbook?		1		13	46	4.7
4. Would you recommend the textbooks to a friend or colleague?					52	4.9

Source: Prepared by the authors. Data collected from the didactic works evaluation survey form.

Conclusions

The insertion of computing in schools is essential to provide students with a new experience of how to think to solve problems. Through the inclusion of this new knowledge, students tend to understand the complexity of problems in a more systematized way and, consequently, may become capable of having more autonomy, flexibility, resilience, proactivity and creativity, which are necessary skills in the contemporary world.

In terms of public policies, we have already defined in Brazil that the implementation of Computing must occur through Computational Thinking in Basic Education, this is explicit both in the BNCC and in the calls of the PNLD.

However, for this future implementation – of Computational Thinking in schools – to take place, it is first necessary to make adequate teaching materials on the subject, in terms of content, language and design, so that from this, it is possible to authorities, support teachers, while school managers also need help to understand and support the theme and, imbued with the same intention, adhere to the proposal to insert Computational Thinking into the school curriculum.

As a consequence, a wide offer of continuing education for teachers should be promoted, so that they become capable of carrying out the didactic transposition of these contents and be prepared to integrate Computational Thinking in the classroom with autonomy and quality.

The study aimed to present a set of didactic materials for teacher training in CT, as well as their acceptance and applicability. The results showed an AR of 4.9 out of 5.0 considering the books accessible and that they would recommend them to friends, 4.3 out of 5.0 considered using the proposed activities in their classrooms and 4.7 out of 5.0 stated that they found it possible to create new activities based on the unified model that are results very positive.

The collection of didactic works includes the presentation of a unified model of activities that aims to lead and help teachers to think about strategies for inserting the CT in the classroom in a practical way, bringing the pillars of the CT closer to the curricular components of the BNCC, favoring the interdisciplinarity.

In this sense, the materials as well as the data from this study can provide opportunities to discuss the inclusion of CT in the K-12 Education curriculum, in an integral way, as well as influence the creation of future educational policies for its proper implementation.

Finally, as future works, it is intended to stimulate the making of new activities based on the unified model (produced by the teachers) so that they can immerse themselves and learn by doing and, so that it is possible to verify the appropriation of the CT concepts in practice, as well as the transposition of the approach to their classrooms.

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RESUMO:

O Brasil tem avançado notoriamente na formulação de políticas públicas no que tange a integração da Computação na Educação Básica. Com a aprovação da Resolução nº 1 que dispõe das Normas sobre Computação na Educação Básica, complemento à BNCC, cabe aos estados, aos municípios e ao Distrito Federal iniciar a implementação. Nessa direção, há indefinições sobre como realizar essa implementação especialmente em relação a ausência de formação de professores e materiais didáticos que possibilitem a realização da transposição didática. Com metodologia quantitativa, o presente estudo apresenta um conjunto de materiais didáticos para promoção de cursos de formação continuada para professores do Ensino Fundamental, as obras foram validadas por 312 professores, os dados estatísticos foram coletados via formulários survey. Os resultados mostraram que o público-alvo considerou as obras acessíveis e que os recomendariam aos amigos. Consideraram ainda, utilizar as atividades propostas em suas salas de aula e afirmaram achar possível criar novas atividades que são resultados muito positivos.

PALAVRAS-CHAVE: Pensamento Computacional; Materiais Didáticos; Formação Continuada de Professores.

RESUMEN:

Brasil ha avanzado notablemente en la formulación de políticas públicas en materia de integración de la Informática en la Enseñanza Básica. Con la aprobación de la Resolución nº 1 que establece el Reglamento de Informática en la Enseñanza Básica, complemento de la BNCC, corresponde a los estados, municipios y Distrito Federal iniciar su implementación. En ese sentido, existe indefiniciones sobre cómo llevar a cabo esta implementación, especialmente en relación a la ausencia de formación docente y materiales didáticos que posibiliten realizar la transposición didáctica. Con una metodología cuantitativa, el presente estudio presenta un conjunto de materiales didáticos para promover cursos de educación continua para profesores de enseñanza básica, los trabajos fueron validados por 312 profesores, los datos estadísticos fueron recolectados a través de formularios de encuesta. Los resultados mostraron que el público objetivo consideraba las obras accesibles y las recomendaría a sus amigos. También consideraron utilizar las actividades propuestas en sus aulas y manifestaron que les fue posible crear nuevas actividades con resultados muy positivos.

PALABRAS CLAVE: Pensamiento Computacional; Materiales de enseñanza