



The Perspective of Azorean Early Childhood and Elementary School Teachers on Computational Thinking

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Abstract

Computational Thinking is now an innovative and effective pedagogical approach for promoting meaningful learning in preschool and elementary education, preparing children for the challenges and opportunities of the 21st century. In Portugal, CT has been part of the mathematics curriculum in the primary education since 2021. In 2022, a CT project began to be implemented in schools in the Autonomous Region of the Azores (ARA). To date, no studies have revealed how teachers are working in this area. This study seeks to understand how early childhood and primary school teachers work in public schools in the ARA view CT, considering the work that teachers report doing in various curricular areas to promote CT skills in children, in particular factors such as the necessary resources, skills to be promoted and activities implemented. This exploratory study used a questionnaire with open and closed questions, distributed by e-mail and answered by 81 teachers, and the data obtained was analyzed quantitatively and qualitatively. The results show that CT is a concept that is well known to teachers, that the skills involved are promoted in many schools in the Region, and that the activities carried out are varied. However, the study also indicates challenges in CT implementation, including the lack of teacher training and resources. Although it is a developing area, CT still needs to be explored further to enrich teachers' practices and maximize the knowledge and potential that can be gained from integrating CT-related activities into the curriculum.

Keywords: Computational Thinking; Early Childhood Teachers; Elementary School Teachers; Conceptions.



1. Introduction

The importance of Computational Thinking (CT) in today's educational context is related to the need to prepare students for the challenges of the 21st century, which require increasingly complex cognitive skills. In this sense, introducing Computational Thinking into school curriculum activities from an early age can contribute to the development of skills such as logical reasoning, problem-solving, creativity and collaboration, among others (Falloon, 2024; Kong et al., 2020).

In turn, the challenges facing educators and/or teachers, in a society where technological resources are gaining prominence at a high speed, are becoming ever greater and more complex. Nowadays, in addition to thinking about how to engage students in acquiring the knowledge that the school proposes to teach and the skills that students should develop, a teacher needs to update and include the use of technologies in their educational practices, considering the contributions that these technological resources can make to students' education.

In Portugal, Computational Thinking appears in the educational context for the first time with the reformulation of the Essential Learning of Mathematics in 2021 (Ministry of Education and Science, 2021), understanding it as "...a curricular novelty to be developed in an integrated way from the 1st cycle". Since 2022, the CT has been implemented in schools in the Autonomous Region of the Azores (ARA) as a cross-curricular project. Through research, it is also being implemented through projects such as PeCOT - Computational Thinking with Tangible Objects (Funk et al., 2022), which aimed to introduce educational robotics in the first years of school and analyze its impact on students' CT development, or studies that are being developed in initial teacher training in the ARA, as is the case with this work.

While previous research has investigated the definition and implementation of CT in a variety of educational situations, little is known about how early childhood and primary school teachers in ARA perceive and use CT in their pedagogical practices. In this sense, our aim was to understand how early childhood and primary school teachers, working in public schools in the ARA, view CT. When examining CT's potential, this study seeks to understand the work that teachers report developing in various curricular areas to foster computational thinking competencies in children, considering factors such as the resources needed, the competencies to be promoted, and the activities implemented.

2. Computational Thinking in Educational Context

Computational Thinking (CT) began to gain prominence in scientific and educational fields when Wing (2006) advocated its use and adoption by the entire community, including young people. As a promoter of computational thinking as a transversal skill that goes beyond the boundaries of computing, Wing (2006) states that "To reading, writing, and arithmetic, we should add computational thinking to every child's analytical ability" (p. 33), linking CT to the development of a set of skills that aid reasoning, the way we learn and the knowledge we have about the world. These skills work on logic, representation, and sequential thinking, as well as the ability to think more broadly, to persist in solving problems and to develop abstraction skills. In addition, CT is seen as something that relates to creativity, innovation and the integration of various areas. As a concept under (re)construction, Shute et al. (2017), in a systematic review of studies mobilizing it, conclude that CT integrates a total of six foundational competencies: problem decomposition,



abstraction, algorithmic thinking, debugging, iteration and generalization. More recently, Asbell-Clarke et al. (2021) define CT as a set of practices involving problem decomposition, pattern recognition, algorithmic thinking (which includes sequencing), and abstraction.

To make this concept more concrete and better understood for its development and assessment, some works have highlighted key skills that should be considered, (Beecher, 2017; Çoban & Korkmaz, 2021; Csizmadia et al., 2015; Selby & Woollard, 2014), which we will explain below:

- Problem decomposition: involves the ability to break down a complex problem into smaller, more manageable parts.
- Pattern recognition: refers to the ability to identify similarities, regularities or recurring characteristics in a set of data or a specific problem.
- Abstraction: involves the ability to isolate the relevant aspects of a problem or situation, ignore unnecessary details, allow individuals to focus on the core of the problem, simplify it, and make it easier to solve.
- Algorithmic thinking: consists of the ability to develop and follow a logical sequence of steps to solve a problem; these skills involve understanding how algorithms work and the ability to create, implement and debug algorithms to solve complex problems.
- Debugging: involves the ability to analyze a possible solution, identifying and correcting errors to make it more functional and effective.

All these skills are aimed at working on and perfecting a set of competencies that, in the long term, will make a difference when it comes to making decisions relating to society and everyone's personal and professional life. The objective is to cultivate greater autonomy, foster logical thinking, enhance digital literacy, and establish a robust foundation for future challenges.

In Portugal, in curricular terms, CT has been included in Mathematics, as it is considered essential in mathematical activity and because it provides “students with tools that allow them to solve problems, especially those related to programming” (ME/DGIDC, 2018, p. 3). According to the Essential Learning in Mathematics (ME/DGIDC, 2018) for the 1st Cycle of Basic Education, CT “presupposes the integrated development of practices such as abstraction, decomposition, pattern recognition, analysis and definition of algorithms, and the development of debugging and process optimization habits” (p. 3).

In Early Childhood Education, although it is not explicitly included in the Curriculum Guidelines (Lopes da Silva et al., 2016) in force, CT is promoted in various ways: in the “awareness of self as a learner” component, by demonstrating that they are capable of finding different strategies to solve the difficulties and problems they are faced with, children work on decomposing a problem; when they use simple graphs and tables to organize information or when they identify patterns or symmetries in geometric figures, they are working on pattern recognition; when, in physical education, they cooperate in game situations or when in mathematics they solve “everyday problems, [...], using addition and subtraction” (Lopes da Silva et al., 2016, p. 84), children also approach algorithmic thinking.

As this is an area that has only recently been included in the curriculum, there are not many studies that reflect the way in which CT is implemented in Portuguese schools, especially in the early years. While studies such as Graça and Colaço (2024) highlight the challenges faced by primary school teachers when working with CT in the classroom and point to the need for comprehensive training to enable them to deal with the best practices associated with CT, studies such as Rodrigues et al. (2025), Azevedo Gomes et al. (2022) or Mestre et al. (2023) point to the importance of this training taking place during the initial training of teachers, especially in the field of mathematics, in order to better adapt teaching practices to the needs of students and the existing curriculum.



At an international level, studies such as those by Kim et al. (2024), Li (2021) or Leung et al. (2024) support these ideas and emphasize the importance of the teacher's role and knowledge in designing a curriculum that is appropriate to children's characteristics and development.

In searching for studies on the implementation of CT in the ARA, no studies developed in an educational context were found to report on the impact of the regional government's project on students. However, Santos et al. (2023), in a study carried out as part of a robotics festival held in the region, conclude that a high percentage of teachers find it difficult to use robotics to promote CT in the classroom due to a lack of knowledge or resources.

For these skills to be developed by children, the pedagogical intent of teachers when planning and implementing their work is fundamental, so understanding the perspective of teachers in relation to the development of CT in Education becomes evident, as a way of highlighting potential and listing practices for improvement.

In general, recent studies report that teachers already have some knowledge about CT, consider it important for children's development, with positive results on a cognitive and socio-emotional level, in problem-solving and communication (Pollarolo et al., 2024), and recognize its interdisciplinary nature (Fessakis & Prantsoudi, 2019).

However, many studies reveal difficulties in implementing it in teaching practice. Aspects such as lack of confidence in one's own ability to teach or assess CT (Yadav et al., 2017), difficulty in understanding how to integrate it into the curriculum and lack of specific training (Feng & Yang, 2021; Love et al., 2022; Lye & Koh, 2014; Maguth et al., 2018), lack of adequate educational resources (Lye & Koh, 2014; Maguth et al., 2018) or lack of time (Feng & Yang, 2021; Love et al., 2022), are pointed out as obstacles to carrying out systematic and intentional work in an educational context, all of which were also identified in the work by Dagienė et al. (2022).

These difficulties also lead early childhood and elementary teachers to think of the development of CT skills as difficult to achieve because of the direct and necessary link they establish with the use of technology (Avcı & Deniz, 2022), unaware of or not recognizing the possibilities that activities do not require the use of tablets, computers or robots offer. Known as unplugged activities, their effectiveness in the development of CT is not only demonstrated (Brackmann et al. 2017) but also seems to be more appropriate for the early years of school, as their hands-on and play-based logic is more in line with children's development (Lavigne et al., 2020; Lee et al., 2023).

Since it is true that teachers who have greater knowledge about CT and more experience in incorporating these skills into their teaching practice have more positive attitudes toward the subject (Yadav et al., 2017), it is essential to invest in teacher training as an element that allows them to leverage the quality of their practices. As Fessakis and Prantsoudi (2019) state, to successfully integrate CT into the curriculum, teachers need to clarify what this concept means, how it can be integrated into their practices, in what they call the didactics of its content, which can only be achieved through initial and ongoing training. It is therefore a matter of improving what Koehler and Mishra (2009) defined as TPACK – technological, pedagogical and content knowledge necessary for teaching CT.

Given that, as Falloon (2024) points out, the teacher plays a crucial role in the development of students' competencies, and that we know little about the way teachers in ARA think and act, it became relevant to understand how early childhood and elementary teachers look at computational thinking and how they envision it in their pedagogical practice.



3. Materials and Methods

The questionnaire survey was used as a data collection instrument, providing the broadest possible perspective on early childhood and primary education in the ARA. As Ferreira de Almeida et al. (1995) point out, questionnaire surveys typically enable researchers to collect data from a large number of individuals, compare responses precisely, and, in some cases, generalize findings to a broader population.

The questionnaire, made up of open and closed questions, with a total of 10 questions, is organized into two sections: a first one aimed at characterizing the respondents, which includes information such as gender, age, years of teaching service, initial training and continuous training in the area of CT; and a second part that seeks to deepen the way teachers think about CT and its implementation in the educational context, focusing on aspects such as the definition of CT, the resources and strategies for working on CT skills, the skills that are promoted and the work that teachers actually say they implement in this context. This questionnaire was validated by two academic experts and given to two early childhood teachers and two primary school teachers who did not participate in the study as respondents. This validation made it possible to check the relevance and comprehensiveness of the questions asked and to clarify some issues regarding the wording.

A link to the questionnaire was sent by e-mail, via the Regional Secretariat for Education and Culture, to the 18 Integrated Basic Schools in the ARA, and 81 responses were received. The sample was not representative of all early childhood and elementary school teachers in ARA, limiting the generalizability of the findings. Considering this fact, as well as the need to find out more about teachers' thinking in the absence of known studies, this exploratory study will present the results using mainly descriptive statistics.

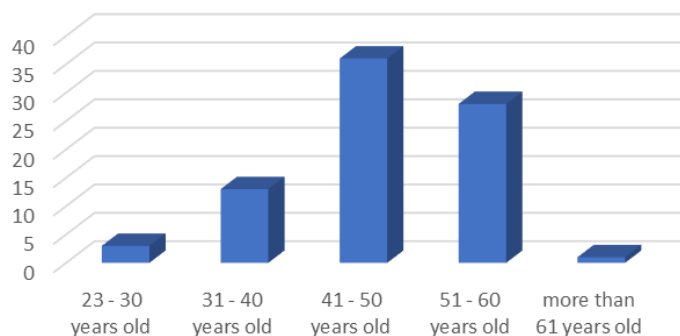
After the entire data collection process, the data was subjected to an interpretative analysis to respond to the objectives set at the beginning of the research. For the analysis of closed-ended responses, we applied a quantitative frequency analysis. For open-ended responses, we used content analysis, which allowed us to systematically examine and interpret the data. This method involved categorizing responses to reduce the large volume of text into more precise and summarized information, following an inductive logic (Gómez et al., 1999).

Finally, it should be noted that, throughout the data collection process, all the ethical and deontological issues inherent in any research process were considered, particularly with regard to the anonymity of the participants and obtaining their informed consent, in accordance with Recommendation No. 1/2018 of the Ethics Committee of the University of the Azores.

Characterization of the Participants

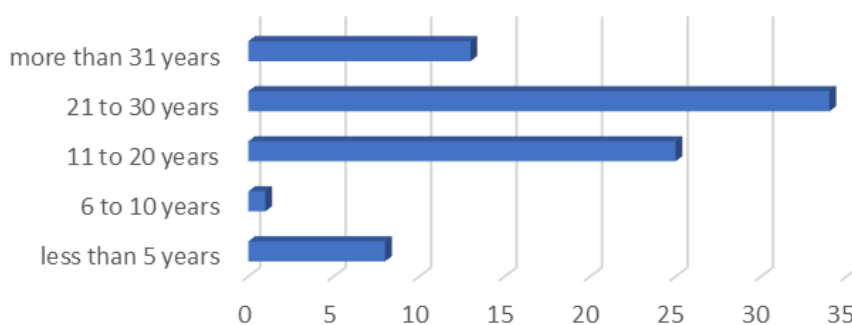
The questionnaire was responded to by 81 teachers, 74 of whom were female and 7 male. Of the 81 respondents, 22 were early childhood teachers (27.16%) and 59 were elementary school teachers (72.84%); in terms of age, 36 were aged between 41 and 50, 28 between 51 and 60, 13 between 31 and 40, 3 between 23 and 30 and 1 was over 61 (Figure 1).

Figure 1
Age of the Respondents



Regarding years of teaching service (Figure 2), 8 respondents said they had less than 5 years; 1 said they had between 6 and 10 years of service; 25 between 11 and 20 years of service; 34 between 21 and 30 years and, finally, 13 said they had more than 31 years of service.

Figure 2
Years of teaching experience



Regarding academic training, 50 of the respondents have a graduation's degree, 14 have a master's degree, 10 have a postgraduate degree, 2 have complementary scientific and pedagogical training, 2 have a bachelor's degree, 2 have a former teaching degree and only 1 have a PhD. According to the data collected, most respondents (81.5%) have not taken part in any training or course related to Computational Thinking in the last two years.

4. Results

The CT and its use in educational contexts

In the second section, the questionnaire sought to find out how teachers think about CT and its use in an educational context.

Asked if they had ever heard of CT, most teachers answered in the affirmative (97.5%). This knowledge comes from:

- a. Outside the school context, at home (1 answer), through friends (1 answer), or in research contexts (4 answers).



- b. Within school, through posters (1 answer), in the role of trainer (1 answer), through the curricular regulations in force (3 answers), through colleagues (6 answers), in training (11 answers), in the context of classroom activities, generally associated with the implementation of the CT project in their classroom (15 answers) and at school in various situations (41 answers).

To determine the respondents' understanding of the definition of computational thinking, they were presented with four answer options, only one of which reflected a complete definition that is widely accepted by the scientific community as the most correct.

Most respondents (90.1%) selected the option considered correct - "Computational Thinking is related to the development of a set of skills (logic, sequential thinking, problem-solving, abstraction) that help to reason, the way we learn and the knowledge we have about the world", as shown in Table 1.

Table 1
Understanding of CT Definition

Definition of CT	%
Computational Thinking is related to the development of a set of skills (logic, sequential thinking, problem-solving, abstraction) that help us reason, learn, and understand the world.	90.10
Computational Thinking refers to the use of the computer and its potential as a resource that motivates children and consequently facilitates learning.	8.60
Computational Thinking is only related to technology, programming, and the use of computers, seeking to get individuals to formulate problems, express solutions, and carry out the solution and evaluation.	1.30
Computational Thinking refers to a set of mechanisms followed by a computer, transforming it into a machine capable of interacting with the environment and executing actions defined by a program created by the programmer.	0

The remaining 8.6% considered that "Computational Thinking refers to the use of the computer and its potential as a resource that motivates children and consequently facilitates learning".

We then tried to find out whether CT should be part of children's learning from preschool onwards. 76 answers were positive (93.8%) and 5 negative (6.2%).

Those who answered in the affirmative justified their response by basically considering that working with CT enhances the development of skills and knowledge, in particular:

- Logical thinking (33 answers) - "So that they start developing skills associated with logical reasoning from an early age".
- Global skills (16 responses) - "because it promotes creative problem-solving".
- Skills for acting in today's society (13 answers) - "Given the reality that surrounds us, it's important".
- CT skills, such as abstraction, patterns, and problem-solving (11 answers) - "...the child's ability to abstract".
- Skills that contribute to future professional performance (5 answers) - "... for a good professional future".

- f. Skills from an early age and without the use of technology (1 answer) - “Because the activities are suitable for the younger age groups, they're not just about using technology”.
- g. Interdisciplinary skills (1 answer) - “develop transdisciplinary skills...”.

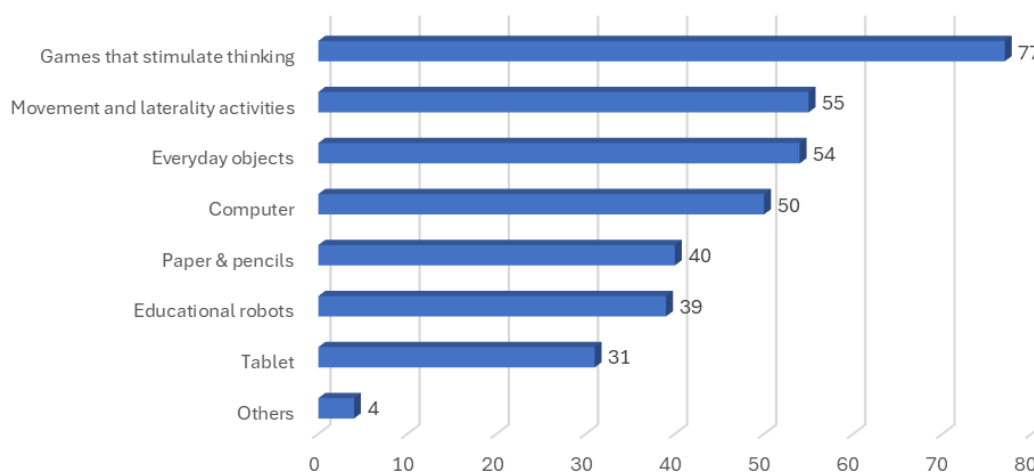
Those who answered negatively basically justified their response by considering the negative factors it can have for children, namely:

- a. The fact that it can be addictive (2 answers) - “they shouldn't be allowed access to technology from an early age, because it's addictive...”.
- b. The age factor (2 answers) - “they are still very immature”.
- c. And the fact that it's irrelevant (1 answer) - “It's irrelevant”.

Considering the previous question, we then tried to understand which resources teachers considered to be useful for working with CT, asking them to select, from a set of options, the ones that made the most sense. The answers, shown in Figure 3, revealed that although most of the respondents had selected resources without the use of technology, technological resources obtained a very high percentage, and in the “other” option there were still those who added the cell phone as a resource for developing CT.

Figure 3

Resources needed to work on Computational Thinking



The answer “games that stimulate thinking” was the one that got the most responses (77 answers), followed by “movement and laterality activities” (55 answers), “everyday objects” (54 answers), “computer” (50 answers), “paper and pencil” (40 answers), “educational robots” (39 answers), and finally “tablets” (31 answers). In the “other” answer, there were four responses indicating cell phones (2 responses), recyclable materials and physical education materials (1 response each) as resources.

Following this, respondents were asked if technological equipment was needed to work on Computational Thinking. Most respondents (69.1%) answered no, which is consistent with the answer to the previous question, where the most frequently mentioned resources were precisely those where technology is not needed, such as games and everyday objects. However, almost a third of respondents said yes (30.9%).

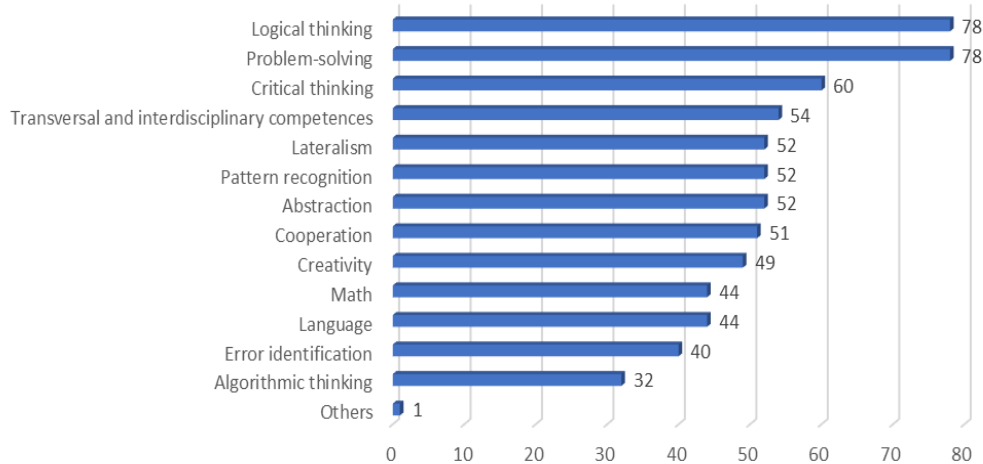
Next, we tried to find out what the respondents thought about the skills that CT can promote in children (Figure 4).

The most frequently mentioned skills, with 78 answers each, are logical reasoning and problem-solving, followed by critical thinking skills (60 answers), interdisciplinary and transversal skills

(54 answers), laterality, pattern recognition and abstraction, with 52 answers each, cooperation (51 answers), creativity (49 answers), mathematics and language (44 answers each), error identification (40 answers) and algorithmic thinking (32 answers). In another response, one teacher identified resilience as a skill that is promoted when working on CT.

Figure 4

CT skills that are promoted in children



Alongside this question, we tried to find out what the respondents thought about the curricular/disciplinary areas that could be affected by working with Computational Thinking (Table 2). The majority (58 respondents) replied that CT allows all curricular and disciplinary areas to be enhanced, and a small number of the sample (3 respondents) replied that the development of Computational Thinking did not promote any curricular/disciplinary area.

Table 2

Curricular/disciplinary areas enhanced by CT

Curricular/disciplinary areas	Yes	No	Maybe	I don't know
Oral Language and Approach to Writing/Portuguese	3	-	3	1
Mathematics	10	1	-	-
Digital technologies	4	1	3	1
Science/World Knowledge/Environmental Studies	-	-	3	-
Personal and Social Education/Civic Education	-	-	1	2
Physical Education	2	1	1	-
All the above	58	2	2	-
None of them	3	2	-	-
Other: (specify)	-	-	-	2

The CT in the pedagogical practice of early childhood and elementary teachers



The third and final part of the questionnaire was focused on how educators and teachers view their teaching practice and whether they integrate any work that seeks to promote CT.

When asked if they used technological resources in their teaching practice, the answers were mostly positive (93.8%), stating:

- a. Technological resources, such as computers (62 responses), projectors (13 responses), tablets (12 responses), cell phones (8 responses), interactive whiteboards (7 responses) and educational robots (4 responses).
- b. Online resources, such as interactive games (8 answers), the internet (3 answers) and educational apps such as UBBU or Kahoot (2 answers).

We also wanted to know if children were allowed to use technology in the classroom.

From the answers, we can see that most respondents allow children to use equipment inside the classroom (86.4%), compared to 13.6% who do not.

Teachers who answered yes to the previous question were asked to indicate in which context students used these resources. The answers were grouped into two main subcategories:

- a. In didactic activities (52 responses), including in formative and diagnostic assessment (1 response), as can be seen in the examples:
 - i. Researching topics and information for assignments and other knowledge”.
 - ii. “Interactive manuals”.
 - iii. “Formative, diagnostic assessment using applications such as Kahoot, Plickers, Socrative, google search, Youtube on subjects covered in class.”.
- b. In free activities (35 answers), such as: “Playing games”; “In free activities...”.

Those who answered in the negative were asked to justify their answer. Two types of answers emerged from this justification:

- a. Related to existing conditions, such as:
 - i. Lack of resources (8 answers).
 - ii. The lack of conditions (1 answer).
 - iii. A ban on the use of technology (1 answer).
- b. Related to the age of the children (1 answer) - “I’m not an advocate of children using cell phones before the age of 10, they only use the school’s laptop, under my supervision, to do the exercises in the Atelier Code and to do research and/or work, that’s all”.

Finally, we wanted to know whether educators and teachers reported implementing activities related to CT in their teaching practice. The responses, which were mostly positive (63%), allow us to state that more than a third (37%) do not carry out any work with this objective.

Those who said they had implemented activities of this kind indicated a range of activities without the use of technology (unplugged), activities with the use of technology and other activities.

In activities without the use of technology (unplugged), we identified a variety of activities in different curricular/disciplinary areas (Table 3). Most of these activities are related to math and reasoning, but there are also many that seek to promote children’s laterality.

Table 3

Activities without the use of technology or unplugged

Activities	Number of answers	Examples
Problem-solving	10	“group problem-solving activities”;



Mathematical and thinking games	Logical thinking and reasoning	9	“Logical-mathematical thinking games”, “games that develop reasoning”
	Sequences	2	“Temporal/sequential ordering of images in a story”
	Other math games or activities	5	“... double-entry boards from the room's routine register”; “math-related activities”
Spatial and laterality games	Laterality	12	“Activities to develop laterality”; “exploration of laterality...”
	Spatial orientation and routes	6	“...spatial orientation.”; “...directions/routes...”
	Other motor games	1	“With motor expression games... with other games (whether they're slot games, construction games or puzzles)”
Critical thinking activities	Questioning and reflection	2	“Questioning strategies,”; “Reflecting on whether the work you've done is in line with what was requested, why you chose what you did at a particular moment...”
	General	3	“Critical thinking”
Cooperative activities	Group work	4	“Activities that develop teamwork”, “group work”
	General activities	1	“Cooperation”
Language activities	Oral	2	“Oral expression”
	Reading and Writing	2	“Pictograms”, “language, writing”
Research activities		1	“looking for information outside the textbooks”
Textbook activities		2	“The 3 rd -grade textbooks themselves have content directed at Computational Thinking”
Activities within the scope of the CT project		2	“My class benefits from the project”, “In addition to those being implemented by the PCOM program...”
Other activities using various materials		2	“worksheets or games”
Activities that globally explore various skills		6	“Carrying out weekly experiments...”, “coloring following code”

In activities using technology, teachers indicated the use of:

- a. Platforms that allow you to work with code, particularly UBBU (5 responses).
- b. Digital resources (2 responses), essentially educational and interactive games.
- c. Educational robots (3 responses).
- d. Other resources, such as computers (1 answer) or QR codes (1 answer).

Regarding other activities, classes were mentioned (1 answer), as well as activities that seek to develop transversal skills (1 answer).

The respondents who said they didn't implement this type of activity gave the following reasons:

- a. Not having enough knowledge about the subject (76.7% - 23 responses).



- b. It is not a content of the Curricular and Programmatic Guidelines for the level and year in which they teach (33.3% - 10 responses).
- c. Not having access to resources that allow consistent work in the area (20% - 6 answers).
- d. Other answers such as “not being the head of the class” (3.3% - 1 answer), “there is a teacher in the school who tutors this project” (3.3% - 1 answer), “giving educational support” (3.3% - 1 answer) or the fact that the “programs are very extensive” (3.3% - 1 answer).

The options “It's not important for my students” and “I don't think it's useful in pedagogical terms” were left unanswered.

Discussion

Reading the results, the first thing that stands out is the fact that most teachers surveyed have some knowledge of CT or have heard of the subject, particularly in an educational context, closely linked to colleagues who are involved in implementing the project in schools and to some training. Their understanding of CT as related to a set of skills that cut across different areas of knowledge is quite broad and accurate, which shows that they do have some idea of what it is, a position that is in line with the results presented by Rehmat et al. (2022). However, at least in terms of its conceptualization, there seems to be a better understanding on the part of teachers, contrary to what is expressed by Fessakis and Prantsoudi (2019).

It is also positive that they believe that CT should be part of everyday life in preschool and elementary school educational contexts, due to the diversity of skills and knowledge it helps to enhance, particularly those related to the ability to think, reason and solve problems, which are very present in the way of thinking of teachers who have participated in research of a similar nature (Rehmat et al., 2022). These skills are clearly privileged in addition to other skills directly linked to CT and specific content/disciplinary areas and are present in the resources that are listed by teachers as those that best enhance work in the context of CT, with games that stimulate thinking, laterality games, or everyday objects standing out.

Regarding resources, while the ones that stand out the most are those that don't use technology, i.e. are part of “unplugged” activities, we also found references to technological resources that are increasingly gaining ground in our schools' classrooms, such as computers, tablets and educational robots. In fact, most teachers say they use technological resources and allow children to use them, mainly for educational purposes, although many teachers allow them to be used for free activities. The specific reference to unplugged activities is noteworthy as it is regarded as an appropriate intervention strategy within these educational contexts, aligning with the developmental characteristics of younger children (Lavigne et al., 2020; Lee et al., 2023).

Despite this very positive outlook that teachers have towards CT, the reality shows us that more than a third of respondents say they don't carry out any activities related to the development of CT in an intentional way, justifying the situation with a lack of knowledge, resources and the fact that CT is not present in the current program guidelines, which is only true in the case of early childhood education, or that these are too extensive and don't allow for other types of approaches. Not disregarding the analysis of the data collected, it is important not to forget that since 2022 the Computational Thinking Project has been implemented in schools in the ARA in the 1st cycle of basic education, a project through which schools have been provided with resources to carry out CT activities without the use of technology or “unplugged” and educational robots.

While we believe that in some schools these resources may not have arrived yet, what we can deduce from the results of this work is that, although teachers are open to implementing it, due to



a lack of training and/or knowledge, they don't do so. We know that a simple activity related to color sequences or the solution of challenges that, through a certain number of steps, allow students to achieve a goal, can be pedagogically designed moments to develop, work on, and deepen CT skills, without the use of many resources or resources specifically designed for this purpose. In this sense, it is necessary to focus on the empowerment of technological, pedagogical and content knowledge mentioned by Koehler and Mishra (2009), as the lack of training does indeed seem to be an obstacle to the further development of computational thinking in schools. These results corroborate the findings of studies such as those by Lye and Koh (2014), Yadav et al. (2017) or Maguth et al. (2018), are agreed on the importance that teachers attach to CT, but who find it difficult to implement, due to the lack of specific training to help them transpose the skills inherent to it into practice, identifying and designing the best pedagogical strategies to do so and planning appropriate ways to evaluate it, highlighting the need to invest in training as a lever for building better practices in this field (Çimşir et al., 2023).

This reality reveals the need to continue thinking about better ways of integrating CT into the work that teachers do, in the quest to promote skills in students that can be truly meaningful and enhance the skills necessary for their future personal, school, academic, and professional training in an increasingly digitalized and demanding society.

5. Conclusion

Whilst it is not possible to generalize based on the available data, which does not appear to be representative of the population of preschool and primary school teachers in the Azores, it can be concluded that while the concept is known to some degree to a number of the teachers and is included in their practices, there still appears to be a significant number of teachers who express a certain lack of knowledge about implementing this concept in the classroom. However, many teachers list a variety of activities, both with and without the use of technology, to boost their students' CT skills, which is very positive and in line with what is currently expected of elementary school teachers in particular.

Therefore, the proposals for future work based on this study are to extend the sample to a more representative number of elementary school teachers and educators, so that we can get as accurate a picture as possible of the reality, to understand how the CT project may be changing ways of thinking and acting in the teachers who are directly benefiting from its implementation, or to understand what teachers at other educational levels know and how they think, and to invest in training.

Because CT still needs to become established as a set of important skills that should be part of everyday teaching in the classrooms of schools in the Autonomous Region of Azores, it is important to continue to invest in its research to gain a better understanding of the reality and seek answers that will contribute positively to this happening.

Finally, further research in this area will make it possible, in the future, to design government training policies adapted to the needs of teachers, aimed mainly at integrating CT into the curriculum and making more effective use of the resources already present in schools. This training could include, as proposed by Rich et al. [39], continuous and systematic moments that combine the exploration of content with practical activities in a professional context.



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