Heritage and Computational Thinking: Intersections for Meaningful Learning in Primary School

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Abstract

As the school is a place of culture, oral and material heritage can play an important role in a close connection with the historical past and linguistic development. Integrating this work into a disciplinary articulation with computational thinking can be an initiative that promotes meaningful learning and stimulates the development of cognitive and creative problem-solving skills. Based on the current curricular guidelines of the Profile of Students Leaving Compulsory Schooling [1] and the Core Learning Frameworks for Environmental Studies [2] and Maths [3], we sought to investigate how the different components of computational thinking promote the construction of historical and cultural knowledge experienced by children in the classroom. To this end, lesson plans were drawn up in which the articulation of knowledge was the fundamental axis of the learning experiences outlined, with the child constructing their own learning through observation, critical analysis and problem-solving, mobilising knowledge to make decisions and thus build more solid learning.
From a qualitative perspective, this research was carried out in the context of initial teacher training for Professional Master's programmes, based on the trilogy of planning, intervention and after-action reflection, and on an interpretative process that allowed us to consider categories of analysis highlighted in the discussion of results. The following categories will be presented in this article: connecting computational thinking with history and culture, connecting computational thinking with the present and the future, stimulating problem-solving skills with the use of a robot.
The results show that connecting computational thinking with oral and material heritage fosters a reality-simulating environment that makes learning meaningful and gives meaning to curricular content. It also favours interdisciplinary learning in a problem-solving environment in which students understand the past and present of the context in which they live, building knowledge, attitudes and values for life.

Keywords: cultural heritage; computational thinking; interdisciplinarity; initial teacher training

1. Introduction

The need to understand learning processes and reflect on the challenges of the 21st century indicates the need for pedagogically renewed, contextualised and meaningful lessons, and therefore challenge future teachers to be creative and up-to-date. This is also reflected in the Portuguese Curriculum [4], which integrates the Essential Learning of the different curricular areas, the Profile of Students Leaving Compulsory Education [1] and Curricular Flexibility. These documents show the need to connect education with culture and science in an attitude of knowing, doing, being and being, considering the person we are; they reflect inclusion as a requirement and the contribution to sustainable development as a challenge; they reinforce the connection between the individual and society, the past and the future and warn of the reconfiguration of the school to respond to the demands of these changing times. In this scenario, the curriculum points towards meaningful training and intervention in the social environment.
This study, which is part of initial teacher training, especially Supervised Teaching Practice as part of a professional master's degree, aims to analyse two educational practices carried out in primary school

in order to understand how the different components of computational thinking promote the construction of historical and cultural knowledge experienced by children in the classroom. It involved around 40 children between the ages of 6 and 8. This is a qualitative study whose data was collected by analysing photos and documents that were collected during class observations.

2. Theoretical framework

Cultural heritage, whether immaterial or material, has the potential to define the society in which it was born, and therefore becomes unique. We can therefore understand the growing body of theory around cultural heritage as a historical source and teaching resource, which reveals the extent of awareness of its importance in education [5], [6], [7]. This is linked to a veritable "research revolution" in heritage education [8] that took place between the 1990s and the first decade of the 21st century. The usefulness of cultural heritage for building citizenship and understanding collective identities was realised, and cultural heritage began to be understood in a holistic way, as part of an educational process and even as part of the goals set for education, particularly citizenship education [6].
Heritage education is able to promote the valorisation of cultural identity and respect for a society's historical heritage [9]. By learning about local and national cultural heritage, children are encouraged to value and preserve these assets for future generations. It is a question of awakening in children a respect and concern for the preservation and conservation of cultural heritage as principles of citizenship [10].
Therefore, the use of cultural heritage as a first-rate resource for teaching the humanities and social sciences is fundamental to creating a living connection between children and the past, as well as promoting the development of historical skills and respect for this heritage [10]. Intangible cultural heritage is also fundamental in the formation of historical awareness [11], and this study also takes this into account in the learning experiences it has outlined. For all these reasons, heritage education offers children the chance to analyse material and sometimes even oral evidence from the past and to develop skills in processing information and using sources. They can thus examine artefacts, study historical documents and analyse the architecture of historic buildings. It should be noted that computational thinking integrates reasoning and understanding the world, since it is through reasoning that problems are solved and the world is better understood. For Wing [12], computational thinking (CT) is a fundamental skill for anyone, it involves understanding human behaviour, "it is reformulating an apparently difficult problem into one that we can solve, perhaps by reduction, incorporation, transformation or simulation" (p. 2), "it is using heuristic reasoning to discover a solution. It is planning, learning and scheduling in the presence of uncertainty" (p. 3), and it contributes to everyday life, communication and interaction with others. Citing Wing (2006), Liu and Wang (2010), Voskoglou and Buckley (2012), Barr and Stephenson (2011), Kanaki and Kalogiannakis (2018), Lee et al, (2011), Psychicar and Kotzampasaki, (2019), Weese (2017), Weese and Feldhausen (2017) and Asa (2006), Ntourou, Kalogiannakis and Psycharis [13] show that CT is a skill to be developed at school, as it is a hybrid form of thinking that challenges students to build complex thinking and creation, so it is important to understand how it is applied in the classroom, namely the use of programming that favours its cultivation. In this sense, computational thinking contributes to training people who not only identify the problem but also find ways to solve it, understanding society and everyday life. This topic is currently covered in the Primary School Maths curriculum [3] with five associated practices: abstraction, decomposition, pattern recognition, algorithm and debugging.
The growth of research into heritage education has also been accompanied by developments in the Primary School Curriculum, specifically in the document Essential Learning for Primary School Environmental Studies [2]. There we find specific content relating to cultural heritage, specifically in Year 3, in the Society domain with the performance descriptor "Recognise traces of the local past: buildings; old tools and the activities to which they were linked; customs and traditions" [2] (p. 5) and in Year 4, in the Society/Nature/Technology domain with the performance descriptor "Recognise and value natural and cultural heritage - local, national, etc. - by identifying natural features in the landscape (sites, etc.). identifying natural elements in the landscape (geological sites, Natura Network areas, etc.) and material traces of the past (buildings, bridges, mills and statues, etc.), customs, traditions, symbols and events" [2].
It is essential that heritage education is present in the teaching of Environmental Studies, as it contributes to the integral formation of the student, promoting the recovery of cultural identity, the development of values and awareness in relation to the preservation of heritage. It also makes learning more meaningful and connected to the students' reality. In this sense, using cultural heritage in learning about environmental studies allows identities to be generated. By exploring heritage,

children have the opportunity to understand the history and culture of their region, developing a sense of identity and belonging [10]. At the same time, it allows children to get to know and value the heritage of their environment.
In this sense, we developed a project in which heritage education involved various areas of knowledge, in an interdisciplinary process, promoting a dialogical, reflective and critical heritage education [14]. Among the areas of knowledge, we highlight Maths, specifically the topic of computational thinking. In the context of Supervised Teaching Practice, the study by Santos et al. [15] shows that computational thinking, combined with a collaborative and interdisciplinary process based on robotics, promotes abstract thinking and fosters students' interest and involvement in the problem-solving process, stimulating various personal and social skills. The study by Dinis et al. [16] also reveals the potential of computational thinking with reality and emphasises the ability to reason mathematically to solve problems, forming informed, autonomous and responsible individuals. In line with these results is the article by Papadakis, Kalogiannakis, e Gözüm [17] which refers to some studies showing that robotics favours student involvement in the task and promotes computational thinking, improving student performance.

3. Methodology

Methodologically, this is an exploratory case study of a qualitative nature, integrated into the area of Social Sciences, which aims to produce knowledge about real phenomena [18] that occurred in the context of Supervised Teaching Practice. For data collection, we used participant observation, carried out by institutional supervisors, and recorded memories, such as photography and video. The students in the practices were asked for their informed consent to carry out this study, as required by the Ethics Committee of the InED (Centre for Research and Innovation in Education). Reading the records enabled the following categories to be constructed: connecting computational thinking with history and culture, connecting computational thinking with the present and the future, stimulating problem-solving skills with the use of a robot.
It involved a group of participants from the 1st Cycle of Basic Education, around 40 children between the ages of 6 and 8, and two different school groups. Each of the classes was fairly homogeneous and there was no need for pedagogical differentiation.

3.1 Report on educational practices

Plan 1 for 3rd grade - The main objectives of this lesson were to develop concepts related to heritage and local history in connection with the progression of the children's reasoning and to encourage savings in connection with computational thinking. To this end, it was assumed that the children had prior knowledge of the addition and subtraction algorithm with and without regrouping, with natural numbers and decimals, as well as operations involving money. The methodology was based on simulation as a pedagogical tool for experiential learning. The aim was to respond to a local reality: Cruise ships full of tourists often arrive in Leixões. How can we make our city known to tourists? The following map of disciplinary articulation was then planned:
i) the subject of Environmental Studies was centred on the treatment of the Society and Society/Nature/Technology Domain of the Essential Learnings of the 1st CEB. With regard to the Society domain, the following knowledge, skills and attitudes were to be developed: recognising the units of time: decade and century; relating dates and facts that are important for understanding local history; recognising traces of the local past (buildings; old tools and the activities they were linked to; customs and traditions). With regard to Society/Nature/Technology, the aim is to develop the following knowledge, skills and attitudes: identify differences and similarities between the past and present of a place in terms of social and cultural aspects; recognise the potential of the Internet, using information and communication technologies safely and respectfully, keeping personal information confidential; know how to ask questions, raise hypotheses, make inferences, check results and know how to communicate them, recognising how knowledge is built;
ii) for Maths, the themes, topics and subtopics selected were Geometry and Measurement (Measurement: Money) and plans were made to develop the following knowledge, skills and attitudes: drawing up and analysing shopping lists for different purposes, including estimating costs, recognising the importance of money when purchasing goods, choosing the best route, developing computational thinking skills to be verified in robotics.
The educational practice began with the presentation of the problem question that would guide the work of the class by watching the video 'Being Porto is...' which poses the following question: 'What is

being Porto?' (Figure 1). To this end, the video was explored through an open dialogue about some of Porto's monuments and how the children felt about being from Porto. The class was then divided into four groups of five and each group was given a computer with an avatar to guide the task, a mesh, a Blue-bot and a Travel Diary.

Figure 1 - Educational Practice "What it means to be Porto"

The work proposal was entitled 'A hop to Porto!', structured with a set of challenges, launched using the PowerPoint tool, and recording all the calculations and answers in the Travel Diary. Each group was responsible for a different theme: Baroque Porto, Medieval Porto, 19th century Porto and Porto Tiles. The children had to carry out the following tasks: i) check how much money they had in their wallets to visit the sites in Porto; ii) calculate the price of the tickets for each site; iii) choose the monuments they wanted to visit, as well as the order in which they would visit them, by drawing an itinerary on the grid handed out earlier; iv) discover each site, using the Blue-bot and moving it on the grid by answering a set of challenges associated with each site. All the answers had to be recorded in each group's Travel Diary. This was followed by each group presenting their itinerary, i.e. all the places they had visited and the amount they had spent, using a PowerPoint, built by the students, based on a previously defined structure. Finally, the children had to create a tour itinerary of the monuments on cardboard and present it to the class, at the end of which they were given a ribbon recognising them as Official Guides of Porto.
Plan 2, for 1st graders - Based on the story "Peek Through the Window" by Katerina Gorelik, a story that uses characters that refer to traditional oral tales, the lesson aimed to develop problem-solving skills through computational thinking in a dynamic sphere of traditional oral characters whose actions refer to family spaces in close connection with the construction of ethics and citizenship. It was assumed that the children had prior knowledge of understanding numbers and the characteristics of the characters in oral heritage stories, as well as the concept of family. The following disciplinary articulation map was then planned: in order to understand a narrative text and the need to make evaluative judgements by developing critical, argumentative and creative skills, connections were made with the area of environmental studies under the domain Society, content Family, and with the area of mathematics under the theme Mathematical Skills with the topics Problem Solving and Computational Thinking.
To stimulate curiosity, the lesson began with the following question: *What's behind our window?* In theatrical form, the students peered through a window and met the characters from the oral tradition, characterising them in a participatory dialogue. The stories included Red Riding Hood and the characters of Granny and the Wolf. This moment enriched the exploration of the paratextual elements and the analysis of the work's illustrations. The work was explored in a card game format, making it easier to identify the problem (abstraction) and was carried out autonomously under the guidance of an audio (avatar) to be played on a grid using a robot, Blue-Boot (Figure 2). It should be noted that, given the complexity of the algorithm, the avatar presented appropriate representations to facilitate understanding of the problem. Thus, each code to be chosen represented a route from one image to another, meaning that the students had five challenges to fulfil in order to reach the final objective. Stopping at the houses led to reflections on history and the need to solve some maths problems in

connection with the theme of family and citizenship, such as the oral tradition story "Little Red Riding Hood".

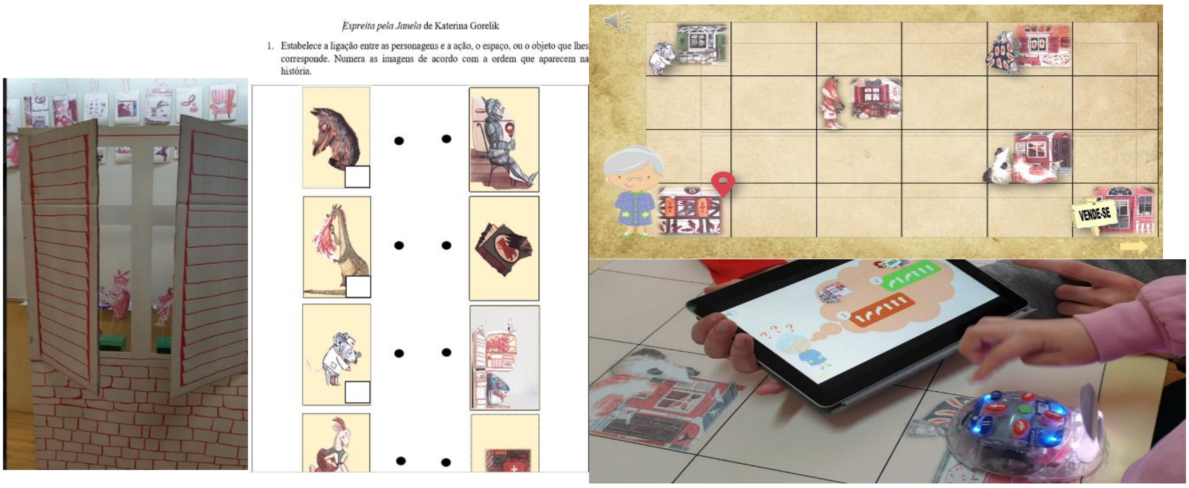

Figure 2 - Stages of educational practice

So, to get to the debugging stage, where the student makes sure the code works with the robot, or corrects the error, they had to recognise patterns and make decisions beforehand in the face of the challenges proposed by the avatar and these were recorded in a script to be finally materialised by the use of the robot (Fig. 3).

At each obligatory stop on the grid, there is an image that corresponds to a challenge and provides an opportunity for large group dialogue about the story. The operationalisation of the itineraries allows for the creation of a new story.

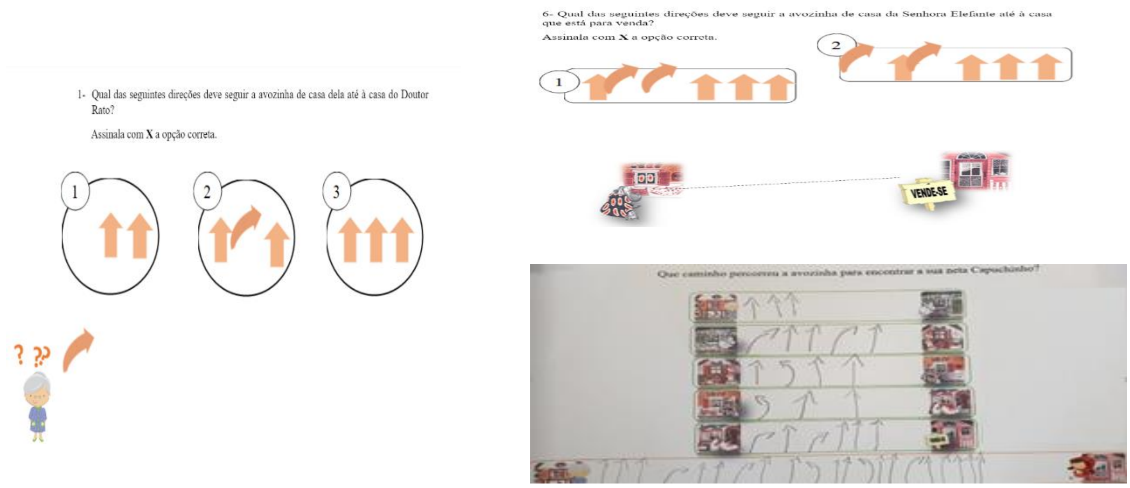

Figure 3 - Computational thinking

4. Discussion of results

Based on the analysis of the description of the two lesson plans, table 1 was created with three categories corresponding to an overview of the connections of computational thinking.

Tabela 1 - *Computational thinking connections*

Educational practice	*Connecting computational thinking with history and culture*	*Connecting computational thinking with the present and the future*	*Stimulating problem-solving skills using a robot*
Plan 1	- Baroque Porto, Medieval Porto, 19th century Porto and Porto tiles.	- "choosing the monuments they wanted to visit, as well as the order in which they would visit them" - "discovering each site" - "creating an itinerary for visiting the monuments"	- "checking the amount of money they had in their wallets to be able to visit the places in Porto" - "calculating the price of tickets for each place" "Blue-bot - moving it around the grid by answering a set of challenges associated with each location"
Plan 2	Traditional oral tales: -the oral tradition story "Little Red Riding Hood"	-"Family spaces in close connection with the construction of ethics and citizenship"; - "the characters of the oral tradition, characterising them in a participatory dialogue"; -"reflections on history and the need to solve some mathematical problems in connection with the theme of family and citizenship"; - "The operationalisation of the itineraries allows the creation of a new story".	-"identification of the problem (abstraction) and was carried out autonomously under the guidance of an audio (avatar) for execution on a mesh using a robot, Blue-Boot"; - "the avatar presented appropriate representations to facilitate understanding of the problem"; -"he had to recognise patterns and make decisions beforehand in the face of the challenges proposed by the avatar and these were recorded in a script to be finally materialised through the use of the robot" - "...each code to be chosen represented a route from one image to another"; - "the student makes sure that the code works with the robot, or corrects the error".

Computational thinking integrates skills such as the ability to identify the problem, break it down into simpler parts, find patterns and build solutions that can be debugged using a robot. Analysing the table shows that this topic benefits from an interdisciplinary vision with connections to culture, tangible and intangible heritage, as well as fostering skills that allow us to learn about the past and present in order to make better decisions for the future. It thus serves to educate citizens so that they can enjoy social opportunities.

This topic is also versatile enough to be adjusted to the students' level of learning: in 1st grade, the proposal is to make the algorithm available in simpler parts for the student to select and discover the final algorithm for verification in debugging, and in 3rd grade, the student understands the decomposition, finds patterns and builds the algorithm for debugging. Throughout the process, the children were able to express themselves and communicate the knowledge they had built up. The representations created about the value of heritage will allow them to assume an attitude of respect and conservation in the future. Also, the imagination to put themselves in the other person's shoes, understanding conceptions and arguments, fosters an understanding of reality.

5. Final considerations

With the aim of understanding how the different components of computational thinking promote the construction of historical and cultural knowledge experienced by the child in the classroom, this study, based on supervised teaching practice, shows two educational possibilities adjusted to two different levels of schooling: In the 1st plan, the students were guided towards discovery throughout the stages of computational thinking; in the 2nd plan, the students had simplified solutions to make decisions and finally find the algorithm to debug with the robot. In both cases, the permanent connection with the material/immaterial heritage, in a reflective dialogue, involved the student in learning intentions about everyday phenomena as a resource for critical learning and the development of mathematical reasoning. Expressing value judgements develops analytical and communication skills. This scenario shows the potential of interdisciplinarity in promoting meaningful learning and stimulating the development of cognitive and creative problem-solving skills.

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