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Computational thinking in education for a curriculum integrated with digital world and culture

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ABSTRACT. The present article is a study in which by analysis of the computational thinking skills, presented by Wing in 2006 (abstraction, pattern recognition, decomposition and composition and algorithmic thinking), in conjunction with the digital culture and world culture axes aims to answer the following question: how can the computational thinking be included in scholar curricula integrating education to the digital world beyond the mere use of electronical gadgets? For so, it was performed an analysis of the *Sociedade Brasileira de Computação* and *Centro de Inovação para a Educação Brasileira* guidelines regarding the Computational Thinking, which structured and specified the relevant contents able to be included in scholar curricula in Brazilian education, according to the *Base Nacional Comum Curricular*. Therefore, the inclusion of the skill axis described by SBC move towards to the integration of the Computational Thinking favoring and providing development and acquisiton of new technological skills and knowledge by contextualizing and identifying such aspects in the children daily lives in a critical and significative form in order to have this knowledge appropriated by the students in a linked mode to the scholar curricula providing new means to deal with different problem situations.

Keywords: technological education; computational thinking; digital culture.

O Pensamento computacional na educação para um currículo integrado à cultura e ao mundo digital

RESUMO. O presente artigo é um estudo que por meio da análise das habilidades do pensamento computacional, apresentadas principalmente por Wing em 2006 (abstração, reconhecimento de padrões, decomposição e composição e raciocínio algorítmico), juntamente com os eixos cultura digital e o mundo digital procura se responder a seguinte questão: como o pensamento computacional pode ser incluído em currículos escolares integrando a educação ao mundo digital para além do simples uso de aparatos eletrônicos? Para tanto foi realizada a análise das diretrizes elaboradas pela Sociedade Brasileira de Computação e pelo Centro de Inovação para a Educação Brasileira voltadas ao ensino do pensamento computacional, que estruturou e especificou os conteúdos pertinentes à computação possíveis de serem incluídos em currículos escolares da educação brasileira, em acordo com a Base Nacional Comum Curricular. Assim, a inclusão dos eixos de habilidades descritos pela SBC vai ao encontro à integração do Pensamento Computacional favorecendo e oportunizando o desenvolvimento e a aquisição de novas habilidades e conhecimentos tecnológicos por meio de contextualização e identificação destes aspectos no cotidiano das crianças de forma significativa e crítica para que estes conhecimentos sejam apropriados pelos estudantes de modo atrelado ao currículo escolar e proporcionando novos meios de lidar com diferentes situações-problema.

Palavras-chave: educação tecnológica; pensamento computacional; cultura digital.

Pensamiento computacional em educación para um currículo integrado com la cultura y el mundo digital

RESUMEN. El presente artículo es un estudio que, a través del análisis de las habilidades de pensamiento computacional, presentado principalmente por Wing en 2006 (abstracción, reconocimiento de patrones, descomposición y composición y razonamiento algorítmico), junto con las nociones clave de la cultura digital y el mundo digital, busca dar respuesta la siguiente pregunta: ¿cómo se puede incluir el pensamiento computacional en los currículos escolares integrando la educación al mundo digital más allá del simple uso de dispositivos electrónicos? Para ello, se realizó un análisis de las directrices desarrolladas por la Sociedade Brasileira de Computação y el Centro de Inovação para a Educação Brasileira dirigidas a la enseñanza del pensamiento computacional, que estructuraron y especificaron los contenidos relevantes a la informática que podrían ser incluidos en los currículos escolares de la educación brasileña, de acuerdo con la Base Común Curricular Nacional. Para ello, se realizó un análisis de las directrices desarrolladas por la Sociedade Brasileira de Computação y el Centro de Inovação para a Educação Brasileira dirigidas a la enseñanza del pensamiento computacional, que estructuraron y especificaron los contenidos relevantes a la informática que podrían ser incluidos en los currículos escolares de la educación brasileña, de acuerdo con la Base Común Curricular Nacional. Así, la inclusión de las nociones clave de habilidades descritas por el SBC está en línea con la integración del Pensamiento Computacional, favoreciendo y brindando oportunidades para el desarrollo y adquisición de nuevas habilidades y conocimientos tecnológicos por medio de la contextualización e identificación de estos aspectos en la vida cotidiana de los niños de forma significativa y crítica para que estos conocimientos sean apropiados por los alumnos de forma vinculada al currículum escolar y aportando nuevos medios para afrontar distintas situaciones problemáticas.

Palabras-clave: educación tecnológica; pensamiento computacional; cultura digital.

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Introduction

When it comes to the Cyberculture through which our modern world moves it presents a challenge for researchers all over the world, especially when we think about the education. As we look to the way our kids and teens relate to the digital world we face voracious consumers. On the other hand, our cyberculture contemporaneity has shown us the challenge to provide to this public the tools for a limitless use of these practices and knowledges. A sort of a.mythification has been built regarding technological devices and the cyberculture as a whole and it must be unbuilt so the shallow knowledge and understanding among them do not to restrain the teaching-learning process for the collective of students being able to truly appropriate the meaningful knowledge to their full development.

However, it is possible to understand and comprehend different skills on a Thinking that structures and clarify the problem solving for day-to-day issues taking into consideration the universe of the digital cultures society surrounded children, being this society one fully inserted in information and knowledge delivered by electronical devices, even though not being completely understood their operation process and merely taking advantage of their functions.

For so, the present article by the light of Computational Thinking skills, published by the professor Jeanette Wing in 2006 with other authors, such as abstraction, pattern recognitions, composition and decomposition and algorithm thinking, taking the two computational axis, being those Digital Culture and Digital World, aim to answer the following questions: How can the Computational Thinking be inserted in scholars curricula integrating education to the digital world beyond the mere use of electronical devices?

To answer this question the article proceeds with the analysis of the guidelines proposed by the "Sociedade Brasileira de Computação [SBC]" (Brazilian Computing Society) (2019) that structured and specified the relevant contents to computation that can be inserted in Brazilian education scholar curricula, as well as the "Base Nacional Comum Curricular" (National basis for the common curricula). This article, therefore, is divided in three parts: in the first part we present how the skills are composed, the abilities that involve the Computational Thinking; the second one departing from the skills introduced we bring the guidelines from the "Sociedade Brasileira de Computação" directed to the computational thinking teaching in the school context, and lastly we present our conclusions.

The Computational Thinking Skills

Technology has been approached widely in several contemporary discussions of a highly globalized and connected world in which there are more and more technology users and consumers with digital devices, mostly used to consume different media such as programs and series, instant messaging and play games either on or offline (Comitê Gestor da Internet e Centro Regional de Estudos para o Desenvolvimento da Sociedade de Informação [CGI – CETIC], 2019). However, how to develop critical thinking and to promote a reflection regarding the human interaction with such devices for the students?

In 2006, the professor and computer scientist Jeannete Wing brought to light and spread the concept of the Computational Thinking mostly through the publication of an article on this theme. She describes the computational models and method that encourage to project systems and solve problems we would not be able to face by ourselves. Thus, the Computational Thinking confronts the intelligence of a computing machine enigma. In other words, what humans do better than machines and what machines can do better than humans. Essentially saying, inquiries about what can be computable.

The author bring the concept as a fundamental skill for everyone, that can be used to read, write and calculate once refers to an analytical way of thinking that shares, in general: with mathematical thinking to its general manners of solving problems; with engineering thinking in its projection, elaboration and assessments of greatly complex systems that operate in the real world restrictions; and to the scientific thinking in how it can be related to approach the comprehension of computability, intelligence, mind and human behavior (Wing, 2008).So, it is a kind of thinking that reformulates an apparently difficult problem in other or others that we will know how to solve interpretating data as codes and codes as data, making use of variable to describe in a summarized way the behavior of a system.

It is important to point out that, according to Wing, the computer Science is not a synonym to programming because thinking as a computer scientist is beyond the capacity of programming a computer, it is necessary to think in several levels of abstraction. And thinking in several levels of abstraction is an essentially human ability once humans have imaginative capacity, creating and programming computers turning them in machines that excite, amuse and fascinate.

Once computer Science is based inherently on engineering thinking, it is said that computational thinking is a way of thinking that complements and combines mathematical and engineering thinking, for it constructs systems that interact in the real world at the same time as, by the means of thinking as a computer, it becomes possible to create a system beyond the physical world, amplifying the knowledge portfolio and making possible to project other hypothesis and scientific breakthrough engaging and defying scientifically problems to be understood and solved, being then limited only by our curiosity and creativity.

Therefore, the essence of Computational Thinking is the abstraction, once in computing the focus is on notion beyond time and space dimensions. This notion that, at times, makes we direct our attentions on only one, not disregarding at the same time the others in question. And it is even more complex than the notions used in mathematics or physics, considering that, according to Wing (2008), it is not about focus on non-concrete mathematic properties simply definable, but "[...] For example, a stack of elements is a common abstract data type used in computing. We would not think 'to add' two stacks as we would two integers" (2008, p. 3718).

For an efficient parallel processing of two merged algorithms it is used, then, the abstraction. Programming language is an abstraction of a collective of series, to each one when interpreted interacts with the others.

The abstraction[1] is the operation through which something is chosen as an attention object, that is, the filtering process, ignoring the characteristics of patterns that we do not need to focus our attention on what we need, filtering specific details and creating representations or ideas regarding something we are trying to deal with or solve. So, as we created a general idea over something we want to solve we create a concept of a model, which is likewise the basic process we create thoughts that elapse from acquisitions and lived experiences mediated by the communication.

So, we can define abstraction as a mental tool for computing, and its power is amplified by the power of the mental tools we have. And computing is the automation of the abstractions through which we operate mechanizing the abstractions, the layers of abstractions and their relations.

Thus, being the computing the automation of the abstractions, the mechanization is possible due to the precise notions that need to be anchored in models, so, the automation implies in the need of a computer to interpret the abstractions being able to process, store and communicate. Such abilities can be descendant form a device, or computing machine, or even human once we are endowed with computing capacity and the ability to interpretate data.

Even though the abstraction is a main requirement for computing, either by human or computing machine force, there are other abilities that complete in programming and data processing for, then, automate them, and a key ability is pattern recognition (Csizmadia, 2015).

Patterns are a collective of similar characteristics and are present all over nature and ever since our existence it was needed to recognize them for survivor, for instance as identifying fruits, foliage and other

[1] Definition approached by the website of the British Broadcasting Corporating [BBC], accessed by https://www.bbc.com/bitesize/guides/zttrcdm/revision/1.

edible aliments telling them apart from the poisonous, as to prevent phenomena and dominating agriculture prolonging our life span and leaving the nomad way of living behind us.

The pattern observation inspired mankind to build and enhance its deeds, as elucidated by Pierro (2018) in his research approaching the constant presence of algorithms in pattern recognition on our daily lives. Such presence is observed in a simply processing of pre-programmed data to anticipate chess moves for the machine to defeat the human. Moreover, pattern recognition can be of a singular relevance, as in cases that algorithms are being used to investigate child pornography through robots exposed to watch child pornography content apprehended in order to teach them to differ the presence of children in this kind of content, making the data analysis more efficient and automated, allowing to Federal Forces to save time to better analyze a larger amount of data.

As it occurs on developing algebraical thinking in which an individual must generalize different mathematical ideas by observing a collective of evidences (Vale, 2013), a pattern can refer to a description of situations or recurrent problems where there might be a solution that could be reused in several other situations for the same sort of problems.

For Vale (2013), according to Polya (1973) behind those patterns there is a science that studies, aiming to comprehend, describe, create, and generalize situations and problems. So, Vale (2013) elucidates by the reference of Rivera and Becker (2005), "the generalization of patterns is a vehicle with potentialities to make the transition from the numerical thinking to algebraical thinking because it allows to give meaning to generalization without having to recur to variables and formulas" (Vale, 2013, p. 69 our translation).

Activities with patterns provides an opportunity for the development of algebraical thinking, supporting children to generalize, by the meaning of abstracting different ideas by the observation and comprehension of evidence departing from argumentations and mental representations to be gradually expressed in a more formal way according to the child age in as much as generalizations involver higher order thinking such as reasoning, abstraction, holistic thinking, visualization and flexibility.

For so, Vale (2013), describes that the teacher should begin by developing in students the visual capacity, proposing pattern tasks, in order to show the properties of figures and their numerical and geometrical relations, providing at the same time the development of mathematical thinking through the exploration of pattern activities that guide the students to different paths of generalization associated to different means to recognize patterns and making them meaningful.

Pattern recognition is, after all, a human skill inherent to our survival. Beyond what was explained on the recognition of different edible aliments that fit our species, we insured our existence departing from this once we are gregary mammals to whom parenting is core for the infants health growth and make it possible to perpetuate and expand the lifespan of humans in future generations.

So, even before there was the computational thinking concept, it was already notable the importance of recognizing patterns for our species. And it must be improved and included activities that provide the opportunity of recognizing the patterns since kindergarten where children can be in touch with such skill through figurative contexts for then proceed to cognitive perceptions being able to generalize and comprehend different contents, situations, and problems and to develop the construction of their thoughts achieving high levels of abstraction.

Once one can abstract, generalize, and recognize patterns of information, it become essential to manipulate them in order to ease the problem resolution and the interaction between different data. This manipulation should occur by the composition and decomposition skills. Decomposition is a deductive process that includes dealing with complicated factors and situations by distributing it in small parts that are easier to handle. So, at the same time it is solved a small part at a time, a part of the whole is settled. Going forward, step by step, the solution of a whole is obtained (Yasar, 2018).

Decomposing brings to us the divisions, which is a preliminary idea of decomposition in which will be identified constitutive parts of situations and problems in order to understand the complexity of the task or situation. So, as pointed by Yasar (2018), obtaining the preliminary idea of a whole, it is split in minor elements in simpler parts to analyze or solve them individually grouping according to the analysis pattern and obtaining, therefore, the analysis and execution of the more complex situation as a whole.

At last, the fourth Computational Thinking sill presented is Algorithmical thinking which also follows mankind far before computing machines came up. Its name is derivative from the Arabic word خوارزمی (transliterated, Al-Khowarizmi), in tribute to the ninth century Arabian mathematician[2].An algorithm is,

[2] Source: (Nicolielo, 2010).

therefore, a finite query of steps (rules) with a processing scheme that allows the performing of a task, there is, then, a goal. So, the Algorithmical Thinking is a cognitive process for the conception of an algorithm in order to solve a problem or perform a task.

In an algorithm, each instruction is identified and the order in which they should be executed is planned and may be written in a flowchart or a pseudocode. So, even for baking a cake or going into space, we can use the Algorithmical thinking. However, it does not consist merely of following a step-by-step process, but to create them by the instructions development to be presented and described in a defined sequential order (Csizmadia, 2015).

Wing (2008) presents the easiness we have to work Computational Thinking relevant concepts through its computing abilities since children, digital natives, do not fear, au contraire, are curious and eagerly explore unknown devices to interact with them.

The computing field is composed by scientific questions, technological advances and social inquires. This triad has its relevance either separately or combined to each other, so scientific breakthrough feed technological innovation which serve to social application. On the other hand, new technologies inspire new social lifestyles which demand new scientific breakthroughs (Wing, 2008).

In this regard, the teaching of computing and the concepts of innovation and technologic for elementary education in Brazil contribute with key fundaments and structural content for the comprehension of computing processes. For sure, computing is a Science holding fundaments and principles that organizes and systematize mankind knowledge which can be considered equitably a nature science once long before computing machines were developed, we, human, computed. Computer Science explains, then, information processes. Parallelly, computing can also be considered an artificial Science once it is far used to analyze problems and build solutions beyond the real physical world, that is, an artificial world, virtual.

This set of skills and abilities herein described that compose the computational thinking constitute the essence of human thinking development and are present in different knowledge areas presented in our scholar curricula. However, within computer science they gather new shades, once they are guided by scientifical purposes that differ from other knowledge areas. How can we think these abilities inside the scholar curriculum context?

The computational thinking and the scholar curricula

In order to think how we can insert the computational thinking and its skills in the scholar curricula, it is mandatory to present how the SBC has debated this matter. The SBC and CIEB are non-profitable associations that aim to foment the information access and the innovative culture alongside with informatics, promoting the digital inclusion as well as to stimulate the research and the teaching of computing in Brazil, mainly in Brazilian public education. Yet, these associations provide support for public policies, both with means to promote quality, equity and contemporaneity education. For so, they create materials to guide the insertion of technologies in educational practices and policies, by guidelines, technical notes, and reference curricula according to the BNCC.

Before moving forward, it is crucial to understand the term to better comprehend the discussion and the contents. Technology comes from the junction of two greek words[3]: τέχνη (tekni), technic, art, craft; and λόγια (logia), study; being the study of methods and techniques to solve problems, "is the practical application of the scientific knowledge" (Sociedade Brasileira de Computação [SBC], 2019, p. 2). On its turn, "[...] digital technology codes, process and transmit information using numbers (commonly 0s and 1s, but any other countable set can be used)" (SBC, 2019, p. 2).

Therefore, digital data are stored, processed, and distributed, as information, in a digital world. As it happens in the real world, it is necessary to understand what this information is, its relevance for both worlds (physical and digital), what is involved and why to store it understanding how this happens and why to protect it, as to understand the means to transfer and distribute information considering the ethical questions as well as the social and economic impacts related to information treatment.

> The computational Thinking mastery and the comprehension of the Digital World come to strengthen information and communication dynamics, empowering with opinion, which previously were restrained to books and authors, to every single member of a digital society. Nowadays, there are constantly refined tools to process and share information, taking this process as an intrinsic part of human relationships. The mere reception does not characterize appropriation. This culture acquisition is political, social, and economical (SBC, 2019, p. 4).

[3] Recovered from http://www.dict.com

If the Computational Thinking, anchored on its skills, refers to the capacity of understand, define, model, compare, solve, automatize, and analyze problems in a systematic and methodic manner through the construction of algorithms, is with the concept of Digital World that we have the basis for the so identified process to be appropriated, according to SBC (2019) in three main pillars. Coding, that refers to the presentation of information in the Digital World; the capacity of data processing coded in processes models, that is, the algorithm written in programming language, most of all mathematics, which refers to the extreme agility to proceed with several computable processes; also, the capacity to share information on the digital world provides comprehension of the potential risks regarding ethical issues related to data treatment.

Digital World is, therefore, defined as the acquisition of knowledges related to different ways to process, share, and distribute information making use of different digital devices, including physical and virtual devices, as well as including the comprehension of the relevance in coding, storing and protecting information observing the ethical issues of the real world (Brasil, 2018).

When it comes to Digital Culture, is core to reinforce that it is the transversal axis directly present in the essence of BNCC. That is, it refers to an integrating axis suggesting that both knowledge objects and related skills are included in the different knowledge fields. Refers, then, to the comprehension of multidisciplinary relations in Computing with different fields of expertise to which the means is to foment the fluency in the use of computational knowledge to express solutions and cultural manifestations properly critically and contextualized.

So, the guidelines to Computing teaching approach in a summarized manner the specific computing competences articulated in the elementary education including: 1. Interpretation and transformation of the world aiming to the Computational knowledges are applied to comprehend and be an active agent of transformation in the digital world, which implies to understand and analyze critically the impact of information; 2. Applying of computation in different areas through the capacity of creating and using computing tools in different contexts; 3. Formulation, execution and analysis of the process and problem solving by applying the computation concepts, tools and techniques to identify and analyze daily problems being able to engage in order to model and solve them through proper language and representations to describe processes and information; 4. Development of different areas involving Computation; 5. Computing as science, comprehending the fundaments and making use of its skills to elucidate and transform the world considering daily lives and work (SBC, 2019).

To achieve the purposed goals, according to the new current demands of the contemporary society, the guidelines determine, in a structured and organized manner, skills to be developed throughout school years for the student to be able to acquire, develop and establish continuity in the learning process of Computing concepts. For so, SBC structured the “objects of knowledge” and the relevant skills, even for Computational Thinking related contents (CT) as for the Digital World (DW), to be developed year by year with students of elementary and high school. However, the present study will focus solely in the early years of elementary school as in Table 1.

Table 1. Knowledge Objects and abilities for Elementary School Year.

Grade	Knowledge Object	Abilities present in Guidelines proposed by SBC
1	Objects Organization (CT)	Organizing concrete objects in a logical manner using different set of attributes (e.g.: color, size, shape, texture, details, etc)
	Algorithm: definition (CT)	Comprehending the need of algorithms to solve problems.
		Comprehending the definition of algorithms solving problems step by step (e.g.: origami construction, space orientation, producing a recipe)
	Machine: Terminology and use of computational devices (DW)	Name computing devices (desktop, notebook, tablet, smartphone, drone, etc.) and identifying and describing the function of input and output devices (screen, keyboard, mouse, printer, microphone, etc.)
	Information (DW)	Comprehending the concept of information, the relevance of describing information (using oral, texts, images, sounds and numerical languages) and the necessity of storing and transferring information for communication.
	Codes (DW)	Representing information using selected codes and signs.
	Data Protection (DW)	Representing and comprehending the necessity of information protection. For example, using proper passwords to protect information and devices from undesirable access.
2	Behavior pattern recognition (CT)	Behavior patterns recognition (e.g., play games, daily routines, etc.).
	Algorithm: building and simulating (CT)	Defining and simulating algorithms (described in natural our pictographical languages) built as sequences and repetition of a set of basic instructions (move forward, turn right, turn left, etc).
		Create and write down stories departing from a set of scenes.

<table>
<tr><th>Grade</th><th>Knowledge Object</th><th>Abilities present in Guidelines proposed by SBC</th></tr>
<tr><td rowspan="3"></td><td>Objects Modeling (CT)</td><td>Create and compare objects models identifying essential attributes and patterns (e.g., terrain vehicles, living buildings, etc.).</td></tr>
<tr><td>Machine instructions notion (DW)</td><td>Comprehend that machines execute instructions, create different sets of instructions, and build simple programs with them.</td></tr>
<tr><td>Hardware and software (DW)</td><td>Differ hardware (physical components) and software (programs that provide instructions to the hardware).</td></tr>
<tr><td rowspan="8">3</td><td>Problem Definition (CT)</td><td>Identifying problems to which the solution is a process (algorithm), define them through the inputs (resources) and expected outputs.</td></tr>
<tr><td>Introduction to Logics (CT)</td><td>Comprehend the set of truth values and basic operations about them (logical operations)</td></tr>
<tr><td>Algorithm: selection (CT)</td><td>Define and execute algorithm that include sequences, simple repetitions (defined iteration) and selections (described in natural language and/or pictographically) to perform a task, autonomously or in collaboration.</td></tr>
<tr><td rowspan="3">Data (DW)</td><td>Relate the concept of information and data (data is the information stored in a computing device).</td></tr>
<tr><td>Recognize the data space of an individual, organization or state and that such space can be in different media.</td></tr>
<tr><td>Comprehend there are specific format to store different types of information (texts, images, sounds, number, etc.).</td></tr>
<tr><td>Interface (DW)</td><td>Comprehend that in order to communicate and performing tasks the computer uses a physical interface: the computer react to exterior stimulation sent through an input device (keyboard, mouse, microphone, sensors, etc.) and communicate the reactions through output devices (screen, speakers, etc.).</td></tr>
<tr><td rowspan="1" style="display:none"></td></tr>
<tr><td rowspan="8">4</td><td rowspan="4">Statistics on data structures: recording and vectors (CT)</td><td>Comprehend that data organization ease its manipulation (e.g., realizing that a deck is complete splitting by suits, then, put in numerical order).</td></tr>
<tr><td>Dominate the concept of static homogeneous data structures (vectors) through experimenting concrete materials (e.g., password games of unidimensional vectors, Battleship matrix).</td></tr>
<tr><td>Dominate the concept of static heterogeneous data structures (logs) through experimenting concrete materials.</td></tr>
<tr><td>Using a visual representation for static computational abstractions (logs and vectors).</td></tr>
<tr><td rowspan="2">Algorithm: repetition (CT)</td><td>Define and execute algorithms that include sequences and repetitions (defined and undefined, simple, and nested iterations) to perform a task, autonomously and in collaboration.</td></tr>
<tr><td>Simulate, analyze, and debug algorithms including sequences, selections, and repetitions, also algorithms using static data structures.</td></tr>
<tr><td rowspan="2">Coding in digital formats (DW)</td><td>Comprehending that to store, manipulate and transfer data we need to code in way that is comprehensible by the machine (digital formats).</td></tr>
<tr><td>Code different information to represent in a computer (binary, ASCII, pixel attributes like RGB, etc.). Specially in representing numbers, discuss representation in decimals, binary, etc.</td></tr>
<tr><td rowspan="8">5</td><td rowspan="4">Dynamic data structures: lists e graphos (CT)</td><td>Understand what are dynamic structures and their uses to represent information.</td></tr>
<tr><td>Acknowledge the concept of lists, being able to identify real and digital world instances that can be represented by lists (e.g., pile of mail, shopping list, students list, etc.).</td></tr>
<tr><td>Understand the concept of graph, being able to identify real and digital world instances that be represented by graphs (e.g., social networks, maps, etc.).</td></tr>
<tr><td>Using visual representation for dynamical computational abstractions (lists and graphs).</td></tr>
<tr><td rowspan="2">Algorithm on dynamic structures (CT)</td><td>Execute and analyze simple algorithm using lists/graphs, autonomously or in collaboration.</td></tr>
<tr><td>Identifying, comprehending, and comparing different methods (algorithm) of data searching in lists (sequential, binary, hashing, etc.).</td></tr>
<tr><td>Computers basic architecture (CT)</td><td>Identifying the basic components of a computer (input and output devices, processors, and storage)</td></tr>
<tr><td>Operational System (CT)</td><td>Comprehend the relation between hardware and software (layers/operational system) in an elementary level.</td></tr>
</table>

Source: Adapted by the Author from SBC (2019).

The abilities described in the table, as presented divided in two big areas (Computational Thinking and Digital World), represent different axis of computation teaching and the application of its concepts in daily life.

The green colored abilities imply the ones directly related to the Computational Thinking, in which are identified different capacities inherent to human development, but that are usually associated only to computing machines. Among these skills, abstractive and algorithmic operations can be mainly quoted, in order that the unification of the abilities green colored, along with the capacity to solve problems and analyze the results make the computational capacity of human beings a whole.

Regarding the blue colored abilities, there are the "Digital World" related, through which children would be able to list and classify digital elements to better comprehend the aspect that refers to digital technology, including its manipulation. Among the expected skills we can outline the knowledge to distinguish computing machine and its accessory devices as well to classify, filter and manipulate digital data.

Therefore, it is possible to verify the abilities descendent from BNCC described and grouped by grade in the early years of elementary school systematized and organized according to the field of expertise, aiding educators to have more clarity of relevant knowledge, simplifying then to deepen investigate the content and strategies beyond the guidelines, being this a good start to locate the knowledges and suggest related activities. Collaborating with the teaching intentionality of the teacher.

Ultimately, computational thinking can be used in all daily life situations, directly or indirectly. And its teaching and the practicing of its skills get in schools as a challenge for teachers. However, Wing (2008, p. 3720) punctuates that "In fact, if we wanted to ensure a common and solid basis of understanding and applying computational thinking for all, then this learning should best be done in the early years of childhood". A great challenge is that we want children not to just use the computing tools and devices, but to learn, most of all, the concepts and how to use the tools according to the learning order they are presented. So, computing can be interesting such as making use of the computing devices because computing is to give life, making concrete through visualization of what were mere abstractions in our minds.

Final considerations

Far beyond the manipulation of electronical devices, we have, as an educational possibility, wide curricula already structured by the competent associations to be explored. Elaborated contents specifically aiming to the teaching of computational thinking and digital world echoing in educational bases for the formation of active citizens who comprehend contemporary technological phenomena. For so, in order to comprehend what and how the digital technologic devices are scientifically composed the present study aimed to relate the abilities of the computational thinking and the digital world to a curricular proposal.

Thus, computational thinking covers several abilities that sensitizes the intentional comprehension of situations and problems, as in high level computing contexts with specific programming languages through which is possible to acquire such knowledge. For so, it is necessary to approach the relevant contents since early childhood to allow children to move forward in their computational knowledges and skills which are inherent to the very development of human thought.

In this sense, both the Brazilian Computing Society and the Innovation Center for Brazilian Education have been deliberating and advancing in political discussions in order to insert technology relevant contents in the scholar curricula. The so mentioned proposed contents relate inherent knowledge for students to learn, create model, define and recognize computational thinking abilities as well as the scientific processes of analysis and execution involved in technological devices.

That being said, there are capable teams contributing with the formulation of public policies acting with the participation of professionals formed in the field of science to elaborate official documents and offering complementary supplies. So, once the Computational Thinking is present in our daily lives providing to amplify our possibilities of learning and acquiring new abilities, we cannot let the educational system apart of those learnings, but to integrate it to the scholar contents (SBC, 2019) to promote the communication with education fomenting the criticism of content and information created in a digital culture in a post-truth context widely disseminated in a digital world through the World Wide Web.

References

Brasil. Ministério da Educação. (2018). *Base Nacional Comum Curricular*. Brasília, DF: Ministério da Educação.

Comitê Gestor da Internet e Centro Regional de Estudos para o Desenvolvimento da Sociedade de Informação [CGI – CETIC]. (2019). *Pesquisa sobre o uso da internet por crianças e adolescentes no Brasil: TIC kids online Brasil 2018*. São Paulo, SP: Núcleo de Informação e Coordenação do Ponto BR.

Csizmadia, A., Curzon, P., Dorling, M., Humphreys, S., Ng, T., Selby, C., & Woollard, J. (2015). *Computational thinking - a guide for teachers*. Swindon: UK: Computing at School.

Nicolielo, B. (2010). O que é algoritmo. Retrieved from https://novaescola.org.br/conteudo/2675/o-que-e-algoritmo

Pierro, B. (2018). *O mundo mediado por algoritmos*. *Revista Pesquisa FAPESP, 1*(266), 18-25.

Polya, G. (1973). *Como resolver problemas*. Lisboa, PT: Gradiva.

Rivera, F., & Becker, J. (2005). Figural and numerical models of generalization in Algebra. *Mathematics Teaching in the Middle School, 11*(4), 198-203.

Sociedade Brasileira de Computação [SBC]. (2019). *Diretrizes para ensino de computação na educação básica.* Porto Alegre, RS: SBC. Retrieved from https://www.sbc.org.br/documentos-da-sbc/send/203-educacao-basica/1220-bncc-em-itinerario-informativo-computacao-2

Vale, I. P. (2013). Padrões em contextos figurativos: um caminho para a generalização em matemática. *Revista Eletrônica de Educação Matemática, 8*(2), 64-81. DOI: https://doi.org/10.5007/1981-1322.2013v8n2p64

Wing, J. M. (2006). Computational thinking. *Magazine Communications of the ACM, 49*(3), 33-35. DOI: https://doi.org/10.1145/1118178.1118215

Wing. J. M. (2008). Computational thinking and thinking about computing. *Philosophical transactions of the Royal Society, 366*(1881), 3717-3725. DOI: https://doi.org/10.1098/rsta.2008.0118

Yasar O. (2018). A new perspective on computational thinking. *Magazine Communications of the ACM, 61*(7), 33-39. DOI: https://doi.org/10.1145/3214354

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