From “Authentic Tools” to Authenticity: Using CT to Enable Discovery in Statistics Classrooms

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Abstract: CS Educators pushing to integrate computational thinking (CT) into mathematics classrooms has quickly influenced statistics classrooms where students now analyze data using modern computational tools. Yet while teachers perceive using “authentic tools” in the classroom as providing an “authentic learning experience,” the power of computational tools to help reimagine existing content is often overlooked. Our team worked with teachers to co-design two CT-integrated statistics units across two years. We use a model of professional growth to discuss the teachers’ changing beliefs over the course of the two co-design projects. We see how the enactment of a programming-focused CT-integrated unit led to changes in teachers’ beliefs about the pedagogical impact of CT. These informed the teachers’ approach in a second co-design, resulting in a unit that emphasized empowering students to discover statistical concepts via an authentic learning experience using authentic computational tools.

Introduction
Prior research has advocated for the integration of CT in K-12 STEM classes with three primary goals. First, the use of computational tools can engage students in authentic inquiry experiences that reflect the work of STEM professionals (Weintrop et al., 2016). Second, prior work shows that students’ exploration of computational tools can improve pedagogy and outcomes in STEM as it deepens students’ interaction with content (Wilensky & Reisman, 2006; Sengupta et al., 2013; Kelter et al., in press). Third, it broadens access to computing by engaging all students in computational practices within K-12 classes, particularly in the United States, where STEM classes are required and computing classes are often relegated to elective status meaning CT in STEM can reach students beyond those who traditionally take computing courses. Using the interconnected model of professional growth (Clarke & Hollingsworth, 2002), we examine the way that two mathematics teachers make sense of CT within mathematics contexts, and how these conceptions shift through professional development and classroom experience. In this context, we explore the ways that mathematics teachers express their understanding of CT within statistics as they participate in this professional development cycle. How does the enactment of a programming-focused CT unit lead to changes in teachers’ beliefs about the pedagogical impact of CT?

Methods
We focus on two participants, both experienced mathematics teachers, from the same high school: Steven and Josh. In the first year of the study, Steven attended CT professional development, called CTSI (Kelter et al., in press), and created a CT-integrated unit with a co-design team. Steven implemented this unit in his class and also recruited and helped his colleague, Josh, to implement the unit with his own students. Steven and Josh both attended the following CTSI where they worked together to build a new unit. It is across these three events, the first PD, the implementation, and the second PD that we examine the changes in the perceived salient outcomes of integrating CT into the classroom for Steven and Josh. We leverage clinical interviews with teachers taken after each CTSI and curricular implementations, classroom implementation video data, and observational field notes collected during the implementations and co-design sessions. We utilize the multiple case-studies method to track the changes in teachers’ personal domain—their beliefs, knowledge, and attitudes—and how that impacted their involvement in the external domain across two PDs centered around co-design and the domain of practice (their implementation of the unit). The first two authors coded the teacher interviews according to the IMPG coding scheme, sharing codes and preliminary finds with each other to validate the codes. Video data and field notes from the classroom implementations are used to further triangulate changes in the domain of practice.

Discussion and Conclusion
Steven and Josh both originally approached integrating CT for similar purposes of providing students exposure to authentic computational tools (personal domain). They enacted this belief system by implementing a computationally enriched lesson focused heavily on the exposure to a new computational tool. Both teachers expressed new ideas about how and why computational thinking should be taught to students (domain of
consequence), suggesting this enactment and subsequent reflection played a large part in updating within their beliefs surrounding CT. They struggled to find a balance between the computational content and the statistics content, first focusing on the computational tool then on the statistics content. They grappled with deciding whether to engage using an authentic tool use compared to using scaffolded computational experiences that more deeply engaged students in the statistics content (see Figure 1). They also noted that these scaffolded experiences did not map to their own conceptions of a math classroom as easily as to the science classroom, suggesting the need for additional scaffolding for mathematics teachers in CT PD. They expressed that it was vital to have the design team present to push back on this statistical focus, and to help frame student engagement around the CT elements (external domain). Both teachers expressed a different understanding of CT after participation in the second CTSI professional development but at the time of this work, neither teacher had implemented their second CT-enriched unit, so future work will explore their experiences enacting these new perspectives in the classroom. Broadly, this work contributes to understanding how mathematics teachers conceptualize and approach CT within their domain, with the goal of better supporting computational thinking integration within mathematics and statistics that is more than just exposing students to authentic tools and instead pushes students to engage in authentic practice.

Figure 1. A screenshot from the second unit on Sampling Distributions which uses NetLogo Web with CODAP.

References


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