Evolution of an Integrated, Elementary CSforAll Curriculum

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ABSTRACT

A research-practice partnership (RPP) used a teacher co-design process, supported by equity-focused professional development, to create an elementary-level curriculum that integrates content, practices, and learning progressions from state computing standards with other standards-based curricula. Most district students are part of historically marginalized groups and the RPP chose to develop an equity and inclusion-focused curriculum that would be taught in all elementary classrooms to all students. Twelve teacher teams, supported by researchers and ELL and SPED specialists, designed, piloted, and documented 23 modules of 4-8, 45-minute lessons across K-5. Early adopter teachers followed the pilots and implemented the modules in their classrooms with the goal of facilitating adoption by all elementary classroom teachers. After being interrupted by the pandemic, the RPP developed a strategy where principals in cohorts of schools agreed to collaborate with RPP school-based lead teachers to establish professional learning communities (PLCs) to support classroom implementation of the modules. Eleven schools participated in a 2021-22 cohort and nine more schools joined in 2022-23. Centering equity, PLCs, and quality module documentation and materials are key to sustaining and evolving the CSforAll curriculum. The modules were revised based on feedback obtained from ELL and SPED specialists, early adopters, teacher coordinators, researchers, and district curriculum directors. Using a large data set of meeting and classroom observation records, interviews, field notes, focus groups, surveys, and module documentation, we track the evolution of the curriculum and provide a detailed analysis of one module as an example.

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1 SUMMARY

An NSF CSforAll RPP includes a major research university, a medium-sized, urban school district, and experienced evaluators. Across the district, 69% of 23,800 students are Hispanic/Latinx, 18% are Black or African American, and 85% come from low- income environments. Before the RPP began, students did not have access to computing curricula before high school where students of color seldom enrolled in available courses. To increase interest and reach all students, the RPP focused on the over 10,000 K-5 students in 32 elementary schools where all students can be engaged early in their education with an integrated, equity- centered elementary CS/CT curriculum taught by classroom teachers. The RPP avoided creating another "special" curriculum and instead created K-5 modules that integrate content, practices, and learning progressions derived from the computational thinking (CT) strand of the Massachusetts digital literacy and computer science standards [2] with other standards-based curricula in mathematics, English language arts, social studies, and science, technology, and engineering. The goal was to build equitable computer science and computational thinking expertise and confidence among classroom teachers so they could enable students to apply computational thinking in learning across subject areas.

As part of an iterative co-design process for the initial modules, five RPP teacher coordinators led the design process and later activities and continue to serve as a bridge between the researchers, teachers, and the district. The RPP recruited classroom teachers to co-design, develop, pilot, and assess modules. Eight-person teams were organized in dyads and supported by the teacher coordinators, ELL and SPED consultants, researchers, and the district instructional team. The dyads developed four modules per grade level in two grade levels each year using an iterative process where each module would be designed, piloted, assessed, and refined successively by three dyads. In each year following these pilots, the RPP recruited additional "early adopter" teachers who implemented the modules in their classrooms with the aim of facilitating adoption by all classroom teachers within the district. From 2018-19 through the 2020-2021 school year, the design teachers piloted 23 modules, 4 per grading period in kindergarten through grade 4 and 3 longer, project-based modules in grade 5. Table 1 summarizes the design process and indicates the data collected. While initial module design was largely influenced by PD and mentoring by researchers and coordinators, continuous curricular revisions were largely driven by classroom experience and feedback from the dyad partners, RPP coordinators, ELL and SPED consultants, researchers, and the district academic team.

The RPP continued its curriculum design, piloting, early adoption, and related professional learning over the first three

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Period	Activity & Module documentation	Prof. Development	Revisions	Observations
2018-19	Four K & 3rd modules were designed, piloted, & documented during 3 iterations	Launch-CS PD without equity	During pilot iterations with input from SPED/ELL consultants who emphasized UDL and equity. During summer with input from design teachers and early adopters.	Pilot process and every iteration with field notes, videos & interviews. Researchers followed one module/grade level in 2018-19 observing all modules, one dyad/grade level in 2019-20, observing all but one module, and two grade 2 modules in 2020-21.
2019-20 Covid impact	Four 1st & 4th modules were designed, piloted, & documented during two in-school, one online iteration. Early adopters taught K & 3rd modules	Embedded PD covering CT, standards, devices, platforms, and equity for both design and early adopter teachers		
2020-21 Covid impact	Four 2nd & 5th modules (three in 5th) were designed, piloted, & documented during two-three online iterations. Early adopters taught K, 1, 3 & 4th modules online and after school			
2021-22	Modules taught in some classrooms in first cohort of 11 schools	Lead teacher PD covering modules, devices, and equity. PLCs with classroom teachers	During summer with input from classroom teachers	Artifact interviews in grade 4
2022-23	Modules taught in most classrooms in two cohorts of 11 + 9 = 20 schools			One classroom in 16 schools with field notes, videos & artifacts.
2023-24	Modules taught in most classrooms in three cohorts of 11 + 9 + 6 = 26 schools		Ongoing with input from teacher focus groups	10 planned and pending.

Table 1. A Summary of Curriculum, Design and Development, Revisions, Observations, and Supporting Professional Development

years through closure, online and hybrid learning, and in-class instruction with 145 design and early adopter teachers having taught the curriculum in all 32 elementary schools reaching approximately 2,000 K-5 students. The Covid impact, including pandemic disruptions, teacher shortages, and general stress on district personnel, prevented the planned full implementation of the curriculum, so the RPP proposed a "cohort" model to the district that would be implemented in three cohorts each year. Cohort school principals recruited RPP school lead teachers to form CSforAll professional learning communities (PLCs) in each school to provide support for the over 425 classroom teachers in 20 schools in the first two cohorts. The district hired computer science/technology coordinator (CS/TC) teachers and a district CS supervisor. Each principal, school lead, and CS/TC teacher collaborated to support classroom teachers in the cohort schools. The RPP supported short, twice yearly all cohort PD sessions and quarterly PD and 1-1 mentoring for the lead teachers.

Sustainability and ensuring equity depend on both the effectiveness of PLCs and the quality and useability [7] of the module documentation. Curriculum revisions were undertaken in collaboration with the RPP researchers and included explicit references to CS and the integrated discipline standards, improved content, sample scripts, common formatting, and equity and differentiation guidance in 2018-19, online adaptations in 2019-20, resolved links and copyright issues in 2020-21, simplified documentation and equity spotlights in 2021-22, and options for coordinating pacing and flexibility in 2022-23. Revisions were based on feedback and classroom observations. The full curriculum is posted on a district website and was reviewed and included in the Massachusetts education department DLCS curricula guide [1].

We specifically trace the evolution of a 2nd grade module as an example. This module was designed to allow students to understand how models may represent real-life solutions and how simulations can be used to test these solutions. Students researched natural disasters, gathered data, designed model houses that might withstand natural disasters, and compiled their experiences using a form of an engineering notebook implemented in Scratch. The authoring dyad had hoped to develop lessons, drawing on project equity PD, and applied the HILL [3] model by emphasizing student identities, developing skills, gaining knowledge, and understanding power, authority, and oppression. While the module promotes personal and engineering identities, the assumption that 2nd grade students would have direct experiences with significant natural disasters proved weak. Teachers were given more leeway in choosing scenarios in later revisions. This module was revised several times and lessons from this module were among those observed during 2023. These revisions did improve the useability of the module [7]. We saw a number of variations during classroom observations, however classroom teachers struggled with conveying CT concepts but were more comfortable the science content and promoting engineering identities. We analyzed the module from five perspectives: the state standards [2], two CT frameworks [4-5], a CT & science framework [6] and an equity framework [3]. We identified several shared computational thinking (CT) concepts and skills present in the module - abstraction and decomposition, modeling and simulation, debugging, data, and the creation of inclusive learning resources. Ongoing revisions are focused on providing more explicit guidance around CT concepts and equity.

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