# Contemporary Issues and Challenges in Computer Science Education

In recent years, as computer science (CS) has increasingly become part of compulsory education curricula worldwide, computer science education research (CER) has shifted its focus towards nuanced investigations of how, by whom and under what conditions CS – also referred to as informatics in many educational contexts – and computational thinking (CT) are meaningfully taught and learned (Fincher & Robins, 2019). Recent studies emphasise that the successful integration of CS in education depends not only on curricular reform but also, and crucially, on teachers' conceptual understanding, pedagogical beliefs and assessment practices, as well as on the cultural contexts in which learning takes place (Denning & Tedre, 2021; Yadav et al., 2017).

Drawing on earlier work in computational and constructionist approaches to learning, particularly Papert's constructionist tradition, CT was articulated and brought into broader educational discourse by Wing (2006) as a fundamental competence for everyone, initially being framed primarily in terms of general problem-solving skills. In contemporary CER, however, CT is increasingly conceptualised as a discipline-sensitive, context-dependent competence that emerges through engagement with the specific practices, representations and epistemic norms of computer science (Denning & Tedre, 2021; Weintrop et al., 2016). From this perspective, CT cannot be reduced to a checklist of isolated skills such as abstraction, decomposition, algorithmic thinking or pattern recognition, but is better understood as a constellation of interrelated practices that are enacted differently across learning contexts. Brennan and Resnick's (2012) influential framework captures this shift by distinguishing between computational concepts, computational practices and computational perspectives, while placing particular emphasis on practices as central to understanding how learners think, act and reflect computationally. Importantly, these practices take different forms depending on whether CT is developed through block-based or text-based programming, unplugged activities, game-based learning or cross-curricular integration, each offering distinct pedagogical affordances for the development of computational fluency and understanding.

Against this background, the call for papers for this focus issue emphasised several interrelated challenges: (i) the preparation and professional identity of CS teachers, (ii) pedagogical approaches to teaching CS and CT, (iii) assessment of CT, (iv) learning resources and alternative learning environments, and (v) early and cross-curricular CS education. The contributions in this issue address these themes explicitly, while collectively reflecting current directions and open questions in CER.

A first thematic cluster concerns teacher education, motivation and professional readiness, a topic identified in CER as a critical bottleneck for the sustainability of CS education reforms (Yadav et al., 2017).

Václav Dobiáš, Václav Šimandl and Martin Kouřimský analyse the decision-making processes of pre-service CS teachers in the first paper of the focus section of this issue, entitled *The Factors Influencing the Process of Deciding Whether to Become a Computer Science Teacher*, shedding light on how external labour-market factors intersect with intrinsic motivations and beliefs about teaching. Their findings resonate with the international CER literature showing that CS teacher recruitment and retention are shaped by tensions between disciplinary identity and pedagogical commitment.

Teacher preparation is further addressed by Alenka Žerovnik in her paper *Developing Digital Literacy in Pre-Service Primary School Teachers Through a Massive Open Online Course and Project-Based Learning*. The author investigates the development of digital literacy through a combination of a massive open online course and project-based learning. This contribution responds to the call for papers' focus on teacher training and learning resources, demonstrating how integrated pedagogical approaches can effectively support the development of digital competences in pre-service teachers.

A second cluster of articles engages with teachers' attitudes, competencies and assessment practices in primary education, reflecting the growing CER interest in early CS education.

In the third paper of this section, entitled *Primary Programming: Teachers' Attitudes and Skills in the Light of Computing Reform*, Jiří Vaníček and Jan Pršala examine primary teachers' attitudes towards programming in the context of curricular reform, confirming earlier research that positive attitudes alone are insufficient without sustained professional support and experience.

Complementing this perspective in the paper entitled *Assessing Computational Thinking Practices and Engagement: Primary Teachers' Reflections on an Unplugged Activity*, authors Jakob Škrobar, Andrej Flogie, Alenka Lipovec and Nika Golob focus on how teachers observe and assess CT practices during an unplugged activity based on Bebras Challenge tasks. Their process-oriented approach aligns with recent CER calls for assessment models that capture how learners think, not merely what they produce, while drawing on the well-established Bebras framework for concept-based learning of informatics and CT (Dagienė & Stupurienė, 2016).

A third thematic cluster addresses the development of CT across diverse learning contexts, reflecting CER's growing recognition that CT emerges through varied forms of engagement. In the fifth focus paper of this issue,

entitled *Video Games and the Development of Computational Thinking*, Mária Čujdíková and Ivan Kalaš analysecommercial video games as informal environments for the development of CT-related cognitive processes, reinforcing CER findings that game-based contexts can foster algorithmic thinking, abstraction and evaluation when accompanied by reflection and dialogue.

Focusing on pedagogical approaches to programming education, Matej Zapušek and Irena Nančovska Šerbec examine programming patterns as a pedagogical tool for developing conceptual programming knowledge in future CS teachers, in their submission entitled *Developing Conceptual Programming Knowledge in Pre-Service Computer Science Teachers: The Role of Programming Patterns*. Their study contributes to ongoing CER debates about what constitutes robust programming knowledge for teaching, particularly the relationship between code implementation, conceptual understanding and pedagogical competence.

The focus section concludes with a study by Stavroula Prantsoudi, Georgios Fesakis and Hüseyin Özçınar on culturally responsive, unplugged integration of CT in language, literature and arts lessons, which the authors explore in their paper entitled *Culturally Responsive Unplugged Integration of Computational Thinking Skills in Language/Literature and Arts Lessons: A Case Study in Greece*. This contribution directly addresses the call for papers' emphasis on cross-curricular learning and responds to recent CER arguments that CT should be embedded in culturally meaningful practices rather than treated as a context-free skill set (Weintrop et al., 2016).

The varia section brings together contributions that address broader educational questions beyond the field of CER.

In her paper *The Importance of the School Magazine as an Extra-Curricular Activity in Facilitating Students' Cross-Curricular Skills and Competences*, the author Melita Lemut Bajec examines the role of the school magazine as an extracurricular activity that supports the development of students' cross-curricular skills, including literacy, collaboration and critical engagement with social issues.

Complementing this perspective, José Carlos Bronze, Carlinda Leite and Angélica Monteiro provide a critical review of Erasmus+ mobility research in their paper *Emancipation or Instrumentalisation in Erasmus+ Mobility: A Literature Review*, highlighting tensions between emancipatory and instrumental approaches to internationalisation in education.

In the third paper of the varia section, entitled *Environmental Content as a Part of Science-Oriented Sustainable Development Goals in Grades 6 and 7 of Slovenian Primary School: An Analysis of Science Textbooks*, the authors Matej

Vošnjak, Neva Rebolj and Iztok Devetak contribute an analysis of environmental content in Slovenian science textbooks, examining the extent to which sustainability-oriented learning goals are reflected in curricular materials.

In the next varia paper, *Perceptions of the Teaching Profession and Motivation to Teach Among Slovenian University Students*, authors Melita Puklek Levpušček and Katja Depolli Steiner explore Slovenian university students' perceptions of the teaching profession and their motivation to teach, offering insights into factors shaping career choices in education and raising questions relevant to ongoing teacher shortages in many education systems.

A second varia strand foregrounds artistic expression, creativity and embodied learning in education.

In their paper *The Frequency of Music Improvisation Activities in the Fourth and Fifth Grade of Primary School*, Alja Krevel and Jerneja Žnidaršič investigate the frequency and forms of music improvisation activities in primary school music education, documenting current classroom practices and identifying constraints related to time, teacher confidence and curricular frameworks.

The issue concludes with a review by Alenka Žerovnik of the book entitled *Teaching with AI: A Practical Guide to a New Era of Human Learning* by Bowen and Watson (2024), which critically examines the pedagogical, ethical and practical implications of integrating artificial intelligence into educational practice.

Together, these contributions underscore the importance of creativity, reflection and human-centred approaches in contemporary education, even as digital and AI-based technologies increasingly shape learning environments.

The articles in this focus issue illustrate how contemporary CER is increasingly characterised by methodological diversity, attention to educational context and a shift from purely technical concerns towards pedagogical, cultural and epistemic questions. They collectively underscore the fact that advancing CER requires not only curricular change but also theoretically grounded teacher education, robust assessment practices and learning designs that acknowledge the embodied, social and cultural dimensions of CT. As generative AI increasingly transforms what and how we teach and learn (Prather et al., 2023), these foundational commitments become ever more critical.

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