Developing a Systemic, Scalable Model to Broaden Participation in Middle School Computer Science

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***Abstract*—This poster describes the overarching goals of a newly awarded NSF-funded grant (DRL-1837439) designed to address the provision of equitable access to underrepresented students (e.g., females, African-Americans, Hispanic/Latinx) in computing. *Collaborative Research: Broadening Participation with the STEM Ecosystem: Developing a Scalable Model using an RPP Approach* evolved out of the research team's past experiences with developing strategic partnerships with school administrators and classroom teachers to bring computationally-rich activities to students throughout the school day, but especially in core math and science courses.**

***Index Terms*—Research Practice Partnership, K-12, STEM+C, Computational Thinking**

I. Introduction

Middle school is viewed as a critical juncture to support and nurture students' interests and abilities in STEM in general and to promote those academic capacities tied to computationally-intensive activities [1], [4], [5]. However, a central challenge is the lack of academic infrastructure in support of these experiences for all students. Exposure to computational thinking (CT) and computer science (CS) practices have historically been pursued through elective courses or after/out-of-school activities in which self-selection and sociocultural biases are high. This exclusion begins to close doors for student populations who have not traditionally participated in elective CS activities, as only those with exposure, interest, and support are likely to continue to pursue these opportunities through high school, college, and careers [2], [6]. Thus, this project aims to grow an early Research-Practice Partnership (RPP) between the research team and a nearby digital sciences-themed magnet middle school to further develop conceptual, theoretical, and applied frameworks for integrating CS/CT. Additionally, we will scale this RPP work to another newly-forming CS/CT focused magnet in a different region of the state.

II. Research Questions

1) What are the barriers to developing a STEM ecosystem that supports CS/CT for every student through integration into middle school science and mathematics courses?
2) What factors or interventions are needed to support the development of a CS/CT focused STEM ecosystem that supports everyone in a school?
3) What are the indicators of success for a CS/CT focused STEM ecosystem in a school?
4) How does the ecosystem prepare and engage all students, especially those from underrepresented student groups, for CS/CT work in high school?

III. Leveraging Research-Practice Partnerships and the STEM Ecosystem Model

To address these challenges, this project is informed by a STEM ecosystem model which acknowledges that effective CS/CT learning is the product of the entire connected academic enterprise, including school leadership, teacher and student resources, available learning opportunities, along with prior experiences, encouragement, and training. The ecosystem model will serve as a powerful lens for stakeholders and researchers as they collaborate to address key problems of practice. Using the ecosystem framework members of the RPP team will work to develop strategies that broaden the participation of underrepresented populations in CT/CS academic activities and prepare them for success along such a trajectory. A key component of the CS/CT focused STEM ecosystem at both schools will be providing all students an opportunity to engage in and deepen their knowledge and abilities about CT and CS concepts through science and mathematics classes that they all take.

IV. Early Findings

Building on earlier relationships formed with one of the middle schools through prior grant work, researcher-practitioner collaborations have led to promising early results. The strategies described here will be pivotal as we move forward to build upon this existing RPP and to scale effective strategies from one school to the other. First, our team has engaged in design-based implementation research that to date

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has informed the development of CS/CT-infused math and science curricular modules. Co-development of the modules was in direct response to a common problem of practice expressed by teachers: the need for CS/CT curricular materials that align with existing content they are required to teach. Additionally, in collaboration with teachers, our team has developed a faded support strategy of professional development that scaffolds math and science teachers' adoption of CS/CT modules. This strategy is characterized by members of the research team initially modeling lesson implementation for teachers and then gradually relinquishing support throughout the day as the teacher gains confidence with the content and pedagogy. Our team has also taken a Use-Modify-Create approach [3] to curricular design that scaffolds both student learning and teacher efficacy with incremental, staged CS/CT practices. Early research on this approach suggests it offers students with no prior CS experience a supportive pathway to the content increases student engagement with the material. The Use-Modify-Create approach builds teacher confidence as they become more familiar with the programming environment and how to support student learning. Design-based implementation research is employed to iteratively refine the faded model of support PD strategy and the Use-Modify-Create approach to curricular design. We work with teachers to implement and revise curricular modules through formative and summative data collection and analyses. Finally, through our efforts we have established an active and engaged RPP leadership team comprised of school administrators, teachers, and members of the research team who meet monthly to plan strategies for developing the CS/CT focused STEM ecosystem.

V. Future Work

We are currently at the beginning of this project (beginning of Year 1). We plan to leverage the early successes described above and continue building CS/CT focused STEM ecosystems at both schools. Future goals include formally engaging members of both RPP teams, the project team, and Advisory Board to devise a long-term research agenda based on these preliminary findings. We will continue to identify lead teachers at each school to model best practices schoolwide, as well as create communities-of-practice at each school. Additionally, we will provide opportunities for summer and ongoing professional development during the academic year based on identified teacher and school-wide needs. We will continue to deepen our connection to teachers and their teaching experiences by more closelyco-developing CS/CT-infused lessons that are refined through formative and summative data. Finally, we will continue to engage in an iterative process of reflection and analysis of key barriers and supports as they emerge to inform the development of new strategies and supports to bolster the ecosystem each year.

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