

THE POWER OF COMPUTATIONAL THINKING IN MATHEMATICS AND DATA SCIENCE EDUCATION

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With the increasing emphasis on computational thinking (CT) as a critical skill in K–12 teaching and learning (Committee on STEM Education, 2018), the mathematics education community has an exciting opportunity to broaden its conceptualization of mathematics as a school subject. Although there are various definitions of CT in the existing literature, we refer to Wing’s (2006) article that elaborated on what CT is and sparked the conversation on the importance of integration of CT in different subject areas. She defined CT as “the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be efficiently carried out by an information-processing agent.” (Wing, 2011, p. 1). CT and mathematics are naturally and historically connected (Gadanidis, 2017) because both emphasize pattern seeking and generalization in quantitative and symbolic relationships. Integrating CT and mathematics encourages students to reason using abstraction, decomposition, pattern recognition, and algorithms and to better comprehend and contextualize mathematical concepts and skills. We also see a natural connection to the emerging ideas for K–12 instruction in Data Science, an inherently integrated field.

As CT continues to attract more attention in K–12 STEM education (Román-González et al., 2017; Yadav et al., 2018), there is an increasing number of studies exploring the synergies between computing and mathematics. These studies (e.g., Brating & Kilham, 2021; Hickmott et al., 2021; Rundel & Rundel, 2017) suggest that integration of computation in mathematics and data science (DS) has the potential to foster deep understanding of ideas such as functions, variables, modeling, and data manipulation. But only a few recent studies make explicit connections between mathematical thinking (MT) and CT. Hickmott et al. (2018) reviewed 393 studies and found that the main reason numerous projects only incidentally draw a connection between MT and CT is lack of expertise in mathematics education. Furthermore, Horton & Hardin (2021) described the need for more research on the convergence of mathematics skills and computation within the context of DS. Thus, building upon the emergent interest within the PME-NA community on integration of CT in mathematics learning (e.g., Alegre et al., 2022; Brady et al., 2021; Galanti, 2022; Kocabas et al., 2021) and its examination in a culturally relevant context (Alegre et al., 2022), this new working group will advance conversations about synergies between CT in mathematics and DS education with aims to launch new collaborations.

Session Plans and Focus

Session 1 – Synergies Between CT, MT and DS

As we honor diverse experiences of the working group’s participants across CT, mathematics, and DS education contexts, we will start with a short CT activity to launch a

conversation about conceptual overlaps between CT, MT, and DS in our problem-solving approaches. Building upon our shared language and perspectives, we will collaboratively critique an existing framework for CT-MT Integration (Sneider et al., 2014). Then, small groups will create their own representations that show synergies between MT, CT, and DS using Google Jamboard. Small groups will share their representations, and we will discuss each representation. The following questions will prompt the analysis of these representations: “What are common and different aspects across all representations?,” “Why do we need to explore the synergies between CT, MT, and DS?,” and “What are the implications of these synergies for student learning?”

Session 2 – CT Integration in K–12 Settings, Equity, and Access

Envisioning the use of CT in mathematics and DS education presents a variety of challenges. Many teachers do not have the knowledge, skills, and materials needed to successfully implement CT in their practice (Yadav et al., 2016), and the lack of access to resources to encourage CT integration is particularly pervasive for historically underserved populations (Gilbert et al., 2008). There is a pressing need for research-based pedagogical strategies to foster rigorous and inclusive practices in the CT integrated classrooms (Ni et al., 2021). This session will start with two presentations on equity and access in CS integration in K–12 STEM classes and efforts to support in-service and pre-service teachers’ professional learning for CT integration in mathematics and DS. Next, we will form sub-thematic small groups: Synergies among CT, MT, and DS; Integration of CT in K-12 settings; CT Professional Learning; and Access and Equity in CT Integration. The small group discussions may include how to equip mathematics classrooms to enable CT integration, how to support in-service and pre-service teachers’ understanding of CT integration into their instructional practice, and what possible challenges teachers and schools could experience in this integration. These small group discussions will strategize research agendas to address some of the challenges and opportunities in integrating CT in K–12 settings.

We will also discuss as a whole group the importance of culturally responsive pedagogy (CRP) and how we can adapt our existing knowledge of CRP practices in mathematics education to the integration of CT in K–12 settings and professional learning settings. We will share resources with participants on a few projects on culturally responsive computing that have targeted particular underrepresented communities, such as African American (Gilbert et al., 2008) and Latino girls (Scott & White, 2013).

Session 3 – Promoting Collaboration Among Disciplines and Outcomes

The final session will emphasize that the discussions and engagement in the activities together during the prior sessions are the first step for initiating productive and open conversations and collaboration among people from interdisciplinary backgrounds such as mathematics, CS, and DS Education. CT can empower teachers to leverage abstraction, automation, modeling, and simulations as their students investigate relationships in mathematics and data science. The working group will reflect on the ways in which mathematics, DS, and CS educators can collaborate to realize this goal. Ideas for continuing collaboration will be grounded in the research questions, challenges, and big ideas discussed during the first two sessions of the working group. Time will also be given to thematic sub-groups to continue to work on and enrich their plans for collaboration. In addition, we will encourage collaboration beyond the conference and share means to stay connected after the conference.

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