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Computational thinking in the discussions of the National Congress of Education: A systematic mapping from 2014 to 2020

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ABSTRACT
This paper aims to present an overview of works related to computational thinking in all editions of CONEDU (National Congress of Education). To this end, a systematic mapping was carried out with the annals of CONEDU and a search was performed using the terms computational thinking, robotics and programming, present in the titles of all published works. The results showed that of the 21,510 studies found, only 99 fit the selection criteria of phases 1 and 2 of our mapping. Considering only the works that mention computational thinking, we found only 13 studies. These studies were analyzed in relation to the following aspects: year of publication, theoretical references used, type of research and target audience. What is concluded is that there is a lack of research in the annals of the event that discuss computational thinking in the educational scenario.

Keywords: Computational thinking, Technologies in education, Qualitative research.

1 INTRODUCTION

The discussion on how to bring computing concepts to basic education has expanded in several countries that try to define what to teach, at what stage, how to evaluate and how to integrate computing into the school curriculum. Research such as that of Manilla et al. (2014) and Almeida and Valente (2019) show that in several countries computational thinking (CP) has been included in the curriculum of basic education since the early years. This is due to the fact that the majority of the population will need skills related to the digital world in the future. According to Valente (2016), the economic, social and cultural transformations caused by technology can already be observed from the way we interact socially, how we access information and how we proceed in commercial transactions. In this way, the way of being and being in the world has its effect on different aspects of the area of Education.

In relation to the school reality, Prenski in 2001 already defined the new generation as digital natives and we know the current students are inserted in an increasingly technological environment. Therefore, the school needs to be prepared with new proposals to work with the new areas that arise from the advances in technology.

Among the new proposals, we have the insertion of the PC in school curricula from the National Common Curricular Base (BNCC) in 2018 that included the development of this competence linked to the teaching of mathematics.

In this sense, this research proposes to analyze which discussions emerge from the works published in the annals of all editions of the National Congress of Education (CONEDU) between the years 2014 and 2020 regarding the term Computational Thinking. In this way, it is possible to trace the profile of what has already been and what is being researched on the subject, to perceive what can be deepened. Such a profile will be drawn through information about theoretical references, target audience and way in which computational thinking was explored.

Thus, in what follows, we will deal with the methodology used for this research. Next, we will make notes on the theoretical framework, moving on to the analysis of the data through tables and, finally, we will address the final considerations about this investigation.

2 METHODOLOGY

Making a mapping of a particular field of study becomes necessary to determine and understand what has already been researched on the subject, as well as to support future research. For Fiorentini et al. (2016), a mapping of the research can be understood as a

> systematic process of survey and description of information about the research produced on a specific field of study, covering a certain space (place) and time period. This information concerns the physical aspects of this production (describing where, when and how many studies were produced over the period and who were the authors and participants of this production), as well as its theoretical-methodological and thematic aspects (FIORENTI et al, 2016, p, 18).

This type of study has, in general, a focus on categorizing the research topic of interest. Motta et al. (2019), highlight that the systematic mapping of literature is more concerned with the characterization of studies than with conducting conjectures and analyses on the information investigated. For Moher and Shekelle (2015), systematic mapping of literature can be called *scoping review* and is used when it is not necessary to answer specific questions in such depth. Therefore, it is understood that this is a process done so that the researcher has a broader overview of a certain area.

Thus, this research seeks to present an overview of the discussions about CP from the works presented in all seven editions of CONEDU – National Congress of Education, which took place between 2014 and 2020 from the realization of a systematic mapping.

According to Demerval et al (2020), for the execution of a systematic mapping it is necessary to initially define a research protocol that must be clearly reported before its execution. According to the authors, we must elaborate a research question so that it is like a direction to be followed.

The research was guided by the following question: "What discussions about Computational Thinking emerge from the papers presented in all editions of the National Congress of Education-CONEDU?"

To answer this question, a search was made on the websites of each edition of the event to access the annals. It is noteworthy that this search was a facilitated process since the event maintains a standard of presentation of the annals of the works. In total, 25,510 papers present in the annals were mapped.

Considering that the central theme of this systematic mapping is the PC, we made a first search of the term "computational thinking" in the titles of works in all previous editions of CONEDU without making a distinction of thematic area. For the constitution of the corpus of this research, in addition to the selection criteria already mentioned, we will only use in this mapping the works that are available in full.

In the search to answer the main question, it was investigated how the term "computational thinking" is present in the works. It is considered that CONEDU is one of the largest events in the area of education and that the PC is already part of different national curricula from its presentation at BNCC, so it is desired to verify how the works are discussing the theme.

3 THEORETICAL FRAMEWORK

The term Computational Thinking was highlighted in 2006 by the author Wing who treated it as an approach that is based on concepts that underlie the area of Computing. Wing (2006) argued that the ways of thinking of computer scientists, as well as the problem-solving strategies of these professionals, should be applied not only to computational solutions, but also to school disciplines and people's daily lives. According to her, computational thinking is a skill that should be developed by every child, as well as reading, writing and arithmetic.

Since 2006, discussions about the CP have gained more space and prominence within the educational area. The ability to solve problems through PC can be developed from the stimulation of cognitive activities, such as arithmetic and logical operations.

In the search for a definition for the term computational thinking, Wing (2011) defined it as:

> Computational thinking are the thought processes involved in the formulation of problems and their solutions, so that they are represented in a way that can be effectively executed by an information processing agent (WING, 2011, p. X, our translation).

With the growing relevance of computing to society, computational thinking has become an important skill for a twenty-first century citizen. According to Phillips (2009) and Resnick (2012), by stimulating computational thinking in people, they get closer to understanding technological information and become creators and not only users of technology elements. In addition, it increases the ability to develop programs and develops capabilities such as: abstract thinking, algorithmic thinking, logical thinking and scalable thinking (PHILLIPS, 2009; Wing, 2006). Resnick (2012) states that computational thinking allows to increase the analytical capacity in the various areas of

knowledge. Therefore, we understand that this expansion of knowledge is not limited only to the school environment, but can help people in the most different contexts.

In the search for a definition for the PC, we can find several definitions given by different authors according to their knowledge. For Bundy (2007) and Nunes (2011), the PC deals with skills commonly used in the creation of computer programs as a methodology to solve specific problems in the most diverse areas. Another definition discussed is given by Liukas (2015), who defines the PC as an ability to think about problems so that a computer can solve them. The author points out that the PC is run by people and not by computers. PC includes logical thinking, the ability to recognize patterns, reason through algorithms, decompose and abstract a problem.

Although there is no consensus on a single definition for CP, its proponents agree that Basic Education can and should enjoy several benefits when articulated to it.

Attentive to the process of transformation that education has been going through because of ICT, educational policy makers have become concerned with emphasizing the importance of programming and concepts from Computer Science for everyone in school curricula around the world. According to Valente (2016), most of the proposals implemented or the studies carried out seek to revive programming through activities such as *coding computer science* or *computer programming*, aiming at creating conditions for the development of computational thinking.

In Brazil, within schools, although students are already familiar with the most different technological resources, few have contact with activities that develop computational thinking. According to Valente (2016), computing is still little explored in Basic Education and its fundamentals often end up being restricted only to those who opt for technical courses or graduation in the area.

In 2018 the Ministry of Education approved the BNCC, presenting the PC within the area of Mathematics. The document points out that the PC involves the capabilities to understand, analyze, define, model, solve, compare, automate problems and their solutions, in a methodical and systematic way, through the development of algorithms.

In the stage of Elementary School the PC appears in the area of Mathematics, being cited 4 times in Elementary School and ratified in the progression of essential learning from Elementary School to High School. What draws our attention is the fact that the BNCC does not present a definition for the PC. Regarding the BNCC and the PC, Barbosa and Maltempi (2020) point out that:

> The context in which this term is inserted in Elementary School suggests that the PC consists of a competence and/or ability to be developed during processes of teaching mathematics contents. Related to these contents, the text states that by working on certain mathematical learning strategies such as problem solving, investigation and mathematical modeling, a rich environment is created to develop skills related to mathematical literacy and also to computational thinking. Similarly, another excerpt states that learning Algebra contributes to the development of PC in students. In High School, the PC is resumed as one of the elements whose learning should be initiated at the previous level, but expanded and consolidated at this level, seeking to expand "the range of resources to solve more complex problems, which require greater reflection and abstraction" (BRASIL, 2018). Its importance is further

> reinforced by being included as one of the educational dimensions that contemplate knowledge, attitudes and values to be developed during the three years of this cycle (BARBOSA & MALTEMPI, 2020, p. 749).

4 RESULTS AND DISCUSSION

To answer the guiding question of this systematic mapping, 21,510 works available in the annals of all editions of CONEDU between the years 2014 and 2019 were mapped. Following the process of inclusion of papers for our research corpus, 8 studies were found that met the criteria defined in the methodology section Table 1 presents the distribution of studies according to the year and number of studies selected from our mapping.

Table 1: Works mapped in the first phase in the editions of CONEDU

Year	Edition	Total jobs mapped	Total works selected
2014	I CONEDU	1419	0
2015	II CONEDU	2019	0
2016	III CONEDU	2893	1
2017	IV CONEDU	3991	0
2018	IN CONEDO	3887	2
2019	VI CONEDU	5068	3
2020	VII CONEDU	2233	2

Source: Own authorship (2022)

From the search for works that contain the term "computational thinking" in their titles, we consider that the result of the amount of works is still small. Only 8 papers were found throughout the seven editions of the event. This first fact points to a rather timid discussion on the subject.

Because we consider that this systematic mapping seeks to present which discussions about CP emerge from the works presented in the editions of CONEDU, we conducted a second search for works that could contribute to this process. Taking into account that the PC can be developed from programming and robotics activities and that works with these themes can also discuss the PC, we searched for titles of works with the terms "programming" and/or "robotics". Table 2 presents the results of this second search phase:

Table 2: Works mapped in the second phase in the editions of CONEDU

Year	Edition	Total jobs mapped	Total works selected
2014	I CONEDU	1419	9
2015	II CONEDU	2019	5
2016	III CONEDU	2893	14
2017	IV CONEDU	3991	17
2018	IN CONEDO	3887	14
2019	VI CONEDU	5068	33
2020	VII CONEDU	2233	7

Source: Own authorship (2022)

With the research corpus defined and considering our main question which is "What discussions about Computational Thinking emerge from the papers presented in all editions of the

National Congress of Education-CONEDU?", we begin the process of analysis of the 99 selected works. Even with the addition of papers in our research corpus, the selected works represent approximately only 0.46% of the 21,510 mapped works. If we consider the initial results of phase 1, this number is even lower. The works that contain in their title the term PC represent approximately 0.04% of the total works of all editions of the event. These data show us a huge lack of research on CP in the area of education.

In the search to answer the main question, it was investigated whether the term "computational thinking" was present in the studies. The objective of this search is to verify how the works are discussing the theme. From this investigation, it was found that although the 91 works added in the second phase of the mapping discussed aspects related to CP, such as robotics and programming, only 5 of them mention CP. In addition to these 5 studies, the 8 papers selected in phase 1 present discussions about CP. Therefore, of the 99 studies mapped from the inclusion criteria for this mapping, only 13 of them present contributions to the answer to our guiding question.

Regarding the analysis of the theoretical framework used in the discussions of the works that refer on CP, the two authors who most appeared in works were Wing (2006) and Valente (2016). The authors who appeared in at least two papers were: Barcelos and Silveira (2012), Barr and Stephenson (2011), Papert (1994) and Resnick (2012). Such works present the definition of Computational Thinking, its skills and competencies and defend its relationship with Basic Education.

Regarding the proposal of each of the 13 studies, 8 of them deal with reports of experiences with activities that develop the CP. Among these 8 works, 4 were developed in high school classes, 3 in high school classes and one in a technical course. In addition, 2 works present proposals for course/activity, where one of them is for the teaching of programming in elementary school class and another deals with unplugged activities in quilombola community. Finally, 3 papers present theoretical discussions about CP (systematic review, reflective analysis, and literature review).

5 FINAL CONSIDERATIONS

The systematic mapping was made from the annals of all editions of CONEDU in view of the importance of the event for the area of education. The event is one of the largest in the educational scenario and every edition presents important discussions in different thematic areas. Our main goal was to present an overview of research that deals with the CP. To this end, a systematic mapping and it is possible to conclude that the interest in presenting discussions about CP is still quite timid in this event. However, it is noted that interest in this area is increasing over time. This fact can be noted by observing that from the V CONEDU (2018), there was the presence of works that deal specifically with the CP in all subsequent editions. From this mapping, it was noticed that the literature used for

clarification about CP is still based, in most cases, on international works and authors. In the national scenario, there are few options for recognized authors in this area.

It is believed that with the change of school curricula from the BNCC, the PC becomes more present in the classroom and as a consequence, research in this area gains more prominence.

To answer the question of our mapping, we chose to add the search for the terms robotics and programming so that we could have a greater amount of work to analyze. This choice was also made to verify if these subjects are being presented with a connection to computational thinking. It is concluded that among the 91 studies added in phase 2 of the mapping, only 8 of those that dealt specifically with robotics and/or programming made notes about the CP. This fact draws attention, because it is known that when robotics and/or programming activities are developed, those involved are about to develop computational thinking skills.

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