Using a Resource Activation Lens to Understand Classroom Enactments of Computationally-Based Science Curricula

Jooeun Shim, University of Pennsylvania, jshim@gse.upenn.edu
Susan Yoon, University of Pennsylvania, yoonsa@upenn.edu
Noora F. Noushad, Heritage Xperiential Learning School, nora.noushad@gmail.com

Abstract: In this study, we examine how teachers use existing resources to enhance their teaching practices in a computationally-based science curriculum. We used a theoretical framework that examined how two teachers differentially activated material, cultural, social, and symbolic resources in different teaching contexts. This led to differing instantiations of their curricula and ultimately differing student learning outcomes. We discuss implications for this research in terms of the qualities of implementation that need to be emphasized in professional development activities.

Introduction and theoretical considerations

Studies on reforming science teaching in urban schools stress the need to design high-quality computationally-based curricula (Denning, 2017). Due to a lack of administrative support to teach inquiry-based science, teachers in urban schools need to have opportunities to acquire support elsewhere (Barton & Berchini, 2013; Furman et al., 2012). Furthermore, despite the importance of collaboration between teachers for lesson planning and delivery, teachers in urban schools often become isolated (Vangrieken et al., 2015) and are not able to find experts to support curricular reform efforts (Fischer et al., 2017). In previous research, we have written about the need to use social capital strategies to support teachers to adopt new curricula in urban contexts. Social capital is the garnering of resources from one's network, which is distinct from human capital that consists of the knowledge and skills each individual possesses. Using resource activation framework (Rivera Maulucci, 2010), we describe two cases in which the teachers show differential activation methods and abilities and the aspects of the teaching that more or less supported this activation. This study is guided by the following questions: (1) To what extent does activation happen? (2) Are there additional resources that need to be activated? and (3) What are the implications for activation of resources for professional development (PD)?

Rivera Maulucci (2010) describes a science teaching framework based on the activation of material, cultural, social, and symbolic resources in urban schools. In science teaching contexts, *activating material resources* could look like a teacher finding a short news clip to facilitate students' discussion about the application of science in the real world. *Activating cultural resources* could be a teacher participating in PD and adapting their lesson plans to their district's science vision. Whether and how the development of social networks and collaboration are encouraged in the teaching system falls under the category of social resources. A teacher's symbolic resources might be activated when the teacher is afforded some autonomy to design lessons using new pedagogy.

Methods and context

Two high school science teachers, Emily and James, were voluntarily recruited in their second year of teaching for this study. Both teachers were trained in the same pre-service program in which the principal investigator taught and interacted with the teachers in course work. Emily taught ninth-grade biology in an independent school that was comprised of 25% underrepresented minority students and 47% low income. James taught ninth-grade chemistry in an urban public school that was comprised of 99% underrepresented minority students and 100% low income. Both teachers attended a two-week long PD workshop during the spring semester of 2017. As part of a larger design-based exploratory research study, the PD workshop was designed to help teachers develop mobile curricula for students to take scientific action in their community through an app programming tool called App Inventor. The workshop entailed content-based modules focusing on the App Inventor programming tool (week 1), and opportunity to design their own app projects and to construct curricula (week 2). Emily developed an eight-day lesson plan within an ecology unit to teach concepts related to the health of environmental streams, including analyzing and collecting data to make decisions about the water quality of their local stream. James developed five-day lesson plans for a water cycle unit to teach essential characteristics of the water cycle as part of environmental chemistry, including the investigation of water problems with drought or floods in their neighborhood and making apps to address water overabundance or shortage.

To answer our research questions, we collected data from four sources: (i) teacher's post-implementation interviews with 19 overarching questions to probe their experience and perspectives on the success of their implementation; (ii) classroom observations including classroom context, reports of the instruction and activities taking place, and their interactions with resources; (iii) lesson plans and worksheets that contained detailed information about the design of the curricula and classroom activities; (iv) students' app projects that contained additional information about how they applied what they had learned from the computational activities. We used a multiple case study methodology (Yin, 2017) to provide a rich description of our participant's resource activation. Since the study was exploratory and design-based, all data sources were qualitatively assessed and discussed by the project team.

Findings

Differences in activating material and cultural resources

The data from our study also revealed that teachers activated material resources to enhance cultural resources in their classrooms in different ways and with varying degrees of difficulty. For Emily, her very clear understanding of how she intended for the apps (material resource) to support content knowledge (cultural resource) influenced what she perceived as challenges and how she needed to activate support. The biggest challenge for Emily was finding out the best ways to teach App Inventor to students along different developmental paths so that they individually would have enough understanding of programming to complete the science activity she planned. After Emily revisited the PD materials, she created her own instructional materials to integrate. For example, after assessing the available PD resources, she found a recycling app, which is adapted from Hello Purr. Emily asked students questions about the purpose of each block in the app to familiarize them with the engineering design process. Then, she asked students to remix the app using at least two of the suggestions from the PD website. From the data, James showed a weaker understanding of how building and using apps could support his science instruction goals. His idea was to have students work in groups to create apps that addressed some problems related to water. That could mean tracking the users' water usage, educating the users about water crises around the world, or animating the water cycle. However, the actual implementation did not go as planned. On Day 1, James introduced the sample rock-scissors-paper (RSP) app and students followed James step by step. On Day 2, James distributed handouts that included different ideas that allowed students to remix the RSP app individually. On Days 3 through 5, students were asked to develop an app using the worksheets where they could write their app idea and draw a prototype. Unlike Emily, James was most interested in figuring out what to teach with App Inventor rather than how this material resource could be used to support students' content learning of the water cycle. Somewhere in the implementation of his lessons, James forgot his pedagogical goals (cultural resource), which led to computation focus-teaching in his classroom. This lack of contextualized resources for James to activate cultural resources precluded him from seeking and learning more about available and applicable science topics or ways to teach them like Emily did. Both teachers thought of ways to utilize PD resources to support student learning during their unit implementations; however, James's inability to situate the programming in his science curriculum limited the time to teach the science content.

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