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Open Educational Resources for Computational Thinking as a Skill for Social Participation in Early Childhood

M-Manuela Ordonez*

Graduated in early childhood education, Master's in Learning Difficulties and Cognitive Processes, PhD student in equity and innovation in education, University of Vigo, Ourense, Spain, <https://orcid.org/0000-0002-6179-9085>

Almudena Alonso-Ferreiro

PhD, Lecturer in Educational Technology at Didactics, School Organisation and Research Methods Department, University of Vigo, Spain, <https://orcid.org/0000-0002-9438-2681>

Esperanza Requejo

Graduated in Psychology, Master's in Teacher Training for Secondary Education, Upper Secondary Education (Baccalaureate), Vocational Training and Language Teaching, Master's in General Health Psychology, PhD in Equity and Innovation in Education, Teacher at the University of Vigo, Ourense, Spain, <https://orcid.org/0000-0001-6914-5484>

***Corresponding author:** mariamauela.ordonez@uvigo.gal.

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Abstract: Open Educational Resources (OERs) are positioned as a key element to promote quality education and are especially relevant at a time when computational thinking (CT) has been established as one of the fundamental skills for 21st-century citizenship, yet it is a topic that has received little research in early childhood. This research conducts a qualitative content analysis of OERs in the repositories of the Spanish Ministry of Education and Vocational Training that promote computational thinking for ages 0-6. 17 OER were selected from the Procomún and CodeIntef



repositories after applying eligibility criteria and analysed using an 11-category matrix covering CT skills, programming languages, resources, and teaching methodology. The results show that, among computational thinking skills, algorithmic thinking was the most developed, appearing in 14 of 17 OERs. Debugging (n=2) and automation (n=1), skills typically associated with higher levels of learning, were the least present in the proposals. Regarding programming languages, unplugged was the most frequent format (n=9), followed by button panel programming (n=6). Digital keypad is the most abstract programming language present in the proposals and the least common, present in only 3 of the OERs. Looking at the technologies used, 83.3% of the educational robotics used was commercial and proprietary. Only two of the proposals include open-source educational robotics. Analysis of teaching methodologies revealed that direct instruction dominated (76.5%), with constructivist approaches significantly underrepresented. This aligns with the predominant orientation of the proposals: "learning to code" (n=12) over "coding to learn" (n=2). The findings highlight the need for more OERs that employ constructivist methodologies, incorporate open-source resources, and prioritise developing higher-order CT skills, such as debugging and automation, in early childhood education. The analysis of OERs allows us to assess the quality and rigour of the resources included in institutional repositories, which are fundamental to guaranteeing educational equity.

Keywords: computational thinking, digital skills, early childhood education, educational robotics, Open Educational Resources.

Introduction

Technology is an integral part of the lives of children of all ages, an integral element of their reality, and its impact on them falls to both the educational and family contexts. Educational institutions have a duty to integrate technology into the classroom to provide a quality education that promotes equity and equal opportunities (UNESCO, 2021).

To achieve this objective, UNESCO (2021) proposes, among its specific actions, promoting Open Educational Resources (OER) and freely accessible tools under open licenses. The interest shown by public administrations in promoting and cooperating in the creation and dissemination of OER offers a path to achieving a more inclusive and equitable quality education, one that contributes to achieving Sustainable Development Goals (SDG) 4th of the 2030 Agenda (Ramírez, Celi & Lligüín, 2022; UNESCO, 2019).

Open Educational Resources (OER) are defined by UNESCO (2019) as:

learning, teaching, and research materials, in any format and medium, in the public domain or protected by copyright, and published under an open license that permits access, reuse, repurposing, adaptation, and redistribution free of charge by third parties (p. 22).



OER offer all education professionals the possibility of adapting these resources to their context: students, characteristics of the educational institution, and specific educational objectives (Admiraal, 2022; Recio, Gutiérrez-Esteban & Suárez-Guerrero, 2021; UNESCO, 2019). Their integration has been studied at all educational levels, with their inclusion in basic education (ages 6 to 16) being particularly noteworthy (Bethencourt-Aguilar et al., 2021; Ramírez et al., 2022). The evaluation of OER is crucial to ensuring their quality, usability, accessibility and impact in education (Lopes et al., 2025).

The growth of policies related to the integration of technologies at the global and European levels highlights the digital competence of both teachers and students, as well as the importance of fostering learning different languages from an early age (Alonso-Ferreiro & Zabalza-Cerdeiriña, 2024; Mellado-Moreno & Bernal-Bravo, 2023; Rey, 2022).

Inclusion and literacy in the classroom must be coherent and promote the achievement of educational objectives. Teachers, playing an active role in adapting to specific needs and characteristics, are responsible for implementing these educational proposals (Rey, 2022; UNESCO, 2021). Reflecting on the methodology and pedagogical perspective to be used is considered a priority, since the mere incorporation of technology does not produce significant results in the teaching and learning process (UNESCO, 2023). Its success depends on creating learning situations that allow students to develop the skills necessary to adapt to the demands of the context.

Schools, as spaces that must promote social justice and universalise access to knowledge, cannot remain indifferent to the need to provide literacy in different languages to a digital society (Alonso-Ferreiro & Zabalza-Cerdeiriña, 2024). Student literacy in educational centres must be progressive and begin in early childhood, stimulating multiple forms of representation and interpretation that foster their adaptation to this new digital era, among which Computational Thinking (CT) stands out (Alsina & Acosta, 2018; Zapata-Ros, 2015, 2019).

CT has gained greater relevance in recent years in the field of education (Levinson & Bers, 2025; Moreno et al., 2024; Sánchez-Vera, 2020). In this regard, in Spain, with the regulatory update through Real Decreto 95/2022, which establishes the organisation and minimum curriculum for Early Childhood Education, CT is incorporated for the first time, and in a prescriptive manner, into the second cycle of the Early Childhood Education stage (ages 3-6).

The conceptualisation of CT is a challenge for the scientific community. Corrales-Álvarez, Ocampo & Cardona-Torres (2024), after analysing definitions of CT, defined it as “a set of cognitive, emotional, and social skills oriented toward the formulation and resolution of problems based on different domains of knowledge and/or concepts specific to programming, linked to connected or disconnected activities” (pp. 19-20). Its components are another challenge for the scientific community, and there is no consensus on them (Adell et al., 2019; Sánchez-Camacho & Grané, 2023). Following the advice of the European Commission (European Commission. Joint Research Centre, 2016), after its research on CT, it establishes six skills:



- Abstraction: a simplification process in which non-essential characteristics are eliminated.
- Algorithmic thinking: the ability to establish sequences that allow one to achieve a goal or resolve a situation.
- Automation: a process in which a pattern is identified, and the machine is instructed to repeat it, resulting in increased process efficiency.
- Decomposition: the ability to recognise the elements that make up a whole to facilitate understanding and problem-solving.
- Debugging: a process of reflection and analysis through which aspects that can be automated or that present errors are identified.
- Generalisation: a process of evaluating elements and their relationships to develop a framework for solving future problems.

The development of these skills can occur with or without technology; the latter is known as unplugged CT (Levinson & Bers, 2025; Lijó-Sánchez et al., 2023; Sánchez-Vera, 2020; Zapata-Ros, 2019), which is gaining relevance in early childhood education (Acevedo-Borrega et al., 2022). Interventions that incorporate technology into the classroom primarily use proprietary Educational Robotics (ER) systems (Raposo-Rivas, García-Fuentes & Martínez-Figueira, 2022; Taslibeyaz et al., 2020) or graphical block-based languages such as ScratchJr (Bers et al., 2023; Yang et al., 2025).

Several studies have incorporated activities to develop CT in early childhood education, and these interventions generally yield positive results in terms of achieving the stated objectives (Caballero-González & García-Valcárcel, 2020; Lijó-Sánchez et al., 2023). Furthermore, studies that include screen-free activities also find significant improvements in students (Lijó-Sánchez et al., 2023; Moreno et al., 2024). The teacher's role as an agent who designs learning situations to achieve the proposed objectives is key to developing CT (National Institute of Educational Technologies and Teacher Training [INTEF], 2022; Sánchez-Vera, 2020). It has been demonstrated that simply including technology in the classroom without an appropriate methodological approach does not constitute literacy in CT (González-González, 2019). To achieve this, teachers must possess the necessary skills and be aware of the importance of sharing innovation to bring about a change in the educational paradigm (INTEF, 2022) from a constructivist approach (Alimisis et al., 2019). However, research on CT in early childhood education highlights the lack of confidence and training among teachers at this stage (Hollenstein et al., 2022; Kourti et al., 2023), especially in the pedagogical dimension.

In this context, where the production of open and accessible resources that contribute to SDG 4 is being promoted, and where CT is established as a fundamental literacy from early childhood, it is relevant to analyse the OER offered by the Spanish Government through the Ministry of Education and Vocational Training (MEFP) in its repositories for teachers and families. This work focuses on identifying and describing OER geared towards the development of CT in children aged 0-6.



Research Problem

CT skills have become essential for social participation. Therefore, it is necessary to investigate how these skills are being developed in educational settings. Analysing Open Educational Resources (OER) allows us to understand the proposals that preschool teachers and teachers at other educational levels develop and share. In Spain, CT skills are included in the curriculum from the early childhood education stage, and it is important to understand the pedagogical perspective being implemented and shared in institutional repositories as a model for classrooms.

Analysing and reflecting on pedagogical proposals allows for the improvement of the teaching and learning process by using a scientific perspective to evaluate and enhance teaching practices. This research aims to delve deeper into these proposals with the goal of continuing to develop scientific and pedagogical knowledge in this field, which, although not new, is highly relevant in our increasingly technological society.

Research on CT in early childhood education is common and on the rise. However, this research primarily focuses on specific, one-off interventions such as workshops. Analysing OERs allows us to identify more continuous and systematic classroom approaches that stem not from scientific research but from classroom realities, which are often overlooked in scientific literature.

Research Focus

The purpose of this study is to describe and analyse the OERs that teachers share in institutional repositories and that are used as an example and/or model for the development of educational proposals by active teachers in early childhood education.

Research Aim and Research Questions

This work focuses on identifying and describing OERs oriented towards the development of Computational Thinking for ages 0-6.

The research questions that this study seeks to answer are:

- What are the characteristics of OER in terms of authorship, affiliation, year of publication, and target audience age?
- What CT skills are developed in early childhood, and with what programming language?
- What technologies and materials are used in OER?
- What teaching methodologies are used to develop CT in early childhood?



Materials and Methods

Research Design

To address the stated objective, a qualitative design centred on content analysis methodology (Bardin, 2002) has been proposed. This approach enables a systematic analysis of the data set's content and seeks to understand its meaning.

The process began with a review of the repositories on the INTEF (2025) website, a platform created by the Ministry of Education and Vocational Training (MEFP) to train teachers and promote the creation and dissemination of open educational resources. Specifically, the following websites were selected: Procomún (<https://procomun.intef.es/>), the platform dedicated to collecting and publishing open educational resources, and CodeIntef (<https://code.intef.es/>), an INTEF initiative specifically aimed at promoting Computational Thinking and artificial intelligence in education by offering resources for their inclusion in classrooms (INTEF, 2025).

The procedure used on the Procomún website to select resources involved using the "early childhood education" filter to refine results by educational stage, then searching for the term "computational thinking." On CodeIntef, the filter was applied only to the "early childhood" educational level.

Subsequently, each digital resource was manually checked to ensure it met the eligibility criteria:

- Addresses computational thinking.
- Affects the Early Childhood Education stage.
- Full access to the resource.
- Educational experience.

This research has an ethical approval report from the ethics committee of the University of Vigo (EVALUATION REPORT 0052-F-2025-02-13).

Sample and Participants

The results of the search procedure yielded a total of 33 educational experiences, of which 16 were eliminated for not meeting the eligibility criteria (Table 1).

Table 1

Open Educational Resources Selection Process

Repository	Results	Deleted	Sample
Procomún	18	It does not address CT (n=4)	9
		Not Early Childhood Education (n=2)	
		Not access (n=2)	



		Theoretical publication (n=1)	
		It does not address CT (n=1)	
CodeIntef	15	Not Early Childhood Education (n=2)	8
		Theoretical publication (n=4)	
TOTAL	33	16	17

The final sample consists of a total of 17 OERs, 9 published in Procomún and 8 in CodeIntef, intended to develop CT at early ages.

Instruments

Based on the scientific literature, an analysis matrix was designed to explore and analyse the resources. This instrument, created ad hoc, includes the system of categories (Bardin, 2002) identified for the content analysis of the selected resources (Table 2).

Table 2

Analysis Sheet

Repository	Procomún or CodeIntef
Authorship, affiliation and year	Name of the author of the OER, position and place of work, and year of publication
Title	Name given to the resource
Stage-age	Age range for which the proposal was designed or developed
Programming language	Code used to encode information
CT Skills	Abstraction, algorithmic thinking, debugging, decomposition, automation, and generalization
Resources	Materials needed to carry out the proposals, including technologies and other consumable or non-consumable materials.
Software (license, origin)	Permissions granted by the authors for access, use, and modification of the resources.
Teaching methodology	Didactic design and pedagogical approach developed by the teacher to facilitate the teaching-learning process
Link	Link to resource
Medium	Identify the type of media on which it is shared
Observations	All those noteworthy aspects



Data Analysis

The analysis was carried out by the researchers, ensuring that all OERs were analysed and evaluated by two people. After the individual analysis, which included a thorough reading and coding of the information using the category table (Table 2) in Excel, the category matrix results were shared, and a consensus was reached on a common coding system. From this table, the relationships between the different categories were analysed to answer the research questions.

Results

The analysis of the final sample reveals 17 OERs available to families and schools that develop the CT for ages 0-6 (Early Childhood Education). The results are presented below and answer the research questions posed.

What are the characteristics of the OERs in terms of authorship, affiliation, year of publication, and age of the target audience?

Table 3 presents the data identifying the 17 OERs analysed, all published under a CC-BY-SA license. As can be seen, 13 are authored exclusively by women, and of the remaining 2, two are anonymous. Regarding affiliation, the authors include early childhood education teachers from across Spain (n=11), a primary school teacher, a digital mentor, a university professor, and an instructor of assistive technology for the visually impaired.

The analysis reveals that the first publication of an OER that promotes the development of CT in EI, shared in the INTEF repositories, dates to 2016. In addition, it is worth highlighting the upward trend in the publication of resources on CT for early childhood, especially since 2023 (n=12).

Table 3

Relationship and identification of educational experiences (OER)

OER	Title	Filiation	Year	Age	Link
1	Jurasic class 2.0	Early Childhood Education Teacher in Galicia	2017	4-5 years	https://procomun.intef.es/ode/view/1493756830335
2	YOROBOT	Early Childhood Education Teacher in Andalucía	2023	3-6 years	https://procomun.intef.es/ode/view/es_2023110412_9185305
3	¿Los robots también leen?	Early Childhood Education Teacher in Andalucía	2024	3-5 years	https://procomun.intef.es/ode/view/es_2024012012_9120038
4	Un lobo muy travieso	Early Childhood Education Teacher in Andalucía	2024	3 years	https://procomun.intef.es/ode/view/es_2024072312_9150558



5	¿Qué celebramos hoy con CAT?	Early Childhood Education Teacher in Andalucía	2023	5-6 years	https://procomun.intef.es/ode/view/es_2023121312_9241944
6	"Dos ardillas y una piña" robótica en el aula	Early Childhood Education Teacher in Andalucía	2023	3 years	https://procomun.intef.es/ode/view/es_2023120612_9205329
7	"Vamos a recolectar setas" robótica en el aula	Early Childhood Education Teacher in Andalucía	2023	4 years	https://procomun.intef.es/ode/view/es_2023121312_9170919
8	MI CASA Y MI FAMILIA	Early Childhood Education Teacher in Andalucía	2024	3 years	https://procomun.intef.es/ode/view/es_2024120912_9230319
9	SCRATCH: Bichos Ed.Infantil 3 años	Early Childhood Education Teacher in Madrid	2016	3 years	https://procomun.intef.es/ode/view/1461141360161
10	Scracth Jr en Educación Infantil	Early Childhood Education Teacher	2025	5 years (5° EI)	https://code.intef.es/prop_didacticas/scratch-jr-en-educacion-infantil/
11	Vaya lío en la granja	Digital mentor at CP in Zaragoza	2024	5 years	https://code.intef.es/prop_didacticas/vaya-lío-en-la-granja/
12	Robot Matatabot como recurso didáctico en el aula de Educación Infantil	Primary School Teacher. Extremadura	2024	5 years	https://code.intef.es/prop_didacticas/robot-matatabot-como-recurso-didactico-en-el-aula-de-educacion-infantil/
13	Scracth Jr tactile	University lecturer from Cataluña	2024	4 or more years	https://code.intef.es/prop_didacticas/scratch-jr-tactile/
14	Empezamos a programar con Dipper	-	2023	5 years	https://code.intef.es/prop_didacticas/empezamos-a-programar-con-dipper/
15	Adaptación de tableros para trabajar la robótica educativa con alumnado con discapacidad visual	Assistive Technology Instructor (ONCE). Galicia	2021	3-8 years	https://code.intef.es/prop_didacticas/adaptacion-de-tableros-para-trabajar-la-robotica-educativa-con-alumnado-con-discapacidad-visual/



16	Escornabot como herramienta didáctica	–	2020	–	https://code.intef.es/pro_p_didacticas/escornabot-como-herramienta-didactica/
17	Iniciación a la robótica	Early Childhood Education Teacher Madrid	2022	1-2 years 2-3 years	https://code.intef.es/experiencias_aula/iniciacion-a-la-robotica/

The OERs analysed are mostly geared solely towards Early Childhood Education. However, four of them also consider the Primary Education, Secondary Education, and Vocational Training stages. Regarding age, the children for whom the most experiences have been designed are 5-year-olds (n=10), followed by 3-year-olds (n=9). It should be noted that several of the proposals analysed are aimed at a specific age group; this can be explained by the authors' assertion that the proposals are adaptable and flexible resources, including OER13 and OER15, which are adapted for various ages.

What CT skills are developed in early childhood, and with which programming language?

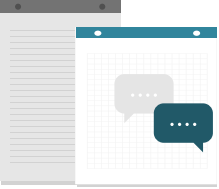
For students aged 1 to 2, only one proposal was found in the analysed repositories, which uses unplugged programming to develop algorithmic thinking skills.

Regarding 3-year-old students, as shown in Table 4, the different proposals included 4 of the 6 CT skills, with algorithmic thinking being the most developed, primarily through unplugged programming (n=5). This was followed by generalisation, addressed through both unplugged and button-panel programming (n=2). Specifically, for 3-year-old students, unplugged programming is established as the preferred language for addressing the 4 CT skills (Table 4) developed at this age.

Table 4

CT skills, programming language and OER for 3-year-old students

CT Skills	Programming language	OER
Abstraction	Unplugged	OER4
	Unplugged	OER2, OER3, OER4, OER6, OER17
Algorithmic thinking	Button panel	OER2, OER6, OER15
	Digital keypad	OER6
	Tangibles blocks	OER15
Decomposition	Unplugged	OER4
	Unplugged	OER2, OER3
Generalization	Button panel	OER2, OER3
	Digital keypad	OER3
	Graphic blocks	OER3



Regarding 4-year-old students, five CT skills were included in the OER (Table 5), the most prevalent being algorithmic thinking, which was addressed across all programming languages analysed, particularly unplugged (n=5) and button panel (n=4). This was followed by generalisation, primarily addressed with the aforementioned programming languages. The automation skill emerges at this age, often through the use of tangible blocks.

Table 5

CT skills, programming language, and OER for 4-year-old students.

CT Skills	Programming language	OER
Abstraction	Unplugged	OER11
	Unplugged	OER1, OER2, OER3, OER7, OER11
Algorithmic thinking	Graphic blocks	OER1, OER3
	Button panel	OER2, OER3, OER7, OER15
	Digital keypad	OER3, OER7
	Tangibles blocks	OER13, OER15
Automation	Tangibles blocks	OER13
Decomposition	Unplugged	OER11
	Tangibles blocks	OER13
Generalization	Unplugged	OER2, OER3, OER7
	Button panel	OER2, OER3, OER7
	Graphic blocks	OER3
	Digital keypad	OER3, OER7

With the 5-year-old students, the experiences have shown that all CT skills have been included (Table 6), with most research focusing on developing algorithmic thinking (n=10). For this purpose, different programming languages have been used: unplugged (n=5), tangibles blocks (n=4), graphic blocks (n=4), button panel (n=3), and digital keypad (n=1).

It is with 5-year-old students that debugging skills are first introduced. This skill has been developed through unplugged programming and with tangible blocks (n=1).

Table 6

CT skills, programming language, and OER for 5-year-old students

CT Skills	Programming language	OER
Abstraction	Unplugged	OER11, OER14
	Tangibles blocks	OER14



Algorithmic thinking	Unplugged	OER1, OER2, OER3, OER11, OER14
	Button panel	OER2, OER3, OER15
	Tangibles blocks	OER12, OER13, OER14, OER15
	Graphic blocks	OER1, OER3, OER5, OER10
	Digital keypad	OER3
Automation	Tangibles blocks	OER13
Decomposition	Unplugged	OER11, OER14
	Tangibles blocks	OER13, OER14
Debugging	Unplugged	OER14
	Tangibles blocks	OER14
Generalization	Unplugged	OER2, OER3
	Button panel	OER2, OER3
	Digital keypad	OER3
	Graphic blocks	OER3

Regarding the 6-year-old students (Table 7), the OERs analysed included 4 of the 6 CT skills, the most frequent being algorithmic thinking, using programming languages with tangible blocks (n=2) and button panel (n=2).

Table 7

CT skills, programming language, and OERs for 6-year-old students

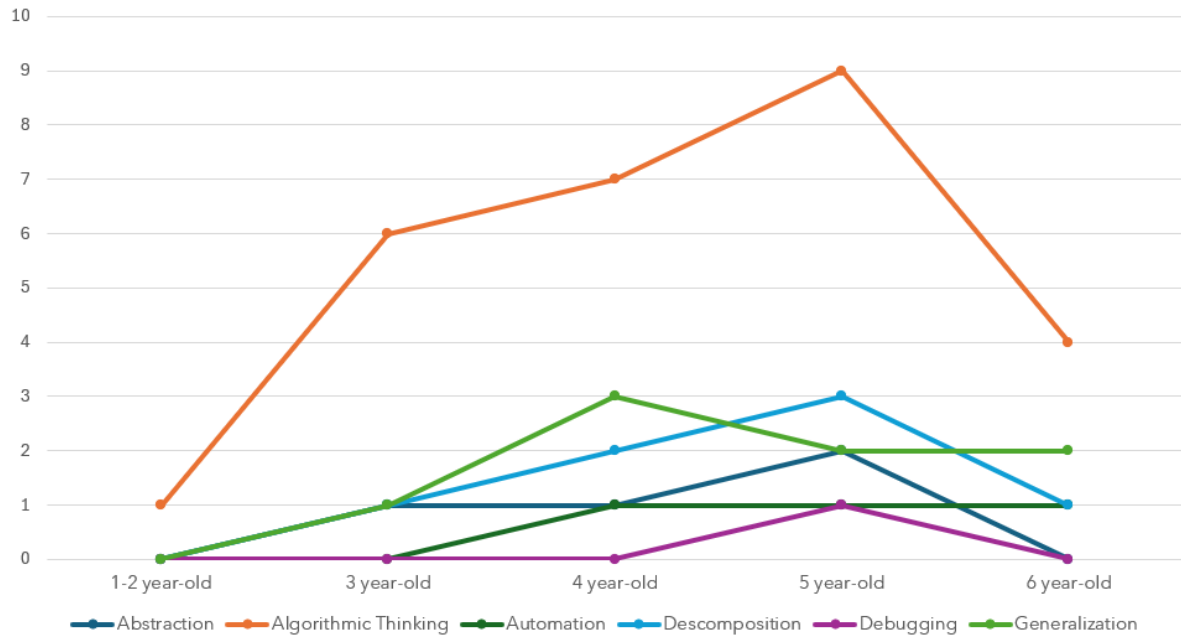
CT Skills	Programming language	OER
Algorithmic thinking	Unplugged	OER2
	Button panel	OER2, OER15
	Graphic blocks	OER5
	Tangibles blocks	OER13, OER15
Automation	Tangibles blocks	OER13
Decomposition	Tangibles blocks	OER13
Generalization	Unplugged	OER2
	Button panel	OER2

It has been observed that the skill most emphasised in OERs aimed at developing CT in early childhood is algorithmic thinking (n=14), followed by decomposition and abstraction (both n=4), generalisation (n=3), debugging (n=2), and automation (n=1). OER14 is the educational experience that addresses the most CT skills, specifically contributing to the development of 4 of the 6 categorised skills (Figure 1).



Figure 1

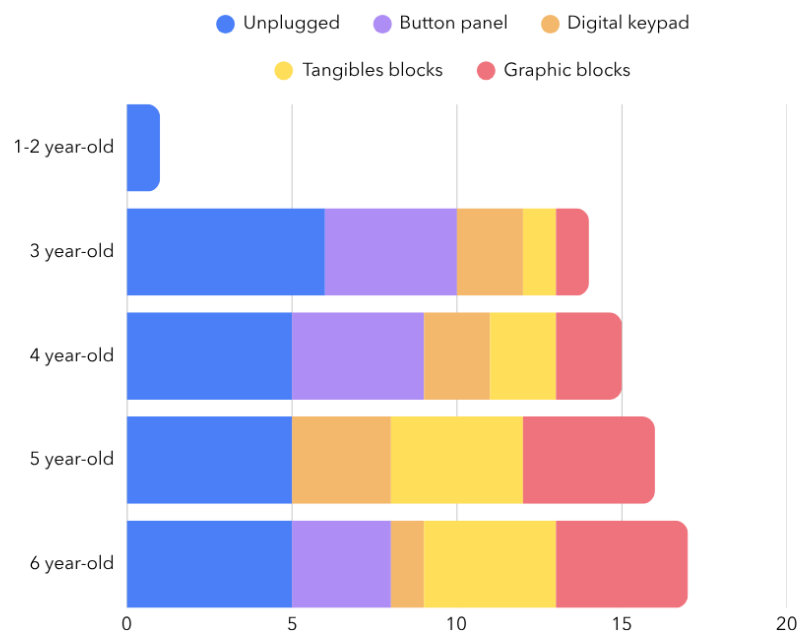
CT skills distributed by age



In summary, when globally analysing the programming languages used at different ages, unplugged (n=9) is present throughout the early childhood education stage, followed by button panel (n=6), graphic blocks and tangibles blocks (n=4), and is the least represented, with digital keypad (n=3) (Figure 2).

Figure 2

Programming languages distributed by age





As shown in Table 8, which relates CT skills to programming languages, it is noteworthy that unplugged programming and tangible blocks have been used to address the greatest number of CT skills.

Table 8

Distribution of OER according to CT skills and programming language

	Unplugged	Button panel	Digital keypad	Graphic blocks	Tangibles blocks
Abstraction	OER4, OER11, OER14	OER16			OER14
Algorithmic thinking	OER1, OER2, OER3, OER4, OER6, OER7, OER11, OER14, OER17	OER2, OER3, OER6, OER7, OER15, OER16	OER3, OER6, OER7	OER1, OER3, OER5, OER10	OER12, OER13, OER14, OER15
Automation					OER13
Decomposition	OER4, OER11, OER14				OER13, OER14
Debugging	OER14	OER16			OER14
Generalization	OER2, OER3, OER7	OER2, OER3, OER7	OER3, OER7	OER3	

What technologies and materials are used in OERs?

There is a wide variety of resources proposed in different experiences; some have integrated several resources to achieve their objectives. The most commonly used are floor and board robots (n=8) and address cards (n=7).

The results show that most of the educational robotics used is private and commercial (83.3%), including: Bee-bot/Blue-bot, Matatalab, Robot Mouse, Roamer, and Codi-oruga (Figure 3). OER15 and OER16 are exceptions, employing open-source robotics with open hardware and free software.

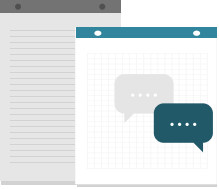
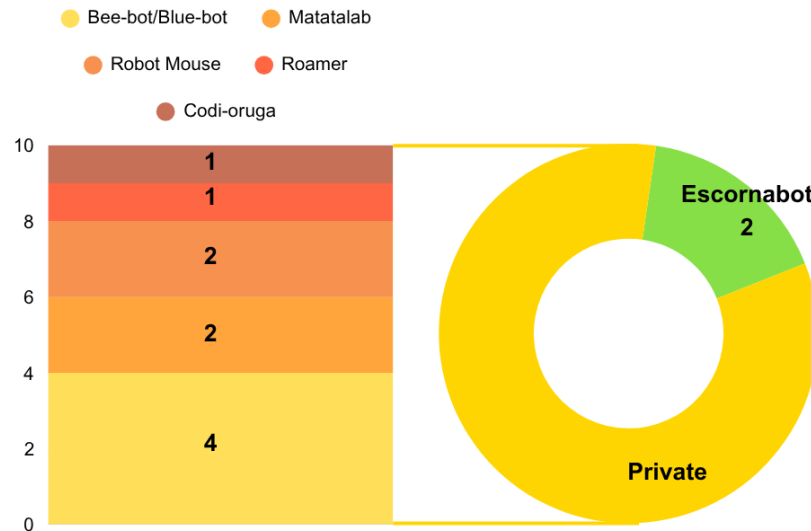


Figure 3

Classification of OERs



In addition to the educational robots, the proposals include other technologies such as ScratchJr (n=5), a free application that allows users to create character movement sequences on the screen using a graphical block programming language.

To bring the educational experiences to life, the teachers integrated other materials, such as projectors, computers, mobile phones, tablets, consumables, stories, blindfolds, and direction or order cards. Experience OER17 stands out as the only one that includes paper circuits as a strategy for developing unplugged CT skills with children under 3 years old.

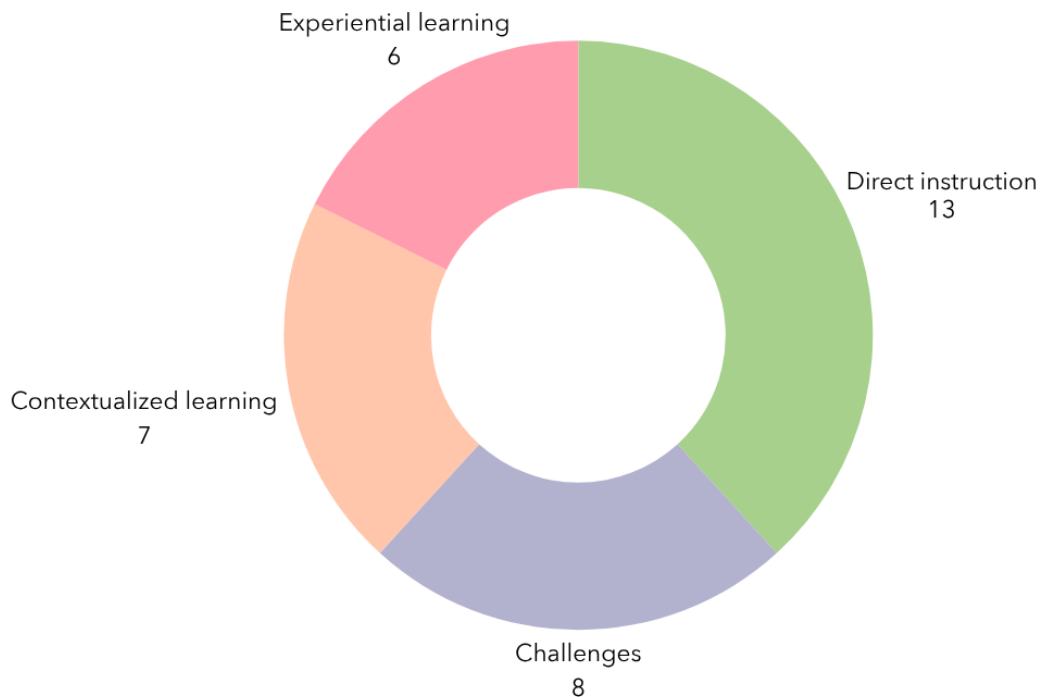
What teaching methodologies are used to develop CT in early childhood?

The educational experiences analysed include different teaching methodologies, with one or more coexisting in each proposal. However, OER16 does not provide an explanation of the educational experience, so we cannot draw conclusions about its teaching methodology. The analysis reveals that the most common teaching methodology is direct instruction (n=13), in which the teacher explains the activity and students carry it out. Challenges, designed as activities where students, guided by the teacher, solve tasks, correspond to 8 of the OERs analysed. Contextualised learning methodologies (n=7) imply that computer programming is included within the classroom project as a cross-curricular learning experience. In the case of the experiential category (n=6), it never appears as the sole methodology of the educational experience, but rather as an essential component prior to interaction with the technology (Figure 4).



Figure 4

Teaching methodologies are used to develop CT.



If we analyse the OERs from the perspective of the ultimate goal of working with computer programming in students, we obtain two options: either learning to code (acquiring programming concepts and using specific technologies or software) or coding to learn (the practical application of computer programming skills mediates learning). The results show that the most prevalent approach is to focus on learning to code ($n=12$) rather than coding to learn ($n=2$); OER1 and OER11 incorporate both approaches.

Furthermore, if we analyse the response options students can offer for the task, we find OERs with single-response experiences ($n=13$), with divergent responses ($n=8$), and OER4, OER5, OER13, and OER15 include activities with some of these possibilities.

Discussion

Currently, the education system faces the challenge of providing a quality and equitable education that integrates technology as a potential element, enabling critical participation from an early age. To achieve this integration, it is necessary to update teachers' digital competence, empower and equip students with skills from early childhood, and offer opportunities for collaboration and dissemination of high-quality open educational resources.

The results of this research show that the creation of OER for early childhood focused on the development of CT skills began to be published in 2016, but exponential growth has been observed in the last three years. This may be due to a surge of interest among teachers because Real Decreto



95/2022, which legally regulates the 0-6 age group, recognises CT development as a specific competence, specifically within the area of "Discovery and Exploration of the Environment." Including it in this area recognises CT as a set of skills necessary for interacting with and exploring the environment.

Regarding the affiliation of individuals who have shared OER in the analysed repositories, the majority are early childhood women's education teachers. This data reveals the feminisation of the early childhood education stage, which the National Institute of Statistics (INE) (2024) indicates represents 97.4% of teachers at this stage. This contrasts with the findings of Admiraal's research (2022), which, while indicating that primary school teachers are the ones who most frequently integrate OER into their practice, shows that university professors are the ones who most often create and share their OER with the community.

CT Skills and Programming Languages in Early Childhood OER

The analysis of educational experiences does not reveal a pattern that relates age to cognitive skills. There are proposals for 3-year-old students that encompass different cognitive skills (algorithmic thinking, abstraction, decomposition), such as OER4, and experiences for older students that focus only on algorithmic thinking, such as OER5 and OER12. This may be related to the key methodological design for developing CT, since the mere inclusion of technologies without a critical pedagogical approach that focuses on the student does not contribute to digital competence (González-González, 2019; UNESCO, 2023). Although there is no clear relationship, it is noteworthy that the automation skill is not included until age 4 (OER13), and the debugging skill is only included in OER14, aimed at 5-year-old students. This is interesting when compared to the stage-specific objectives proposed by the European Commission. Joint Research Centre (2016), among whom automation is considered a target skill for the Primary Education stage (ages 6-12).

The results show that unplugged was the most used language in the analysed OERs and most comprehensively develops CT at these ages (OER14, OER4, OER11). This aligns with the rise in the use of this programming language in early childhood (Acevedo-Borrega et al., 2022). The educational floor robots can be understood as an intermediate step between unplugged activities and virtual platforms. These tangible resources enable the introduction of computer programming through manipulation in a more concrete and defined way, as they allow for immediate error checking (Lin et al., 2023).

Bers et al. (2023) and Yang et al. (2025) conclude that introducing programming activities using graphic blocks in early childhood improves coding skills, but not computer programming skills. The improvements achieved are not transferred to other contexts because the learning is decontextualised (Yang et al., 2025). This may be because platforms like ScratchJr do not work on abstraction skills but rather with abstract elements (Bers et al., 2023), which is one of the greatest difficulties for students aged 0-6 (Alsina & Acosta, 2018).



Technologies and the Question of Digital Equity

Private and expensive educational robotics, accompanied by grid mats, has been the most used tool. This can be explained by the fact that selection is sometimes based on popularity (Taslibeyaz et al., 2020), which overlooks accessibility for all social groups (UNESCO, 2023). These prefabricated, closed-source robots (Alimisis et al., 2019) make it difficult for users to understand what the devices are made of and what they do (Alonso-Ferreiro & Zabalza-Cerdeiriña, 2024). Regarding the materials used in unplugged programming, the resources are diverse: the body itself, materials for paper circuits, materials for building obstacles, and art supplies for creating final products, such as a story.

Teaching Methodologies and Pedagogical Implications

While the resources used can encourage cooperation and learning, teacher guidance is key to ensuring that this cooperation is effective and supports the development of unplugged programming (Lin et al., 2023).

The results show that OERs include proposals with a strong presence of methodological designs based on direct instruction (76.5%), while designs based on experiential and contextualised learning are less prevalent. These findings are supported by the work of Bethencourt-Aguilar et al. (2021), who identified and characterised INTEF's educational resources for the Early Childhood Education stage as decontextualised. Furthermore, the research concurs in pointing out the scarcity of constructivist proposals (Alimisis et al., 2019) that place students at the centre of the learning process (Alonso-Ferreiro and Zabalza-Cerdeiriña, 2024).

Transforming the education system into an open and accessible space for everyone requires reducing the obstacles identified by teachers, such as a lack of time (Admiraal, 2022) or a lack of training in CT (Hollenstein et al., 2022; Kourti et al., 2023). To achieve this, administrations must focus on the pedagogical dimension of teachers' digital competence. This means, as Bethencourt-Aguilar et al. (2021) point out, giving the educational community an active role in updating, reviewing, and adapting OERs. To this end, the evaluation of the technical, methodological and pedagogical characteristics of the OERs is essential, since, as Lopes et al. (2025) point out, evaluation is crucial to ensure the accessibility, effectiveness and quality of these resources.

The implications of these findings at the international level point primarily in two directions: the necessary development of CT in early childhood through pedagogy-centred approaches using open resources, and the value of OER for achieving quality and equitable education, in alignment with SDG 4.

The European Digital Competence Framework (DigComp 3.0) incorporates computational thinking among the 21 competences that define digital competence (Cosgrove & Cachia, 2025), making it clear that this is a transversal competence, interconnected with others and highly relevant for the development of additional competences. In this regard, our research highlights the lack of a



cross-curricular approach to CT in the analysed OER, where the emphasis is on the “learning to code” perspective, as is also the case in widely known international initiatives such as “Hour of Code.” In contrast, the “coding to learn” perspective—where CT is developed in context, prioritising pedagogy over technology—remains marginal. This perspective is crucial, as it involves integrating programming as a new language for expression and participation in society (Levinson & Bers, 2025). To promote initiatives aligned with this approach, educational authorities across countries need to provide teacher training in this area, along with a curricular framework and a greater number of open-source resources (Alimisis et al., 2019).

Furthermore, the findings underscore the value of OER as resources that foster educational equity, contributing to the reduction of inequalities. Their impact depends on both their quality and the teachers’ capacity to adapt and evaluate them. In this sense, the evaluation of OER is crucial (Lopes et al., 2025), which entails analysing their accessibility and curricular alignment before they are included in institutional repositories.

Limitations

The limitations of this research are the small sample analysed, conditioned by the selection of educational repositories and the offer included in them on the subject of study, due to the focus on the Spanish sphere, selecting only institutional repositories of the government of Spain.

The study focuses on analysing published OERs, although it has not been possible to carry out an in-depth, contextualised analysis of the educational proposals in classrooms. This means that the proposals have been analysed, but not their implementation. Thus, losing relevant information on student satisfaction, the adult-child interaction that is generated in the classroom, and the scope of the proposal.

Another limitation, in line with the lack of contextualization of the didactic proposal and its integration into the didactic programming, is that a structural analysis of the OERs focused on CT was carried out without deepening the curricular content included in each proposal, because it lacked the previous and subsequent context.

Conclusions

The main findings of this research are that, in the 0-6 years stage, there is interest in developing CT skills, as evidenced by proposals in institutional repositories for OERs to work on these skills at this stage. The development of these skills cannot be considered uniform, as they focus especially on algorithmic thinking. The least included skills are automation and debugging. This may be because these are skills that teachers consider higher-level; however, their development will depend on the programming language and methodology selected in the proposals.

In addition, it has been found that the direct instruction methodology is the most prevalent in the proposals, which contradicts the scientific literature, which recommends a constructivist



approach to developing these skills. That is why we consider it relevant to incorporate, within the initial and ongoing teacher training, the resources and their integration, as well as the methodological approaches used.

Another relevant aspect that this research returned is the use of commercial or proprietary educational technologies that hinder accessible and equitable education in the classroom. Commercial robotics, in addition to their high economic cost, are presented as hermetic and non-customizable artefacts. Thinking about CT skills, using tools that students cannot know how they work, becomes a contradiction in student learning. This places the focus on educational administrations, specifically on their obligation to promote the use of open-source technology by teachers. This helps them achieve an overall educational goal, quality, and accessible education.

After reviewing the OERs in the institutional repositories, it was found that these resources shared by specialists or active teachers vary in structure and level of detail. This fact seems to indicate a lack of consensus on what should be included in the repositories from the OERs. In addition, the quality of these types of resources, open to families and the educational community, should be a priority for educational institutions since they are presented as models and examples to work on, in this case, CT skills. That is why we consider it relevant to develop clear criteria for evaluating the resources that repositories disseminate.

However, it is not enough to grant this active role; institutional repositories must offer quality resources that focus on sound methodological design and the selection of technologies based on pedagogical principles. All this shows the need for a greater number of high-quality OER to develop CT in Early Childhood Education, to foster the necessary skills to promote critical social presence and participation in a context of continuous change.

Suggestions for Future Research

After carrying out this research, it is especially relevant to analyse other institutional repositories from other countries to compare these proposals.

A future line of research may involve implementing the designs in real classroom contexts, adapting the content to the characteristics of each group. This can result in an analysis of the scope of the proposals and offer possible improvements.

In addition, it would be of interest to the scientific community to hold a focus group with the teachers who created these educational proposals to learn about their perceptions of the creation process, potential difficulties in integrating them into the classroom, and improvements or updates to their OERs.

As a continuation of this research, a similar analysis could be carried out at the primary education stage (6 to 12 years old) to examine how these CT skills are addressed at the national level across other educational stages and to conduct a comparative analysis.



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Conflict of Interest

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