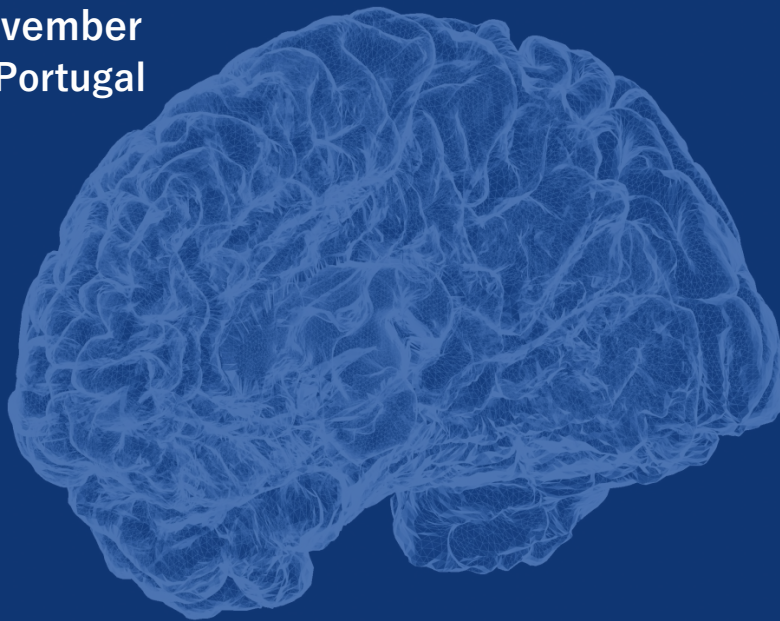


CELDA 2025

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on Cognition and Exploratory Learning in Digital Age

1-3 November
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PROCEEDINGS

Edited by

Demetrios G. Sampson
Dirk Ifenthaler
Pedro Isaías



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**22nd INTERNATIONAL CONFERENCE
on**

**COGNITION
AND EXPLORATORY
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(CELDA 2025)**

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COMPUTATIONAL THINKING IN MATHEMATICS EDUCATION: BETWEEN CURRICULAR EXPECTATIONS AND TEACHING PRACTICES

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ABSTRACT

This paper examines the gap between curricular expectations for the integration of Computational Thinking (CT) and its implementation in mathematics education. Through a reflective analysis that intersects literature with classroom experience, we argue that teachers' fragmented understanding stems not merely from training deficits but from deeper tensions between pedagogical innovation and systemic constraints. We contend that traditional mathematical competencies already implicitly incorporate core elements of CT. Instead of introducing CT as external knowledge, we propose a reconceptualization of teacher education to value existing mathematical practices as a foundation for CT development, thereby avoiding curricular overload and fostering an organic integration that empowers teachers to recognize the CT already present in their classrooms.

KEYWORDS

Computational Thinking, Mathematics Education, Teacher Training, Problem Solving, Reflective Practice

1. INTRODUCTION

Mathematics education faces a contemporary paradox. Computational Thinking (CT), defined by Wing (2006) as decomposition, pattern recognition, abstraction, and algorithm design, shares deep conceptual affinities with mathematical reasoning (Grover & Pea, 2013). Decomposing problems, identifying regularities, abstracting, and constructing algorithms are intrinsic to mathematical work. Yet, despite this proximity, many teachers feel insufficiently prepared to explicitly integrate CT into their practices (Kong & Abelson, 2019; Ye et al., 2023), revealing a tension between the potential for innovation and classroom reality. This contradiction transcends mere technical training issues. As Brennan and Resnick (2012) warned, theoretical compatibility does not guarantee effective pedagogical translation. The challenge involves school culture, curricular policies, and professional identity. Weintrop et al. (2016) identified practices at the mathematics-computing intersection that are already part of teachers' repertoires. However, these practices are seldom recognized as contributions to CT, remaining pedagogically invisible, which fosters the belief that CT is foreign knowledge demanding an additional workload.

2. MATHEMATICS TEACHING AND THE IMPLICIT PRESENCE OF CT

The supposed simplified views of CT held by teachers (Zahid, 2025) deserve an empathetic analysis. Rather than knowledge gaps, this may represent a pragmatic adaptation to educational ecosystems marked by dense curricula and assessment cultures focused on standardized outcomes. Traditional pedagogical practices already tacitly incorporate the pillars of CT. Vygotsky's (1978) seminal work on higher cognitive skills emerging through contextualized social interaction resonates with Papert's (1980) later ideas on the connections between mathematics and programming.

Explicit CT integration faces structural barriers. The pressure to cover extensive curricula and prepare students for exams that historically favor calculation over open-ended problem-solving is a documented constraint (Fullan, 2007; Darling-Hammond, 2010). This tension extends globally. While countries like Finland and Estonia have achieved remarkable cross-curricular integration, many educational systems struggle between innovative discourse and traditional assessment metrics, which rarely value algorithmic efficiency (Bocconi et al., 2016). International approaches vary, with Denmark emphasizing data and programming and Sweden focusing on instructions and commands (Elicer et al., 2023), highlighting the tension between the depth of CT and the pressures of testing.

3. FROM IMPLICIT TO INTENTIONAL PRACTICE: A CONCRETE EXPERIENCE

Effective CT integration emerges when teachers recognize existing practices. Consider a lesson on first-degree equations. When faced with a problem like $3x + 5 = 14$, a student, unknowingly, is delving into CT. First, they decompose the problem: 'I need to isolate x.' This decomposition leads to a sequence of steps. The student recognizes a pattern: in similar problems, operations are inverted to maintain equivalence. This abstraction allows them to create a mental algorithm: 1. Subtract the constant term (5) from both sides. 2. Divide by the coefficient of x (3). This procedure is not just a calculation; it is the design of a systematic and efficient solution. The pedagogical bridge occurs when the teacher intervenes, not to teach a new topic, but to name what has already been done: 'The sequence of steps you created is an algorithm. You are thinking like a computer scientist.' This linguistic bridge transforms a mathematical routine into an explicit CT competency, reinforcing both student and teacher self-efficacy without adding new content.

This approach, which values practical knowledge, is more powerful than the mere introduction of technology. Tools like GeoGebra or Scratch have potential but are often used to mechanize procedures rather than to explore modeling (Ertmer & Ottenbreit-Leftwich, 2010). CT transcends the digital. Euclid's algorithm or the Fibonacci sequence are historical examples of "unplugged" algorithmic reasoning (Bell et al., 2009).

To help teachers access this knowledge, professional development should focus on three concrete strategies: **1. Recognition Activities:** Teachers analyze their own lessons to identify where they already promote the pillars of CT; **2. Linguistic Bridges:** Developing a common vocabulary to legitimize existing skills, explicitly calling procedures "algorithms" or problem-solving divisions "decomposition."; **3. Collaborative Communities:** Creating spaces to share examples and design organic integrations, as demonstrated by Gadanidis et al. (2017).

This aligns with constructivist theories (Piaget, 1977) and the complexities of TPACK (Koehler & Mishra, 2009), suggesting that sustained change occurs through the evolution of practice, not its replacement (Guskey, 2002).

4. CONCLUSION

CT represents a unique opportunity to renew mathematics education, but its successful integration requires a paradigm shift. Instead of an external imposition on overloaded curricula, CT must be recognized as intrinsic to mathematical thinking itself. Our reflection, supported by literature and an analysis of practice, concludes that the primary challenge is to create the conditions for teachers to recognize, name, and enhance the multiple ways they already practice CT.

This evolutionary approach values teachers as experienced professionals (Hargreaves & Fullan, 2012) and builds upon the foundations of mathematics education. Bridging the gap between curricular expectations and classroom reality requires valuing knowledge derived from practice (Cochran-Smith & Lytle, 2009).

Ultimately, recognizing that mathematics teachers are already CT practitioners creates the conditions for authentic and sustained change.

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