Equity across State Systems: Possibilities and Tensions in Understanding Scale

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Abstract: This study of a research-practice partnership asks what it means to build more equitable conditions for learning at scale through a seven-state qualitative comparative analysis. Drawing on literature of equity and school reform, we attended to infrastructure, routines, constancy in vision, and collective efficacy as inputs to these systems. We used case study analytic methods to understand each state context before conducting qualitative comparative analysis to analyze the configurations of inputs that supported the most progress toward equity. The analysis revealed that progress toward equity in state systems was consistent with the configurations of constancy with routines, constancy with infrastructure, or collective efficacy on its own. It is hopeful that collective efficacy was a sole input for two states with progress toward equity and coherence, yet progress should be systemic, not placed on individuals. We discuss tensions in understanding equity at scale through qualitative comparative methodology and case studies as well as practical ramifications for educational leaders.
Keywords: Equity, systemic change, science education, qualitative comparative analysis

Issues

Achieving equity is a challenging and necessary pursuit in K-12 education, as systems continue to provide unequal and unjust opportunities to learn for students of color and other nondominant groups (Darling Hammond, 2018). This is true in US science education, where large studies have shown the percentage of nondominant students in science classes correlates with lower-quality instruction, fewer science instructional resources, fewer technology resources, less experienced teachers, and less qualified teachers (Banilower et al., 2018, p.132). Efforts are being made to understand and deconstruct systems that support inequities in science education, and this includes the efforts of state-level supervisors of science working in State Education Agencies (SEAs), whose professional organization recently released a statement indicating their commitment:

> In the 21st century, an equitable and quality science education is a necessity for all students. Being scientifically literate is a fundamental right of all students throughout a K-12 public education system – science education is a critical component of a student's sustainable future, not a luxury. (...) As state science leaders and affiliated members, we have a responsibility to engage in discourse that interrupts policies and practices that perpetuates the lack of opportunity and belief gaps for our nation's students. The Council of State Science Supervisors will work to foster environments for frank policy discourse, which address systemic inequities, eliminate educational barriers and will afford access and equity for all students. (Council of State Science Supervisors, 2018)

Our multi-year research-practice partnership examined the conditions that seemed to support progress toward these goals. This study examined conditions for promoting equity at the level of a state system of science education, focusing on the leadership activities of science supervisors and their teams. This focus on improving equity at the instructional level in science serves as a focus of the present study and ongoing partnership, and it also responds to concerns of newcomers to the organization who regularly asked, "I'm new; where do I start in the first months on the job?" while expressing sentiments of overwhelmed-ness as well as isolation. Specifically, we address the questions, "What configurations within systems support a state's progress toward equity in science education? What are the particulars of those practices within each state?"

For purposes of the study, we defined equity in relation to the vision of *A Framework for K-12 Science Education* (NRC, 2012), as entailing expansion of opportunities to learn for "all" students, where opportunities to learn is defined as science instruction that "is inclusive of all students' interests, identities, and cultural/linguistic backgrounds," and "valuing multiple modes of expression of learning in the classroom" (NRC, 2012, p. 283-290). At the state level, we operationalized state movement toward equity as evident when 1) leaders express complicated, multi-layered views of equity (e.g., that consider inequity, history, and complicate notions of

"equality") that go beyond adopting rhetoric of "science for all" (Basile & Lopez, 2015; Philip & Azevedo, 2017); 2) significant efforts are placed on including diverse viewpoints in leadership roles, and 3) concrete investments in equity projects, that is, where there are multiple initiatives working to counter inequities in the system, especially for girls, and students of color.

Conceptual Framework

There is very little research in learning sciences or in policy on the role of state agencies in promoting equitable changes to systems (Smarick & Squire, 2014). We turned to the literature on school reform and equity in order to identify potentially salient processes for supporting equity-minded reform to build a framework for studying the similarities and differences across states. We underscore that these four categories have not systematically been applied to understanding state agencies, which are increasingly important actors in supporting and aligning reforms in public education since No Child Left Behind (Authors, 2018b). We identified four possible processes from research on districts and schools.

First, we focused on *vision-building routines* that support educator learning. Routines are "repetitive, recognizable patterns of interdependent actions, involving multiple actors" (Feldman & Pentland, 2003, p. 96). By "vision-building" routines, we mean both formal professional development intended to support educators in changing their ideas about good teaching (Authors, 2018c), and activities that involve soliciting and building a sense of shared vision, such as holding focus groups (Authors 2018a). Other examples of such routines could involve systematically collecting data and input from community members and analyzing alignment of professional learning to a common vision for learning (Elmore & Burney, 1997).

Creating aligned infrastructures or *infrastructuring* is a second way that leaders can support equity. Infrastructuring refers to activities that support an initiative through efforts aimed at leadership, scale, capacity, technical support, policy, organizational learning, and funding (Cohen, 2011; Hopkins et al., 2013; Sabelli & Dede, 2013). Within SEAs, infrastructuring efforts depend on the networks leaders create within their agencies and with district leaders (Massell, Goertz, & Barnes, 2015). Such networks need to be "active" and focused on a common sense of the problems to be addressed and vision for improvement (Bryk, Gomez, Grunow, & LeMahieu, 2015). We examined state policies and test infrastructures as well as networks for learning and scale.

Collective efficacy in educational implementation contexts can provide an impetus for change and growth (e.g., Macy, 1991, 2004), and is characterized as a "nimbleness" of leadership in being able to "wisely develop strategies to respond to and sometimes influence those regulatory, contractual, financial, and political forces that surround them" (Johnson et al., 2015, p. 21). Collective efficacy at the leadership level has been shown to be connected to teachers' individual senses of collective efficacy; if leaders have a sense of collective efficacy, their teachers have shown more collective efficacy as well (Goddard & Goddard, 2001). In this study, this was expressed in interviews and on surveys.

Fourth, we included in our conceptual framework an emergent construct, *constancy*, defined as the long-term presence of leadership that holds the vision consistent with the Framework. We complicate the idea of "turnover" or "churn" because, while it is known that turnover inhibits long-term reforms (Finnigan & Daly, 2017; Sherer & Spillane, 2009), turnover remains the reality of life in school systems and it is not altogether helpful or realistic to say that it should be eliminated. Rather, we promote the idea of *constancy* which includes the presence of *vision* in leadership along with a consistency in leadership.

Methods

The methodology required to understand such a nebulously defined goal as equity across states should seek to interpret the particular within cultural activity (Gutiérrez & Rogoff, 2003) while keeping an eye out for structural patterns that constitute these particulars. It is worth understanding the ways that individual leaders improvise their equity work within their historical, cultural contexts of their state systems, yet few methods allow for such interpretation.

One way to maintain a commitment to the particular and historical elements of the pursuit of equity at scale is through the use of case study methodology. Case studies allow for the interpretation of each particular state as a unit (Merriam, 1998). In this study, we conducted research over three years in seven states to better understand the ways that equity was being worked toward in science education. States were sampled to achieve diversity in rural and urban populations, geography (eastern, western, southern, and central), and resourcing for science education at the state level (states in the study ranged in funding for science from $2M to $10,000 per year). Within these states, we conducted 77 interviews and surveyed approximately 100 different leaders in systems of science education. Data collection was conducted in two waves across two years throughout the study. Interview questions and survey questions were developed to align with three of the four constructs identified above; constancy emerged as a theme from interviews.

In order to systematically understand what kinds of patterns in state activity afforded differential progress toward equity as defined above, we turned to fuzzy set qualitative comparative analysis, or fsQCA (Ragin, 2007). In fsQCA, researchers use the process of calibration to "create a measuring stick" for the degree to which each case displays membership within a set of conditions and outcomes of interest (Davis et al., 2019). At this point, Boolean logic-based mathematical models are applied to surface the possible configurations of conditions support those outcomes. In terms of our dataset, we asked what configurations of our four hypothesized processes--vision-building routines, infrastructuring, collective efficacy, and constancy--supported progress toward our outcome of interest, equity.

To conduct this analysis, we first coded data using a set of theoretically-informed codes. A team of four researchers achieved inter-rater reliability and coded case study interviews for coherence, equity, policies, and challenges. After this initial round of coding, open coding was used to better determine the nuanced ways states were going about equity-focused work, and previous findings have included that state leaders take on widely variable stances related to equity, including those written about in the *Framework* (Authors, 2019a).

We then compared states on each construct in our framework and for the equity outcome. States judged to be completely "in" a set of states demonstrating the presence of a process were assigned a value of 1 and states completely "out" of the set were assigned a value of 0. However, states were not clearly "in or out" of this set. As is the convention in QCA, so we used "fuzzy set" values of 0.2, 0.4, 0.6, etc. in order to indicate states "partially in" the set (Ragin, 2007). fsQCA can help leaders make sense of complicated, interconnected causes in order to set priorities (Davis et al., 2019), and in this case, it allows for the careful interpretation of the particular in each case while looking for larger structural patterns across the dataset. We derived these fuzzy set values from multiple data sources for each hypothesized literature-derived condition: conversations with leaders, knowledge of cases, survey results, and documented policies. To calibrate these sources and arrive at a fuzzy-set value, we operationalized the input conditions using this data, and we found patterns and potential cut-offs in the dataset before assigning fuzzy set membership scores. We present the findings in relation to the fsQCA model followed by a state case that exemplifies that pathway in order to illustrate the particular strategy in use in that context.

Findings

Equity was defined in our comparative case study by the set of states in which leaders worked to construct a nuanced understanding of equity, as well as taking action to remedy inequalities. In our analysis, we found that there was no one common element in all three pathways to equitable science outcomes (Figure 1) with a threshold of 0.8, meaning that overall coverage had to be noted as 0.8 or higher to be included as a configuration. There were five configurations meeting this threshold, with three configurations and consistency of 1.0, meaning that the states with this set of processes present or absent had patterns of equity completely consistent with the pattern of outcomes we observed. Overall the configurations' coverage was 0.83, which is acceptable (Ragin, 2007). We present the complete truth table with the fuzzy-set scores in Table 1 and a flowchart of configurations for equity in Figure 1.

The truth table demonstrates that some states were given a fuzzy-set score of 0 for the outcome, indicating they were "completely out" of the set of states that had made significant progress on equity. State C was one such case, where, although they had made progress in better advocating for the rights of indigenous students, almost solely spoke of equity in terms of workforce development and economic gain for the state. They received a fuzzy-set outcome score of "0" for aligned routines, collective efficacy, constancy, and infrastructure were also "0." This can be interpreted as one configuration that exists in this dataset, interpreted as "a combination of not being in the set of states with either routines, collective efficacy, constancy, or infrastructure." State N also had this combination, as they did not have 3D state standards and or coordinated leadership from the state education agency. Because they are more compelling to equity-focused action, we more deeply illustrate the cases of states "in the set of states" making significant progress toward equity.

Table 1. Truth Table for Qualitative Comparative Analysis

	Inputs				Outcome
State	Aligned Routines	Collective Efficacy	Constancy	Infrastructure	Vision for Equity

J	0.5	1	0	0.5	0.5
U	0	1	1	0.5	1
S	1	0.5	1	0.5	0.5
H	1	0.5	1	1	0.5
R	0.5	0.5	1	1	0.5
N	0	0	0	0	0
C	0	0	0	0	0

The first configuration of conditions that resulted in equitable outcomes was constancy in leadership and routines to support educator vision building. States S and H met the conditions to be included in this set (consistency = 1.0, coverage = 0.5). State S and H both had leaders who had been in science leadership positions for five years or more, and they engaged networks of leaders around them to build shared vision. These leaders were able to repeatedly take part in joint activities as a group where they could develop a shared vision, such as attending the research-practice partnership meetings together to support vision building. Through collaboratively designing and reviewing survey data related to states' vision for science, leaders in State S and H were able to develop complex understandings of equity which went beyond simply believing that all students should have the exact same science experiences (equality). These leaders drew on definitions of equity that required science education to draw on students' interests and identities, and value epistemological diversity. The leader in State H had an equitable vision for science that was shared with team members. This leader noted that she'd seen a change in the emphasis placed on equity within state team decisions related to science learning. The leader said:

> And so now we're really ... our mind shift over the course of these last couple of years, but I would say, especially in this last year, we don't do anything *without* thinking about interest and identity and equity and how our decisions are going to impact all learners. (Leader, State H, emphasis added)

State S achieved equity by making progress across several areas in terms of equity. Leaders demonstrated some historical/injustice-oriented views of equity, while conducting some activities specifically focused on equity and doing equity-oriented professional development. While none of these activities in itself was indicative of substantial progress toward equity, they were partly in the set of states that had made progress. In terms of the supporting configuration, they had constancy in leadership and a strong state-level infrastructure.

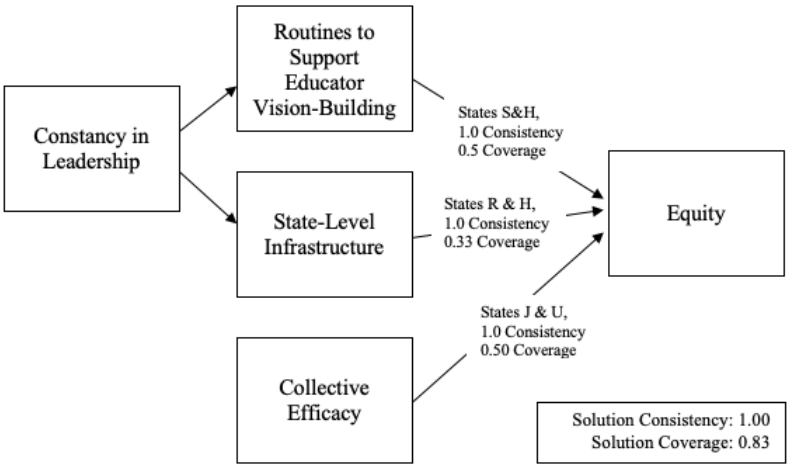

Figure 1. Configurations supporting progress toward equity.

The second configuration supporting equity was constancy + state-level leadership. State R was included in the second configuration, which included constancy in leadership, as did the first pathway, and state level infrastructures that could be leveraged to support equity (consistency = 1.0, coverage = 0.33). State R was characterized by science leaders who had been in their positions for a number of years, and who had developed a process of working with researchers over several projects. Leaders in this state leveraged their Framework aligned standards to develop professional development and assessment practices that supported equity. As one leader from State R reported,

> We spent two entire days just that was the topic of [equity].... then decided how that should look within all professional development. So we've really shifted that as *on the front end, not on the back end* of the professional development. (Leader, State R)

As such, this leader indicates that equity became more central to the shared work of their state leadership team. State H was also included in the second configuration of conditions which supported equity because it was in the set of states with routines, infrastructure, and constancy.

The third configuration which supported equity involved only collective efficacy (consistency = 1.0, coverage = 0.5). States J and U met the conditions for inclusion in this set. In State J, collective efficacy took the form of state leaders who were passionate about equity and who communicated those equity-oriented goals to science educators regularly. The state team felt that they worked well together as a group, and they expressed that sources of incoherence in science education were within their locus of control. When asked about constraints and supports to achieving an equitable system of science education, one state leader noted that, despite the barriers, the state was making progress in the right direction.

> I would say discussions at the state level have started. I'm talking about the policy level have started to help, legislators and decision makers understand the need for a coherent system and need for broadening our understanding of equity and offering experiences for young people that really helped move them forward in the science realm. I think those have been most valuable. I think we can talk at the negative; we lack resources, we lack time, we lack money. But I think with what we have had, there's been a lot that's been able to move people forward. (Leader, State J)

These three configurations indicate the ways that the four inputs were arranged in ways that coincided with increased effort and understanding of equity.

Discussion

The challenge of developing equitable systems in education can be overwhelming. The suggestions for conditions needed to transform systems are vast, and they include professional development resources (e.g., Windschitl, Thompson, & Braaten, 2018), guidance for ensuring constancy in vision (e.g., Hammerness, 2008), a diverse array of studies demonstrating the importance of infrastructuring (e.g., Hopkins et al., 2013), and the need for everyone in the system to be empowered to take charge (Goddard & Goddard, 2001). This is all within a policy context that emphasizes the need for coherence and equity. While it is a good thing to have a number of resources and a list of problems, it is helpful to understand the ways these problems can be *resourced* with finite time and energy.

The study presented here takes the approach of comparison and shows how a variety of factors can be configured in ways that allow for equity work in science teaching and learning. For leaders, this should provide clarity through a framework for engagement. By showing how inputs can be configured into four general buckets, and through illustrations of cases where progress toward equity had been made, researchers and leaders can interpret different possibilities for engaging the educators they serve. In the dataset presented, no more than two states demonstrated any particular configuration of the inputs of routines, infrastructure, collective efficacy, or constancy, yet five of them (S, H, R, J, & U) had made substantial progress on equity with a combination of just two or even one input. In an educational landscape where no leader can "do it all," this analysis offers a principled view of how to engage the people and resources that *are* present in a system.

Continuously engaging different levels of the system. Configurations 1 and 2 described above are a combination of constancy with professional learning routines to support vision-building and constancy with strong infrastructures that support education. This is evidence that *either* working with the people who work directly with students OR working to build infrastructure with other leaders are possible routes to progress toward equity when there is constancy in leadership. Three total states had these configurations. This can be thought of as a thoughtful engagement of the hierarchy; a leader can work with state-level or classroom-level educational leaders and make progress.

Having confidence that there is a will and a way. If continuous leadership is simply not present in your state, this study suggests that collective efficacy can support progress toward equity work. As an example, State J did not express a strong infrastructure for educational reform, and they had continual instability in leadership positions and overall less coherence than other states. However, the leaders *did* regularly indicate how confident they were that they *could* bring about educational change for equity (collective efficacy), which coincided with a number of activities that they had undertaken to achieve equity, especially that the leaders interviewed held complex views of equity including deep understandings of historical transgressions in that state. Qualitative comparative analysis does not purport to describe causal relationships, but it makes sense that a sense of "I *can* impact equity in my state" could be related to the fact that leaders *do* things to impact equity in their states. Together, these findings should offer a framework and a way to filter and understand initiatives in their own contexts, especially when there is much work to be done.

Implications

Research on equity in large systems is important, especially in understanding how opportunities are inequitably distributed. Research to date has made limited progress in understanding the roles of SEAs in conducting equity work, and this study offers a conceptual framing for types of activities that may contribute. Alongside the theoretical ramifications, this study has great potential for *use*; it should provide leaders a conceptual framework for interpreting their equity work and asking where their strengths are. Qualitatively, we have offered cases of *the possible*; by offering illustrations of states that have made substantial progress and a theoretical framework that helps denote the types of work that can contribute to equity. The present study offers a systems-level view for understanding the ways that systems *can be supported* to enact more equitable provisioning of opportunity as a contrast to studies that focus on gaps. A further asset to this study is its genesis within a research-practice partnership; the questions that we sought to answer in this study has the potential to more pragmatically support newcomers to SEAs. Working across policy, practice, and research will be necessary to advance the leadership capacity for enacting more transformative models of equity in science education systems. We believe that we have found a methodologically rich way to preserve the histories and contexts of our participants while working to understand the "variation and regularities" (Gutiérrez & Rogoff, 2003, p.23) that help inform the work of educational leaders and researchers.

Limitations

We recognize that QCA is fundamentally qualitative and causal relationships among activities should not be deduced from this analysis. This study was limited to the perspectives of state leaders and colleagues they

identified in their system as leaders or influencers, so the findings should be interpreted with their perspective in mind. Future work should continue to examine the ways that systems of science education are *experienced by* nondominant youth (e.g., Authors, 2019b) and their teachers through coursework and school participation. The learning sciences community should continue to develop ways of examining systemic inequities while understanding the particular, historicized, on-the-ground processes and experiences within these systems.

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