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COMPUTATIONAL THINKING IN TEACHER DIGITAL COMPETENCE FRAMEWORKS

EL PENSAMIENTO COMPUTACIONAL EN LOS MARCOS DE COMPETENCIA DIGITAL DOCENTE

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ABSTRACT

Several western countries have introduced educational policies to keep up with needs and demands of the digital society. Digital competence frameworks, particularly for the teaching profession, may fit into this context, which also includes the development of computational thinking, a competency construct that many consider necessary for the empowerment of citizens. The analysis of the approach to computational thinking in these references provides information on competences that need to be contextualised in the framing of the concept, to ensure conditions for its integration in the educational environment. This analysis is the aim of this study, focusing on four frameworks guiding teacher education policies: Standards of ICT competence for teachers (UNESCO), Common Framework for Teaching Digital Competence (INTEF, Spain), European framework for the digital competence of educators: DigCompEdu (EU) and ISTE Standards for Educators: A Guide for Teachers and Other Professionals (ISTE, USA). Content analysis was used as methodology. Results show that there is no consensus on the definition of computational thinking, although the frameworks, implicitly or explicitly, recognize the importance of integrating computational thinking in teaching practice. However, there is no evidence of methodological guidelines for the operationalization of digital teaching skills that can ensure the promotion of computational thinking.

RESUMEN

Los países occidentales han introducido políticas educativas para seguir las exigencias de la sociedad digital. El desarrollo de marcos de referencia de competencia digital para la profesión docente, se integran en este contexto, valorando el desarrollo del pensamiento computacional, un constructo competencial, considerado como necesario para la capacitación de los ciudadanos. El análisis del enfoque del pensamiento computacional puede proporcionarnos información sobre una aproximación al encuadramiento del concepto, con el fin de asegurar las condiciones para su integración en el entorno educativo. Este análisis es el objetivo de este estudio, para el que hemos seleccionado cuatro marcos de competencia que pretenden orientar las políticas de formación del profesorado: Estándares de competencia TIC para profesores (UNESCO), Marco Común de Competencia Digital Docente (INTEF, Spain), Marco europeo para la competencia digital de los educadores: DigCompEdu (EU) and ISTE Estándares para educadores (ISTE, USA). Se utilizó como metodología un análisis de contenido. Los resultados muestran ausencia de consenso sobre la definición de pensamiento computacional, aunque los marcos, implícita o explícitamente, reconozcan la importancia de integrarlo en la práctica. Sin embargo, no hay evidencia de directrices metodológicas para la operacionalización de las competencias digitales docentes que puedan asegurar la promoción del pensamiento computacional.

KEYWORDS

Competence frameworks; Computational thinking; Problln solving; Guidelines; Teacher training; Digital competence.

PALABRAS CLAVE

Pensamiento computacional; Marcos de formación; Resolución de problemas; Directrices; Formación docente; Competencia digital.

1. INTRODUCCIÓN

The introduction of Computational Thinking (CT) in educational contexts constitutes a relevant topic in the discussion about the skills to be developed by young people during their schooling and has received considerable recognition from the scientific and educational community as a key competence (Almeida & Valente, 2019; Bers *et al.*, 2019; Brennan, 2021; Kafai, 2016; Kafai & Burke, 2017; Resnick & Rusk, 2020; Valente, 2019). In turn, the development of digital competence frameworks, guiding documents that seek to influence teacher education policies towards the development of competencies that meet the demands or needs of the digital society (Conselho da União Europeia, 2018, OECD, 2016; UNESCO, 2017), could be part of this context, in which there is also an appreciation of the development of computational thinking, a competency construct considered by many to be necessary for the empowerment of citizens. The analysis of the approach to computational thinking in these frameworks of reference (thereafter references) can provide information about the areas of teaching competence where it is necessary to contextualize an approach to the framing of the concept, to ensure conditions for its integration in the educational environment.

In this context, the present study sought to analyse the approaches to computational thinking in four digital competence frameworks: UNESCO (2018), JRC European Union (Redecker, 2017), ISTE United States (2021, 2017) and INTEF Spain (2017). The selection of these frameworks was carried out based on the relevance that their recommendations may have for teacher education and for the educational policy of the European Union member countries. The analysis aims to (i) to characterise the conceptions of computational thinking presented and (ii) to identify the operationalisation of computational thinking in terms of the development of digital teacher competences contained therein. Content analysis was the methodology used within an exploratory approach through an analytical and interpretative procedure (Barros & Lehfeld, 2012; Neuendorf, 2017; Staddon, 2018), supported by a data collection grid consisting of three categories: (1) areas of competence; (2) competence descriptors; (3) CT operationalisation in the development of digital competence.

Initial findings show that there is no consensus on a CT definition. Although the references recognise, implicitly or explicitly, the importance of its integration in teaching practice, not all of thIn show guidelines for the operationalisation of digital competences that can ensure CT promotion.

This text on the process of this study, begins with a section that presents some of the definitions of computational thinking in the literature, followed by the approaches to computational thinking in four digital competence frameworks and by the results of these approaches' analysis. In the discussion of the results, we try to reflect on some theoretical models of teacher education, as well as possible proposals for the operationalisation of computational thinking in the development of digital competencies. The results of the study seln relevant, as they can promote and enable reflection on the theoretical rationale and consistent integration of technologies in educational contexts, thus contributing for an initial and continuous training of teachers adequately responding to the current needs of education.

1.1. SOME DEFINITIONS OF COMPUTATIONAL THINKING IN THE LITERATURE

In the last decade, computational thinking is a considerable expanding topic. Among the many conceptual perspectives found in the literature, there is a convergence to relate computational thinking to the development of logical reasoning by applying computational skills of decomposition, abstraction, pattern recognition, and algorithmic thinking. The term computational thinking was first used by Seymour Papert in his book «Mindstorms: Children, Computers and Powerful Ideas», published in 1980. However, Papert had already introduced the ideas about computational thinking in the early 1970s in the article "Twenty things to do with a computer", written with Cynthia Solomon (Papert & Solomon, 1971). In that article, Papert and Solomon published their studies on the LOGO programming language and the educational potential of using the computer to "innovate" in the teaching and learning process versus using it to continue the same old practices

> *Machines from its engineering branches are changing our way of life. How strange, then, that «computers in education» should so often reduce to «using bright new gadgets to teach the same old stuff in thinly disguised versions of the same old way».* (Papert & Solomon, 1971, p.2)

In "Twenty things to do with a computer", the authors describe their experiences with 5th grade students and a set of activities developed in the construction of several geometric shapes, spirals and flowers, by programming with LOGO. The researchers already argued, at that time, that the programming language introduced the most general knowledge of computing to all people, regardless of their academic level, in addition to developing knowledge in other areas such as mathematics, physics, linguistics and music, demonstrating that programming a computer is possible for everyone and does not require the mastery of a computer language, nor the understanding of how a computer works, it is only necessary to know how to give a set of instructions that describe what is intended to be done.

In his works, Papert did not clearly define computational thinking. It was Jeannette Wing (2006), who presented computational thinking as a fundamental skill for everyone in the digital society, promoting the development of knowledge and skills for problln solving, for systln design, and for understanding human behaviour based on computer science principles. In addition to these skills, Wing presented as characteristics of computational thinking: (i) the conceptualizing of how to think at multiple levels of abstraction, since computational thinking is not exactly about programming; (ii) the complementarity and combination between mathematical and engineering thinking; (iii) the generation of solutions applicable to daily routines by relationships established in computational thinking. Based on the concept that it is cross-disciplinary, universal and useful for everyone, Wing advocated the integration of computational thinking in the educational context.

Since then, different researchers and educators have worked on this concept generating a substantial number of publications, often associating computational thinking with coding. Among the published works on computational thinking, Bers *et al.* (2019, p. 131), for example, present computational thinking as "a new literacy for the 21st century." According to these researchers, computational thinking involves a broader range of concepts for formulating and solving problems than those used by Computer Science. For Bers and his collaborators (Bers *et al.*, 2019), computational thinking enables an expressive process that promotes new ways of communicating ideas, where coding may be a powerful tool.

Riley and Hunt (2014) had already argued as "the best way to characterize computational thinking the way that computer scientists think, the manner in which they reason" (Riley & Hunt, 2014, p. 4). In this same perspective, Resnik and Rusk (2020) present the idea of coding as a promoter of the development of creative and meaningful computational thinking. In activities that involve project work and collaboration, coding becomes more motivating and meaningful for students, making thIn computational creators and thinkers, achieving greater computational fluency: "We use the phrase computational fluency to describe this ability to use computational technologies to communicate ideas effectively and creatively (Resnick & Rusk, p. 122). For these authors, coding should be seen as a means to promote the development of creative thinking, logical reasoning and collaborative work, fundamental skills in the digital society. In turn, Yasmin Kafai (2016) reiterates this conception by proposing that computational thinking in schools should be recreated and seen as computational participation. Computational participation is, for Kafai (2016), a new way of extending computational thinking and the use of programming in the service of learning. The author suggests that programming should go beyond the use of tools and codes, approaching a proposal of shared social practice, in learning communities, usually attended by children. Activities carried out in open environments that allow the creation, sharing and remixing of programs become educational contexts that empower innovation, learning and sharing of the knowledge built.

For Brennan (2021), the development of computational thinking occurs when we promote activities that involve a programming language, currently more accessible to children and young people. This occurs because of new tools, activities, platforms and communities available on the web, such as Scratch, Alice, Code.org, where children and young people develop self-directed programming projects that enable meaningful code learning through sharing and support among community members. In her research, Brennan highlights the strategies children use to solve programming problems and how they self-direct these strategies in a structured way to achieve their goals through coding, developing foundational skills in all areas of knowledge.

Despite this approach to a definition of computational thinking understanding it may not be adequate to assume that among researchers and educational experts there is a conceptual consensus about its potential in learning contexts. Valente (2019) agrees with this perception and complements it by stating that this fact contributes to increase the complexity of the topic when addressed in the educational area, especially when CT is integrated in teacher training. According to Almeida and Valente (2019), Kafai and Burke (2017), Kafai (2016) and Fraillon *et al.* (2019) even being recognized as a relevant topic for the development of the skills that young people should acquire throughout their schooling, in view of future scenarios regarding economic and social development, the introduction of CT in school is still a challenge.

According to Valente (2019, p. 153)

> *[…] the definitions and characteristics of computational thinking are shaped and limited by digitally aided problIn solving. Thus, other dimensions are needed to be explored, especially studies on personal, environmental, social, affective, psychological, and ethical factors that need to be investigated.*

In this context, when looking to initiatives for the introduction of CT in education, in addition to documents and reference guidelines, there is an urgent need for a stronger formative solidity in the development of teachers' digital competence.

2. DESIGN AND METHOD

Considering the contextual and theoretical justification that supports this study, the object of the research is built around the approach to computational thinking in the digital teacher competency frameworks. This analysis is confronted with the aim to (i) to characterise the conceptions of computational thinking presented in four frameworks that seek to guide teacher education policies: UNESCO (UNESCO, 2018), JRC European Union (Redecker, 2017), ISTE United States of America (ISTE, 2021, 2017) and INTEF Spain (INTEF, 2017) and (ii) to identify the operationalisation of computational thinking in terms of the development of digital teacher competences contained therein, being a descriptive interpretive process, which does not resort to the modification of variables. The selection of these frameworks was made based on the relevance that their recommendations may have on teacher education and educational policy in European Union member countries.

Content analysis was the methodology used within an exploratory approach through an analytical and interpretative procedure (Barros & Lehfeld, 2012; Neuendorf, 2017; Staddon, 2018). The relevance of the study lies in the context that this analysis can provide information about the areas of teaching competence where it is necessary to contextualise an approach to the framework of the CT concept, to ensure conditions for its integration into the educational environment.

3. FIELDWORK AND DATA ANALYSIS

This study was structured based on a literature review of the conceptualisation of computational thinking, as part of the theoretical framework of the study, which was used as a basis for the analysis of each of the frameworks and their respective areas that present the competences for the development of CT. In this way, once the frameworks of digital competence to be studied were selected, a categorised grid was designed for data collection and subsequent analysis, organised into three categories: (i) area of competence; (ii) competence descriptors; (iii) operationalisation of CT in the development of digital competence. The descriptive interpretative content analysis of the approaches to computational thinking in the four selected digital competence benchmarks follows below.

3.1. COMPUTATIONAL THINKING IN THE UNESCO ICT COMPETENCY FRAMEWORK FOR TEACHERS

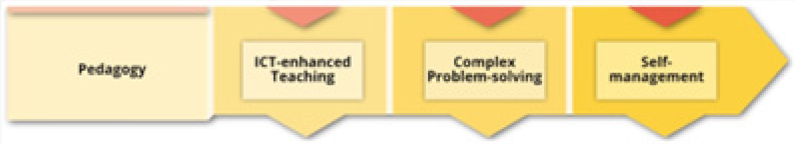
The "ICT Competency Framework for Teachers" consists of 18 competencies organized around six areas of professional teaching practice, distributed over three levels of pedagogical use of ICT: (1) Knowledge acquisition; (2) Knowledge deepening; (3) Knowledge creation.

The underlying idea of this document is «that teachers who have competencies to use ICT in their professional practice will deliver quality education and ultimately be able to effectively guide the development of students’ ICT competencies» (UNESCO, 2018, p. 8).

The six areas of teachers' professional practice are: (i) Understanding the role of ICT in educational policies; (ii) Curriculum and assessment; (iii) Pedagogy; (iv) Applying digital skills; (v) Organization and administration; (vi) Teacher professional development.

The competence related to computational thinking development is found in area (iii), Pedagogy - Complex Problln Solving - within levels (2) Knowledge Deepening and (3) Knowledge Creation (Figure 1).

Figure 1. Objectives of the "Pedagogy" area according to the levels of knowledge



Source: UNESCO ICT Competency Framework for Teachers (UNESCO, 2018, p. 10).

At level (2) Knowledge Deepening, the framework brings as objectives «to increase the ability of teachers to support students of different abilities, ages, genders, and socio-cultural and linguistic backgrounds, to apply knowledge to solve complex, high-priority problems encountered in real-world situations of work, society and everyday life» (UNESCO, 2018, p. 22).

At level (3) Knowledge Creation, the framework recommends that teachers should have the competence to «to explicitly include Knowledge Society skills needed to create new knowledge, namely skills for: problem-solving, communication, collaboration, experimentation, critical thinking and creative expression» (UNESCO, 2018, p. 23).

Innovation with ICT, potentialities and challenges, are principles that govern the guidelines of this referential. Although described in brief references, and not in competence standards, the document presents innovations that must be present in school programs, such as (1) Open Educational Resources (OER); (2) Social networks; (3) Mobile technologies; (4) The Internet of Things; (5) Artificial Intelligence (AI); (6) Virtual Reality (VR) and Augmented Reality (AR); (7) Big Data; (8) Coding; (9) Ethics and privacy protection.

Regarding coding, or programming, as it is also designated, the document discusses the concept of computational thinking as "algorithmic thinking" and the growing expansion of its use in schools: «Algorithmic thinking – also called computational thinking – underlies computer science, and there has been a growing movement on algorithmic thinking in schools» (UNESCO, 2018, p. 18).

This framework presents a repository of open educational resources created by UNESCO and indexed according to the competences and objectives of the "ICT Competency Framework for Teachers", with a dedicated hub that allows searching and identifying resources that can help educators achieve specific objectives of the Competency Framework (c.f. https://www.oercommons.org). The framework also suggests project-based learning as a proposed methodological approach for developing problem-solving skills.

3.2. COMPUTATIONAL THINKING AND THE JRC'S DIGCOMPEDU FRAMEWORK

The European Digital Competence Framework for Educators (Redecker, 2017), known by the acronym DigCompEdu, is the result of research conducted by the European Commission's Joint Research Centre (JRC) on Learning and Skills for the Digital Era. DigCompEdu proposes a model for the assessment and development of pedagogical digital competences, providing a common basis of these competences to the countries of the European Union, with the aim of reflecting on the development, comparison, and discussion of different tools for the development of the educators' digital competence. It presents a set of competences distributed in three categories (i) Educators' professional competences; (ii) Educators' pedagogical competences and (iii) Learners' competences, composed by six areas: Area 1 - Professional Involvement; Area 2 - Digital Resources; Area 3 - Teaching and Learning; Area 4 - Assessment; Area 5 - Empowering Learners; Area 6 - Facilitating Learners' Digital Competence. In the different areas, digital competence is expressed in a total of 22 specific competences to empower educators to use the potential of digital technologies to improve and innovate education (Redecker, 2017, p. 8).

The competence related to the development of computational thinking was identified in area 6, competence 6.5 - Problln solving (Figure 2).

Figure 2. Area 6 DigCompEdu

Source: European Framework for the Digital Competence of Educators: DigCompEdu (Redecker, 2017, p. 16)

Area 6 details the specific pedagogical competences required to promote learners' digital competence. It is a prominent area in DigCompEdu which considers digital competence to be "one of the transversal competences educators need to instill in learners." and recognizes that "the ability to facilitate learners' digital competence is an integral part of educators' digital competence" (Redecker, 2017, p. 23).

As competencies to promote problln solving, the document states that the teacher should be able:

> *to incorporate learning activities, assignments and assessments which require learners to articulate information needs; to find information and resources in digital environments; to organize, process, analyse and interpret information; and to compare and critically evaluate the credibility and reliability of information and its sources* (Redecker, 2017, p. 23).

The framework also proposes that the competent teacher promotes tasks that encourage and require the learner "to identify, evaluate, select and use digital technologies and possible technological responses to solve a given task or problem" (Redecker, 2017, p. 86).

3.3. COMPUTATIONAL THINKING ACCORDING TO THE INTERNATIONAL SOCIETY FOR TECHNOLOGY IN EDUCATION (ISTE)

The ISTE Standards for Educators, produced by the International Society for Technology in Education (ISTE, 2021), was created to address the need to create standards for digital competencies to "guide educator practice, school improvement planning, professional growth and advances in curriculum" (ISTE, 2021, p. 2). This guide has undergone several reformulations over the years, keeping pace with the evolution of learning. The latest version dates from 2021, bringing together all the competency standards in a single document, spread over four sections: Learners, Educators, Educational Leaders and Trainers, followed by a section dedicated to computational thinking, called "Computational thinking competencies for educators". The aim of this section is to set standards to help teachers develop skills to integrate computational thinking in all subjects and with students of all ages.

The framework points to the need to prepare students «for success in a future where computing power underpins every aspect of the systems we encounter in our daily lives" (ISTE, 2021, p. 11), ensuring that every student is able to understand and harness the power of computing to enhance their performance in personal, academic and professional activities.

ISTE defines computational thinking as a problem-solving process that includes, but is not limited to, the following characteristics: (i) formulating problems in ways that enable the use of a computer and other tools to solve them; (ii) organising and logically analysing data; (iii) representing data through abstractions such as models and simulations; (iv) automating solutions through algorithmic thinking (a series of ordered steps); (v) identifying, analysing and implementing possible solutions with the aim of achieving the most efficient and effective combination of steps and resources; and (vi) generalising and transferring this problem-solving process to a wide variety of problems.

The framework emphasises that these competencies are supported and reinforced by skills and attitudes essential to the computational thinking, such as resilience and perseverance in problln solving, tolerance for ambiguity and the ability to deal with open-ended problems, as well as recognition of error as an opportunity to learn to innovate.

ISTE is quite detailed about the indicators of computational thinking skills, describing the competencies for developing computational thinking in five of the seven ISTE parameters for Educators: (i) Learner; (ii) Leader; (iii) Collaborator; (iv) Designer and (v) Facilitator (Figure 3).

Figure 3. Educator competence standards

Source: Own preparation with Affinity Designer 1.10.5 from ISTE- Standards International Society for Technology in Education (ISTE, 2021, p. 5)

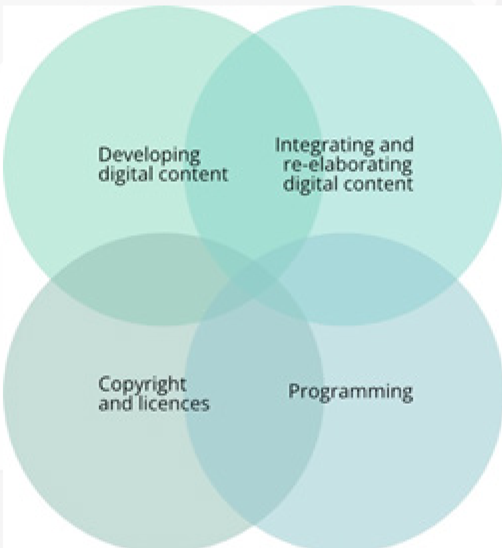
3.4. COMPUTATIONAL THINKING IN THE COMMON DIGITAL COMPETENCE FRAMEWORK FOR TEACHERS BY INTEF

Common Digital Competence Framework For Teachers created by the Instituto Nacional de Tecnologías Educativas y Formación del Profesorado (INTEF), emerges from the context of the need to prepare educational programmes to develop the knowledge and skills that will enable 21st century citizens to live in today's digital society.

The document is divided into five interrelated competence areas: Area 1. Information and data literacy; Area 2. Communication and Collaboration; Area 3. Digital content creation; Area 4. Safety; Area 5. Problln Solving.

Computational thinking is present in two of the areas of this framework. The Area 3. Digital content creation, sub-area Programming (Figure 4), requires teachers "to make modifications to software, applications, settings, programs, devices, understand the principles of programming, and understand what lies behind a program" (INTEF, 2017, p. 45).

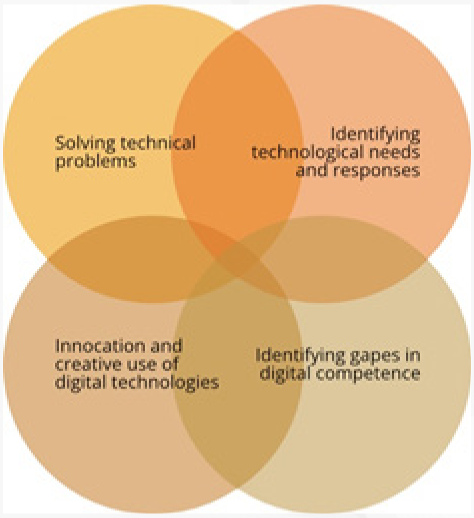
Figure 4. Digital Content Creation Area



Source: Own preparation with Affinity Designer 1.10.5 from Common Digital Competence Framework For Teachers (INTEF, 2017, p. 37)

Area 5. Problln Solving, subareas (i) Solving technical problems, (ii) Identifying technological needs and responses (iii) Innovation and creative use of digital technologies (Figure 5), approaches the teaching capacity to «identify needs in the use of digital resources, make informed decisions about the most appropriate digital tool depending on the purpose or need, solve conceptual problems through digital media or digital tools, use technology creatively, solve technical problems, and upgrade my competence and of others.» (INTEF, 2017, p. 57).

Figure 5. Area 5 Problln Solving



Source: Own preparation with Affinity Designer 1.10.5 from Common Digital Competence Framework For Teachers (INTEF, 2017, p. 57)

Common Digital Competence Framework For Teachers does not present actions for the development of teachers' computational thinking. However, it is the framework that provides the largest number of indicators for teachers to identify, recognise and assess whether they have the necessary skills for this competence.

For area 3 - Digital content creation - Programming, it presents 24 descriptors of competences, and for area 5 - Problln Solving, it presents a total of 60, being 18 dedicated to the Resolution of technical problems, 18 to the Identification of needs and technological answers and 24 to the Innovation and use of digital technology in a creative way.

4. RESULTS

In the analysis of the reference frameworks, and in relation to the conceptions of computational thinking, it was possible to verify some differences in the competences expected from teachers (Table 1).

Table 1. Frameworks, areas and competences related to computational thinking

Frameworks	Area(S)	Competence/ subarea
DigCompEdu (JRC)	(6) Facilitating Learners' Digital Competence	6.5 – Problem solving
Common Digital Competence Framework for Teachers (INTEF)	(3) Digital content creation (5) Problem Solving	3.4 – Programming 5.1. Solving technical problems 5.2. Identifying technological needs and responses 5.3. Innovation and creative use of digital technologies
ICT (UNESCO)	(3) Pedagogy	Level 2 – Knowledge Deepening: Complex Problem Solving. Level 3 - Knowledge Creation: problem solving, communication, collaboration, experimentation, critical thinking and creative expression.
ISTE (EUA)	(1) Learner (2) Leader (3) Collaborator (4) Designer (5) Facilitator	1. 1.Create learning opportunities that challenge students to use a computational design and thinking process to innovate. 2. Promote an inclusive and diverse classroom culture that incorporates and values unique perspectives, builds student self-efficacy and confidence around computing. 3. Recognise that design and creativity can stimulate the Growth Mindset; work on creating meaningful Computer Science learning experiences. 4. Work on planning activities and environments that encourage collaboration and learning outcomes. 5. Integrate computational thinking into classroom practices.

Source: Own preparation

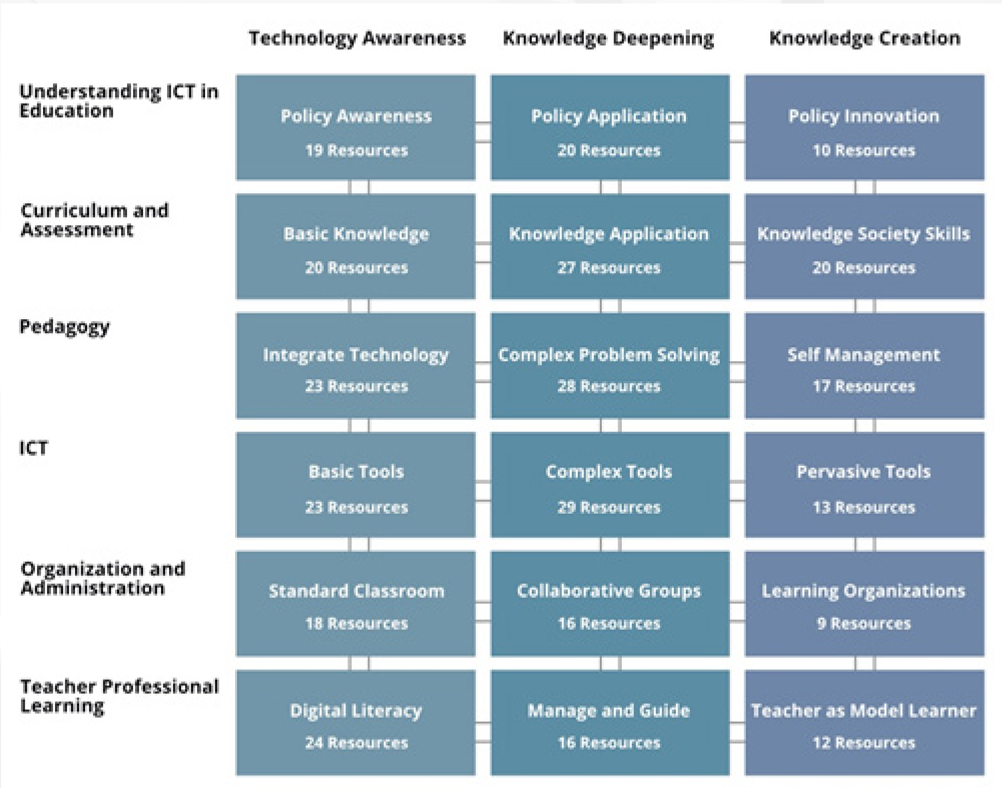
It was verified that DigCompEdu presents descriptors in the area of problIn solving that can be associated with computational thinking, although these descriptors address the students' competences.

Regarding the guidelines for planning activities, it was found that the UNESCO and ISTE standards present some cases and resources for the development of computational thinking: Open CFT Resources on OER Commons (UNESCO, 2018, p. 59) and Getting Started with the Educator Standards (ISTE, 2017, pp. 26–40), respectively, while the European Union and Spanish frameworks do not present any proposals in this area.

Although the Common Digital Competence Framework for Teachers does not present resources or guiding activities for the development of teachers' computational thinking, it is the framework that brings more competence indicators regarding the necessary skills for teachers to identify, recognise and assess whether they have the necessary digital competence to develop this type of thinking. This framework separates programming from computational thinking, although these concepts are closely associated. On the other hand, DigCompEdu does not present any guidance.

In turn, the ICT Competency Framework for Teachers has created a repository of open educational resources indexed according to the competencies and objectives of the framework. The hub dedicated to the framework has a tool that allows searching and identifying resources that can help educators achieve certain specific objectives (Figure 6).

Figure 6. Interactive search matrix on the UNESCO ICT CFT Hub on OER Commons



Source: UNESCO ICT Competency Framework for Teachers (UNESCO, 2018, p. 59)

The resources provided in this framework are openly licensed under Creative Commons conditions, allowing everyone to use and adapt the available units as they see fit.

The ISTE Standards for Educators: A guide for teachers and other professionals (ISTE, 2017) presents in "Part Two - Prepare", a series of reflective and guiding questions for each of the Educator Standards and their indicators, aimed at helping the educator to "consider your current practice and start deepening it through implementation of the specific competencies within the standards" (ISTE, 2017, p. 27). In addition to these guidelines, the document suggests, in "Part Three - Adopt and Implement", to study the profiles of other teachers and provides clues to assist in the adoption and implementation of the ISTE Standards from the experience of teachers, coaching actions and the involvement of administrators, media specialists and librarians, and others.

Regarding the operationalisation of the development of computational thinking in terms of digital teacher competences, of the frameworks studied, only UNESCO's presents examples of teacher training programmes in educational ICT developed in different regions, through national initiatives under the responsibility of Ministries of Education and by corporate initiatives, which serve as references for other countries and public policies that intend to develop training actions in ICT skills for teachers. These examples describe cases of some courses and the design of a curriculum for teacher training, and it is not possible to assess how the development of computational thinking could be contemplated in these experiences.

5. DISCUSSION AND CONCLUSIONS

The present study sought to analyse the approaches to computational thinking in the latest known four digital competence frameworks applied to teacher education; those from UNESCO (2018), JRC European Union (Redecker, 2017), ISTE United States (2021, 2017), and INTEF Spain (2017). The analysis aimed to (i) characterise the conceptions of computational thinking presented and (ii) identify the operationalisation of the development of computational thinking in terms of the development of teacher digital skills.

A review on the conceptualisation of computational thinking suggests there is no consensus on a definition and shows frequent changes and reformulations in the efforts in its definition and characterization whereas this might seln uncomfortable, this reminds of the dynamic nature of science and, possibly, is an interesting challenge to deal with. However, in the studied frameworks, there seems to be a certain convergence in defining it, in general, as the ability to organise mental schemes for problln formulation and resolution; all four documents present problln solving as promoting competences for the development of computational thinking.

Undoubtedly, computational thinking seems to be a topic in evidence in the current educational context and, consequently, in continuous teacher education, field where it looks increasingly present a trend towards presenting competency standards that provide indicators to help teachers assess their computational aptitude, evaluate their current practice and deepen it through the development of computational thinking. And, although much of the literature presents studies and research that point to coding, or programming, as a strategy for developing computational thinking, only the INTEF framework addressed programming as an area of competence.

In general terms, it looks clear that this is a subject in development, with converging and divergent perspectives and conceptualisations, but the movement seems to be towards incorporating computational thinking independently of computer programming and computer science, and transversally across all training and learning in the digital environment. Regrettably, the absence of models for operationalising computational thinking in the development of teacher digital competence is something somehow surprising, since it would be important that, in the future, this kind of documents/frameworks were accompanied by a guide for the implementation of the competences they consider fundamental, in an educational context. It could make these documents more complete, going beyond their diagnostic and competence identification purposes.

Recognising the importance of integrating computational thinking into teaching practice, without, however, providing guidelines for the operationalisation of teaching digital competences that can ensure the promotion of computational thinking may suggest that teacher education implementation of ICT/digital frameworks, such as, for example, TPeCS (Kali *et al.*, 2019) and teacher education policies, when defining teacher profiling and teacher qualification guidelines and programmes, need to thoroughly and consistently address issues raised in this reflective analytical essay.

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