

Shifting Educational Activity Systems: A Cross-Case Analysis of Science Education Reform Efforts in Large Scale Systems

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Abstract: Educational reform at a system scale is challenging due to issues of coherence. In an effort to improve science education reform efforts in the United States, learning scientists and educational leaders collaboratively engaged in design-based implementation research within a research practice partnership. This study describes three state level case studies resulting from this work and draws out the tensions and affordances that emerged.

Keywords: Design based implementation research, collaborative inquiry, equity, coherence

Introduction

The 2012 release of *A Framework for K-12 Science Education (Framework)*; NRC, 2012) signified a shift in science education in the U.S. with the inclusion of an explicit vision of equity within science education that challenged established teaching and learning practices. Subsequent implementation work has been fragmented and uncoordinated with different actors in the system engaging in the new vision at different rates, amidst varied resources, and with diverse strategies due to localized control of educational decisions and funding mechanisms. Additionally, limited timely professional learning opportunities for all participants in science education about these implementation efforts has hindered progress.

Implementation efforts can potentially be improved by attending directly to the issue of coherence, having participants across a system come to a shared vision and a plan of coordinated action. In order to improve coherence across large educational systems that span beyond a single school or district, all participants in the system need to engage in sensemaking (Coburn, 2001) and find effective ways to collaborate to minimize challenges during implementation.

In this study we explored the implementation of the new vision of equitable science education embodied in the *Framework* across large educational systems in the United States by asking the overarching question, *How can education systems design for shifts towards new visions of education?* This study is situated within a multi-state research practice partnership (Coburn & Penuel, 2016) focused on the use of formative assessment to foster teacher learning.

Methods

We use the lens of activity theory to identify mediation points within the system to foster change (Cole & Engeström, 1993). From this perspective, individuals are viewed as situated within various communities of practice (Wenger, 1998) which have particular norms for activity, common historically based funds of knowledge (Moll, Amanti, Neff, & Gonzalez, 1992) and repertoires of practice (Gutiérrez & Rogoff, 2003). Historically contextualized positionalities (Harré, Moghaddam, Cairnie, Rothbart, & Sabat, 2009) that dictate privilege and power in any given interaction exist within and between a community's participants. From this lens, we framed this study in design based implementation research (Fishman, Penuel, Allen, Cheng, & Sabelli, 2013) to engage researchers and science education leaders from a wide range of settings and leverage the resources all participants bring to implementation of the *Framework* vision of equitable science education.

In this study, we utilized individual and cross-case analyses (Merriam, 1998) of implementation efforts at the state scale. Cases were selected to provide a range of rural and urban contexts as well as spatial distribution in the U.S. that intersected with differences in economic prosperity. Data were drawn from three focal states using artifacts from two collaborative meetings that dealt with *Framework* implementation specifically and 16 interviews of state science leaders conducted after the first year of collaborative work. Data analyses employed a critical ethnographic approach (Carspecken, 1996).

Findings

The three states used as case studies were working towards a shared vision of equitable science education; however, they took different pathways. State A focused on the creation and development of shared resources to support teachers, students and parents. State B took an approach that would help uncover gaps in student

learning to illuminate the need of a shared vision through professional learning opportunities. State C designed professional learning experiences that were informed by the work already being done by other states.

Work that each state engaged in impacted the other three states. For example, State A played an important role in drafting and prototyping shared resources with teachers develop three-dimensional formative assessments which informed the work on State B as they scaled professional learning across a regional collective. In turn, State B developed example formative assessments across different domains that were shared with other states. State C used the examples developed by State B and worked to develop a shared vision on equity internally to provide insight into attendant pedagogical moves, which then impacted the work that State A was undertaking.

All states experienced tensions in their implementation work. For example, they all struggled to support rural teachers in the coherent shift towards a *Framework* vision of equitable science education due to variations access to universities, limited numbers of substitute teachers to allow for teacher release, limited numbers of *Framework* experts, and greater travel time to reach collaborative spaces. A second tension named by all case study states, but experienced more profoundly by States B and C, was the issue of shifting or diminishing state and educator personnel. This represented an ongoing challenge to implementation coherence, as individual actors who had extensive knowledge and practice in building capacity regarding equitable science education were then lost to the system. Two solutions were seen to be essential to this challenge: shared visioning and sustained professional development in practice.

Conclusions and implications

Engaging in design based implementation work with state leaders and learning scientists allowed for states to collaborate in codesign and research work using tools such as practical measures, actor network models, and teacher education resources. The collaborative nature of this work, allowed state participants to customize these tools to their specific needs, gaining valuable insights into issues of incoherence in their state systems. They were then subsequently able to design for and iterate on options for improved coherence that were well informed by the efforts of other states. Research into these collective efforts highlights potential pathways and mechanisms that states can engage to improve implementation of the *Framework* vision of equitable science teaching as well as more generally helping to illustrate the importance of networked activity in systems reform.

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