FOSTERING SYSTEMIC COHERENCE THROUGH A SHARED VISION OF HIGH QUALITY MATHEMATICS INSTRUCTION

P. Holt Wilson	Allison McCulloch	Olanrewaju Oriowo	Cathy Holl-Cross	Christine Fisher
UNC Greensboro	UNC Charlotte	UNC Charlotte	UNC Charlotte	UNC Greensboro
phwilson@uncg.edu	amccul1@uncc.edu	ooriowo@uncc.edu	chollcro@uncc.edu	cakierna@uncg.edu

Recent research on instructional vision offers new insights into the challenges of systemic coherence when implementing educational innovations at scale. In this paper, we retrospectively examine the work of our statewide partnership of mathematics education leaders for implementing new state mathematics standards. We identify three categories of designs that improved coherence during implementation and highlight the role of instructional vision in each.

Innovations that aim to create meaningful and sustained improvements in classroom instruction and student learning often fail when scaled. A successful implementation requires coordination and leadership across multiple levels of an educational system (NRC, 2012), and policy researchers have long posited that a misalignment among curriculum materials, assessment systems, and evaluation systems is a significant impediment to reform efforts. Yet despite the significant resources often allocated to alignment during implementation, systemic coherence is rarely achieved.

Recent research on instructional vision offers new insights into the challenges of systemic coherence when implementing educational innovations. Instructional vision is a discourse educators use to characterize ideal classroom practice (Munter, 2014), and researchers have shown that a teacher's vision relates to instructional changes over time (Munter & Correnti, 2017), influences how they filter competing messages about practice (Tichnor & Schwartz, 2017), and is shaped by interactions within professional networks (Munter & Wilhelm, 2021).

In this paper, we argue that instructional vision provides new explanations for longstanding challenges of implementation and new ways of promoting systemic coherence. We examine the work of our statewide partnership of mathematics education leaders for implementing new state mathematics standards, identify three categories of designs that improved coherence during implementation, and highlight the role of instructional vision in each. By doing so, we aim to support other researchers working in partnership with education leaders to support implementation efforts within and across school districts.

Background

More than thirty years ago, the National Council of Teachers of Mathematics (NCTM) released *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) and with them a vision for school mathematics where students engage in rigorous mathematics content and the practices of mathematicians. This effort marked the beginning of an era of standards-based reform in the United States where policy makers have sought to shape classroom instruction at scale through the allocation of resources and accountability systems. Thirty years

later, states and national organizations are still setting mathematics standards that embody this vision. And though some modest advances in student outcomes have been made, standards-based reform has yet to yield significant improvements in mathematics teaching at scale and has failed at addressing the opportunity gap.

Implementation scientists and educational policy researchers have identified obstacles, developed explanations of these shortcomings, and provided insights into the complexity of large-scale systemic reform. For example, educators implementing a new policy tend to focus on its surface features or attend to its similarities with existing policies while ignoring substantive changes and meanings behind them (Spillane et al., 2002). Scholars have repeatedly underscored how efforts aimed at large-scale instructional change place significant demands on both individuals and educational organizations and require opportunities and a significant amount of time for both individuals and organizations to learn (Fullan & Pomfret, 1977). Without such opportunities, multiple interpretations of a new policy and the changes it requires lead to conflicting goals, competing priorities, and incoherence.

There is growing recognition that systemic reform requires coherence; that is, all components of an educational system must work together in support of the vision of teaching and learning underlying the policy (NRC, 2012). Following recommendations from policy researchers, educational leaders have primarily sought to achieve systemic coherence during reform through aligning curricula, assessments, professional development, and evaluation systems with academic standards (Smith & O'Day, 1990). These efforts to create coherence have become central to national organizations' (e.g., WestEd, CCSSO,) recommendations to states and large districts when planning for large-scale implementation. For example, the Center for Standards and Assessment Initiatives' standards implementation framework centralizes alignment in a comprehensive, research-based plan for adopting and implementing academic standards (CSAI, 2019). During the earliest phases of implementation, for example, the framework recommends developing a crosswalk document that links previously and newly adopted standards and serves to guide alignment. Though important, an exclusive focus on alignment fails to consider the tendency for educators to recognize only superficial changes and similarities with existing standards (Spillane et al, 2002). By mapping familiar standards to new, more ambitious ones, such documents signal little change is required.

Some scholars have started to question whether standardized approaches to implementation like alignment will lead to meaningful changes in instruction and systemic coherence because of the significant learning required to change instruction (e.g., Penuel et al., 2009). They argue that coherence is not an objective characteristic of an educational system with all components working synchronously but rather a subjective meaning made by an individual of how that system works. Instead of being a state of perfect alignment, coherence is an ongoing process by which individuals create meaning of reform in their local contexts (Honig & Hatch, 2004). From this perspective, the success of reform largely depends on the ways that educators actively interpret policies and what they prescribe, perceive an alignment of resources and messages with intended goals, and engage in collective sensemaking in their local contexts to "craft coherence."

In the context of reform, academic standards communicate a particular vision of teaching and learning that differs from those held by most educators. Yet the prevailing approaches to standards implementation either a) assumes this vision is shared among educators throughout the system, b) that only key leaders have the vision and can share the vision at scale in the midst of implementation, or c) disregard the vision altogether. In fact, recent research indicates that the visions of high quality mathematics instruction (VHQMI) held throughout educational systems vary (Munter, 2014) and do not automatically change in the context of reform, even with significant professional learning opportunities (Munter & Correntti, 2017).

Theoretical Perspectives

An instructional vision focuses on concrete, "ideal images of practice" (Hammerness, 2006, p.1) with tangible details of content and how students will engage in it. Significant advances have been made in characterizing instruction that supports all students in learning mathematics. Characterized by some as high-quality mathematics instruction, instruction that meets these goals aims for teachers to be intentional in supporting students, for example, by problematizing ideas, supporting students in developing mathematical authority, and scaffolding classroom discussions in ways that formalize learning goals for students. Instruction enacted toward these goals has positive implications for learning.

Established and emerging research suggests that sharing a VHQMI can support successful implementation of new programs or policies (Gamoran, 2003), relates to improved instructional quality (Munter & Correnti, 2017), can lead to improvements in students' academic outcomes (Chance & Segura, 2009), and is an indicator of future practice (Cobb et al., 2018). Munter (2014) developed and tested a set of rubrics to track educators' descriptions of instruction and their alignment toward research-based descriptions of VHQMI. These rubrics articulate VHQMI along several dimensions and have been used in studies focused on mathematics teachers (Munter & Correnti, 2017), leaders (Jackson et al., 2015), and principals (Katterfeld, 2015).

While promising, research also points to the ways in which educators' visions are shaped by participating in different social contexts (Munter & Wilhelm, 2021) and informed by different or conflicting messages from both inside and outside schools (Ticknor & Schwartz, 2017). Teacher collaboration, PD, and productive collaborations across educator roles are rarely effective unless they are tied to a shared vision of instruction (Peterson et al., 1996). The importance of common vision is reflected in Cobb and Jackson's (2011) theory of action for large scale instructional improvement in mathematics, which includes VHQMI underlying a coherent instructional system as one of five key elements of their theory.

We argue that the growing body of research related to instructional vision provides new insights into the challenges of reform and the lack of significant instructional changes occurring in the classroom. Disparate visions help explain the different interpretations educators have and act upon during implementation. The relationship between VHQMI and instructional change suggests that the outcomes of a reform initiative may be understood as the extent to which the visions held by the system are compatible with the vision promoted by standards.

Method

To better understand the role instructional vision plays in promoting coherence, we retrospectively examined the work of our partnership with mathematics leaders in our state to support the implementation of new state mathematics standards. By studying the supports developed by the partnership and the degree to which they reflected VHQMI, we aimed to identify and describe categories of designs that facilitate the development of a shared instructional vision and promote coherence when implementing innovations at scale.

Context

The North Carolina Collaborative for Mathematics Learning is a partnership of researchers from 13 UNC campuses, mathematics leaders in the state education agency, and over 300 collaborating district leaders, instructional coaches, and mathematics teachers. The partnership formed in 2016 when the state began adopting new K-12 mathematics standards and has taken a design-based implementation research approach (Fishman et al., 2013) since then to collaboratively develop implementation resources, create professional learning materials, and grow a statewide network to support teaching and learning through networking and advocacy.

From 2016 – 2019, the partnership iteratively developed a number of resources that have been accessed and used widely by mathematics educators statewide, including 25 online professional learning modules for high school mathematics accessed by approximately 3,600 mathematics teachers and leaders to date, 36 research-practice briefs developed to assist vertical alignment and share research on student learning that have been downloaded over 13,350 times, and 15 grade- or course-specific instructional frameworks that cluster and sequence the new standards used or adapted by all 115 school districts as well as many of the public charter schools. The partnership has also developed virtual platforms for sharing resources and developing community, convened meetings for examining data, facilitated professional learning experiences, and created alternative communication structures for sharing information about statewide policy changes and advocacy.

Data and Analysis

To examine how these designs promoted a shared VHQMI, we produced and examined conjecture maps (Sandoval, 2014) for each iteration of our major designs between 2016 – 2019. Sandoval argued that any design is an embodiment of the designer's conjecture about how its aspects will lead to some desired outcome and describes conjecture mapping as a tool for empirically investigating and elaborating theories of learning and design. Conjecture maps begin with a high-level conjecture about how a particular design will lead to a desired outcome. Using a set of principles derived from theory, evidence, and commitments, the conjecture is embodied in a set of design features. Design conjectures describe how these features are intended to lead to some mediating processes, which in turn are conjectured to result in some learning outcome. After an iteration, a new conjecture map represents a revised embodiment of the high-level conjecture and includes any changes to the features, design conjectures, or learning conjectures. In addition to the conjecture maps, we created "problem analysis" (Edelson, 2002) memos describing the goals for each design, the contextual resources and constraints each, and the procedures and expertise used by the partnership to develop them. Summarized from partnership

documents, meeting notes, and our collective reflections, the memos capture our understanding of the state educational system both at the time of design and retrospectively.

Our analysis of the conjecture maps and problem analysis memos proceeded in two phases. First, the research team independently examined the data and created analytic memos identifying categories and characteristics of the partnership's designs, common procedures and kinds of expertise used to develop them, and abstractions of common influences and constraints imposed by the system. Collectively, the team discussed their independent analyses until consensus was met and used the results to develop categories of the partnership's design efforts. Next, we examined each of these categories to describe how VHQMI was embodied in the designs. This layer of analysis highlighted places where instructional vision was prominent, tacit, and absent and provided an opportunity to refine our designs for future iterations of research.

Designs Promoting a Shared VHQMI for Coherent Standards Implementation

Through our analysis, we identified three categories of designs – implementation resources, implementation practices, and implementation structures – that we conjecture are critical in developing a shared VHQMI when implementing state mathematics standards. In what follows, we describe the goals, characteristics, the role of instructional vision for each category and provide examples from our partnership.

Implementation Resources

Implementation resources refer to the material designs useful for promoting collective sensemaking. The goal for designs in this category is to provide immediate guidance and support for teachers and leaders that highlights what is novel about the innovation (Spillane et al., 2002). They are tools that are either unavailable or those that are not yet refined to consider the innovation. Implementation resources are grounded in research on teacher and student learning, instruction, and implementation. They provide access to safe professional learning opportunities and represent the expertise of a diverse set of educators within the system. These designs embody a sophisticated VHQMI, contain representations of high quality instruction, and feature artifacts of learning that showcase students' social, cultural, and mathematical resources.

The 15 grade- or course-specific instructional frameworks are an example of an implementation resource developed by the partnership. In 2017, the K-8 mathematics standards were revised and mathematics education leaders called for a set of resources that would support implementation. In the past, school districts developed their own pacing guides; however, stakeholders lamented that the large diversity in pacing guides was a barrier to coherence and enactment of teachers' VHQMI. Therefore for each grade level and course, the partnership collaboratively designed state-wide pacing guides, re-named instructional frameworks (IFs) to denote that they would go beyond prescriptive time frames for teaching certain standards by including resources that supported their implementation. Co-designers began their work by reviewing relevant research, revisiting their commitment to promote a shared VHQMI, and deciding on a format for the resource so that teachers could use them with relative ease. To ensure that the IFs would prompt safe, professional learning experiences, a set of research-based design principles were developed so that the frameworks emphasize curriculum guidance and not

prescriptive pacing, focus on central ideas with links to high quality curriculum materials, allow for flexibility and unpredictability based on differences in contexts, and address development of student reasoning from an asset orientation and how to build upon it.

Implementation Practices

Implementation practices refer to routines for accessing the social resources and expertise distributed throughout a system. The goal of designs in this category is to introduce and sustain forms of interaction that disrupt normative behaviors and build productive, mutually respectful professional relationships among educators across levels of a system. These designs promote generosity and empathy in cross-role and cross-organizational sensemaking, a sense of community beyond one's school or district, and challenge the historic narratives and practices about individualism endemic in public education discourses. Implementation practices are designed to surface diverse instructional visions for discussion and revision.

Boundary crossing (Wenger, 1998) is an example of an implementation practice developed by the partnership. Historically, district and school mathematics leaders across the state typically worked within their own districts to prepare for new standards implementation, with each district creating its own resources and tools to the extent possible based on local capacity. While larger districts were typically more confident and prepared to implement new standards, smaller and under-resourced districts were left to prepare and navigate implementation in isolation, often with very little support for their teachers. In developing, refining, and distributing implementation resources, the partnership convened groups of educators from different roles and districts, developed regular routines for participation with educators from different roles and different contexts, and committed to freely and openly sharing across organizational boundaries. As these forms of participation became normalized, they were occasions for disparate instructional visions to be uncovered, discussed, interrogated, refined, and shared over time.

Implementation Structures

Implementation structures refer to mechanisms for locating and sharing information within a system and can either augment or replace existing structures that influence instructional practice. The goal of these designs is to share information across the system using communication networks, relationship-building, and just-in-time advocacy to address the ways new initiatives or parts of the system are and are creating conditions for successful implementation. Implementation structures identify current and future systemic issues that will affect implementation efforts and facilitate formal and informal communication with influencers and experts in the system who can address such issues. These designs complement existing structures and connect organizations in new and productive ways and provide a means for egalitarian access to information, especially those closest to the learning. Because instructional visions are produced and reproduced in professional discourses, implementation structures facilitate the development of a shared and more sophisticated VHQMI.

Our partnership's communication network – including social media platforms, email lists of professional and personal addresses, and group text channels – is an example of an implementation structure. Because formal communications within the state educational system

are hierarchical and largely ineffective, our partnership developed a system for sharing timely information with a broad audience. After implementing new standards, the state agency's assessment division began their process of seeking input from teachers about which standards should be tested on new formative assessments administered quarterly. Many of our district partners reported that the clustering and ordering of these assessments would dictate local pacing and other instructional guidance resources, regardless of their existing curriculum or other implementation resources developed by the partnership. Using our communication network, the partnership was able to alert teachers and district leaders and provide information on how to volunteer to attend a meeting to provide feedback on draft test specifications. Teachers and leaders from across the state responded, and the quarterly formative assessments were ultimately aligned with the partnership's implementation resources. As an implementation structure, the communication network was essential in creating opportunities for developing a shared VHQMI.

Discussion

The goals and characteristics of implementation resources, practices, and structures are the beginnings of what Edelson (2002) calls a design framework that can be used by other mathematics education researchers and leaders who wish to foster systemic coherence in support of implementation efforts. Building from findings from recent research and the ongoing work of our partnership, the framework highlights the importance of attending to instructional vision when implementing educational innovations at scale.

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