ELEMENTARY PRINCIPAL NETWORKS: SENSEMAKING OF SCIENCE EDUCATION POLICY POST-NCLB

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ABSTRACT

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This study investigates the implementation of science instruction in a low SES/high minority district, and the experiences of individuals in an elementary principal network who inform science standards and curriculum implementation. This study specifically examines how principals make sense of science policies. Given the intra-school and inter-school connections principals have, there are many teachers, content experts, district curriculum personnel, and/or organizations that are external to the school that impact the understandings principals have on policies. Examining the interactions between various actors is complex, however necessary to disentangle both the challenges and opportunities school principals may encounter in implementing science education policies.

Given the transformative nature of instruction the Next Generation Science Standards (NGSS) advocates, principals' success will depend on their understandings of science instruction, and their ability to support their staff through resources, time, and capacity building. The majority of elementary principals have limited formal instruction in science, as well as past experiences, which may impact principal support for science. The research questions examined in this study are: how do elementary principals make sense of post-NCLB science education policies, and as elementary principals make sense of post-NCLB era science education, who do elementary principals seek?

This study employs a mixed-methods multiple-case design (Yin, 2009) to gain an in-depth understanding of the decisions about science made by school principals, as well as to

understand the social capital in the networks of elementary principals in one district. The quantitative component of my study employs a social networks selection model, which was done in conjunction with qualitative interviews to better understand the ties, relationships and the seeking of science information by elementary principals.

Overall, this study sheds light on how a principal's science social network impacts how they make sense of science policies and therefore science implementation. It was found that those who have discussions with various people in their network respond to policies as though they are malleable. While those who talk to mainly those in administration about science view science policies as static, and therefore respond to the science related policies as directives. It was also found that the local policies inhibit the implementation of science in elementary schools, limiting equitable sciences in schools.

Recommendations from this study includes promoting community science thinking, the need to create transformative spaces for administrative learning, and that there are benefits to enabling principals as community leaders. When districts begin to consider community science learning, thinking, and leaders, we begin to view science as a means of equity. Ultimately, students will have the potential to return to their home communities as doers of science as a result of systemic science thinking. The research calls for a need to further investigate districts that center science community leaders and how this then impacts teacher practice and therefore student outcomes. It is important to continue to consider systemically based questions about science education in order to improve science education in schools at scale.

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CHAPTER ONE

Introduction

"I hate science." I often heard these three words from my students during my teaching career at a high-minority/low-socioeconomic status (SES) school. What I soon found, though, was that students did not necessarily "hate" science, but rather they did not *know* science. What students referred to as "hate," rather framed the minimal exposure to science they had received in previous years of schooling. Today, how time is spent in classrooms on various content areas has changed, with time spent on science specifically declining (Blank, 2013). This study strives to examine (1) the current state of elementary science education, (2) how principals make sense of science policies, (3) the intra- and inter-school relationships that inform principals' sensemaking of policies, and (4) examine how the race of a principal may frame how he or she makes sense of information and therefore decisions concerning the implementation of science policies. The purpose of this study is to investigate how school principals negotiate policies (e.g., local, state, and federal), therefore impacting the distribution of capital (e.g., human, physical, and financial) in high-minority/low-SES schools.

Today many elementary students across the United States are provided limited, if any, opportunities to explore the sciences (National Research Council, 2012a), and Black and Brown students demonstrate significant gaps in science knowledge when compared to their White counterparts (Quinn & Cooc, 2015). Black and Brown students have been provided less rigorous and engaging curriculum, taught by less experienced teachers (Darling-Hammond, Holtzman, Gatlin, & Vasquez Heilig, 2005) and have been provided fewer resources for instruction (Banilower et al., 2013). Although there is debate on whether there is a need to increase the number of individuals in the STEM workforce, the fact that current policies are inherently

marginalizing some students, specifically those of color and from low-SES backgrounds, must be corrected regardless. Rather than piquing the interest of students at an early age, programs are recruiting students too late, given that many students decide on their future aspirations by middle school (Schaefer, Rivera, & Ophals, 2010). Therefore, engaging students earlier about science is vital to students' future decisions (Schaefer et al., 2010), possibly in pursuing science careers.

The limited resources in schools that serve marginalized populations, my experience working in schools that serve predominately Black and Brown students, and my experience with school leaders as a teacher and program manager have all led to particular interests in principals in high-needs schools. Principals have complex jobs, experience various top-down reforms (Patterson, Eubank, Rathbun, & Noble, 2010), and weigh the needs of their students, parents, and various district and community stakeholders. These decisions impact the education of those who are marginalized and whose science needs are not being met, especially at the elementary level (Quinn & Cooc, 2015). In an interview I conducted with an elementary science teacher for a previous study, the teacher referred to science as the "third wheel" due to the need to emphasize math and reading in elementary schools. This comment led me to consider how policy has directly impacted this teacher's conceptions of science curriculum implementation, as well as where this understanding came from. The framing of policies is one key role of school principals (Coburn, 2005; Spillane, Reiser, & Reimer, 2002). Is the inattentiveness to science the current status quo because of policies that center reading/language arts and math, thereby pushing science to the periphery? Science instruction should support the development of scientifically literate individuals, which is key to developing the next generation of critical scientists, engineers, philosophers, and artists. Science is all that we do, are, and come to understand.

Some researchers advocate for scientific literacy rather than science content but the distinction between teaching for content and for scientific literacy may not be clear to some educators (Krajcik & Sutherland, 2010). As cited by Krajcik & Sutherland (2010), the National Science Education Standards (NSES) defines scientific literacy as the application of learned content and scientific practices in one's own life or in matters that impact the global community. Scientific literacy should equip students to "critique the quality of evidence or validity of conclusions about science in various media" (p.456). Krajcik and Sutherland stated that this knowledge would require students to effectively read, write, communicate, and critically engage with content. Science content speaks to knowledge of facts, while scientific literacy involves engaging information in one's daily life. Students should be provided opportunities to investigate and to question the world in which they live. Without science in early grades, this development is limited, decreasing the potential of such inquiry, ultimately limiting the capacities by which students engage in the world as well as their future aspirations.

Statement of the Problem

I examined how school principals negotiated policies (e.g. local, state, and federal) that impacted the distribution of capital (e.g. human, physical, and financial) for science policy implementation. I specifically centered the role of school principals because they are key decision-makers for resource allocation (e.g. professional development, time spent on science instruction, time spent in science classrooms, etc.). However, I focused on elementary principals because of the importance of students' early exposure to science, in which the decision-making of elementary principals plays a crucial role (Schaefer et al., 2010). There is minimal research that captures how practicing administrators continue developing professionally, particularly in regard to which experiences (e.g. meetings to unpack policies understanding describing

curriculum, etc.) are helpful and in what ways (Leithwood, Seashore Louis, Anderson, & Wahlstrom, 2004). Given the transformative nature of instruction that Next Generation Science Standards (NGSS) promotes, principals are required to enable their staff to operate at full capacity, which takes resources and time.

Central to these decisions is the role of the elementary principal. However, there is limited literature on who or what organizations support the understandings and conceptions that elementary principals have of science education as well as on how principals negotiate the implementation of science. Given the goal to reconceptualize science education under the Michigan Science Standards, enhanced skills, different curricular decisions, and NGSS-aligned capacities of the current education force will need to be developed. Key decisions concerning time, resources spent, professional development to be allocated towards specific content, and maintenance of policies are often based on decisions made by the school principal, holding principals fully responsible, especially since the induction of No Child Left Behind (Spillane & Hunt, 2010). This positions elementary principals as key stakeholders in science education policy decisions. Researchers have argued that principals spend the majority of their time on administrative tasks (Elmore, Fiarman, and Teitel, 2009; Kmetz & Willower, 1982; Spillane & Hunt, 2010), and oftentimes delegate instructional matters to instructional coaches (Domina, Lewis, Agarwal, & Hanselman, 2015). However, others have found that as much as twenty to thirty percent of a principal's time in today's accountability era is spent on instructional matters (Spillane & Beyer, 2010). When principals do not have information from central offices concerning interpreting science policies or curricula, principals turn to teachers (Spillane, Diamond, Walker, Halverson, & Jita, 2001). However, to whom do elementary principals turn when neither central office staff nor teachers have essential information that informs

instructional practice, and from whom do those individuals gain information? Given the role of principals as instructional leaders, in this upcoming phase of implementation of the NGSS, teachers will be seeking support in regard to capacity building, resources, and needed patience from their administrator.

Background of Science Education Policy After No Child Left Behind

No Child Left Behind (NCLB) prompted fundamental changes in the United States' educational system. NCLB led to the implementation of accountability-based reforms that imposed punitive consequences on both teachers and school administrators if principals did not perform accordingly (Marshall & Brownell, 2015). However, these changes have failed to produce improved student outcomes in science education (Blank, 2013). Although NCLB passed in 2001, the requirement for assessing science was not federally mandated until 2007 (Milner Sondergeld, Demir, Johnson, & Czerniak, 2012). Science learning was then assessed once in elementary, once in middle, and once in high school; in contrast, reading and math are tested every year from kindergarten through eighth grade and once in high school. Given the increased pressures of standardized testing used to evaluate both schools and teachers, students are not being exposed to science at early grade levels, largely due to an increase in time devoted to math and reading/language arts, in lieu of science (Carrier, Tugurian, & Thomson, 2013; Milner et al., 2012; Spillane et al., 2001). It is believed by some educators that students will be able to catch up in science in either middle school or high school, further validating the sacrificed time in elementary school (Pratt, 2007). Today's reality for science in elementary schools is that it is often treated as either an elective —taught once per week, not taught in lieu of other subjects, or made optional – or postponed until after standardized testing is completed. This limited exposure then decreases the amount of science content knowledge students develop, decreases the capacity

of students to be critical consumers and thinkers, and ultimately yields limited opportunities for students to consider the potential of pursuing science careers.

Under NCLB, states were responsible for collecting data and implementing state standards, and schools were sanctioned if they did not perform to said standards. Parents were even given the option to transfer their students to other schools if they elected to leave a school that was designated as "failing" (i.e., school choice). NCLB marks a pivotal point in time at which instructional time for science content began to decline in elementary schools due to the need to prepare students for standardized testing (Blank, 2013; Carrier, Tugurian, Thomson, 2013; McMurrer, 2008; Spillane et al., 2001). The pressures of students performing well on standardized testing resulted in an emphasis on rote memorization and drills, rather than standards-based instruction (Milner et al., 2012).

NCLB has been reauthorized as the Every Student Succeeds Act (ESSA), but policy has yet to greatly shift what elementary teachers are doing in schools in regard to science. *What* takes place in schools is largely determined by the state government (Kirst & Wirt, 2009); while *how* the curriculum will be implemented is largely left to the local school districts. Each state is responsible for adopting standards, and then local districts must determine what curricula are best suited for their district as well as how to support human capacity to implement the curricula to meet those standards. The NGSS strive to re-conceptualize what science teachers are doing in classrooms by providing research-based standards that allow local educators the flexibility to design and implement lessons rich in both content and practices (National Resource Council [NRC], 2012a). However, science professional development has most recently been minimal (Nadelson et al., 2013) and designing science investigations is not necessarily an obligation in which teachers have been expected to engage, which means teachers will need extensive support

in doing this NGSS-aligned work. Although NCLB regulations state that science will be tested three times throughout a student's K-12 career, the means by which schools are deemed to be adequately performing under NCLB did not originally incorporate science performance. This reality caused an increase in attention to math and reading, which were considered high-stakes, while science (and social studies) were not.

Science Instruction for Black and Brown Students

There is a science gap and an opportunity gap between black and brown students and their white counterparts. When considering improving the degree of scientific literacy of students, we must consider the racial/ethnic gaps that exist (NRC, 2012a). Although there are few studies that speak to the specific changes inside of classrooms because of high-stakes accountability (Valli & Chambliss, 2007), researchers have found that when science is taught in low-SES communities, there is little, if any, content, which further widens the gap in science (Wright & Neuman, 2014). Wright and Neuman (2014) observed 2.5 minutes of science content in 12 hours of kindergarten observations. Strikingly, children from low-SES households were found to be taught sixty percent of the taught to children from advantaged households. In communities of low SES, vocabulary was taught to students out of context, which counters how students best learn literacy (Wright & Neuman, 2014). Based on the NAEP 2009, the more time spent on science in fourth-grade classrooms, the greater the score achieved. This exemplifies that there are limited opportunities for Black and Brown students to authentically engage in science. Further evidence of the gap is demonstrated through the Trends in International Mathematics and Science Study (TIMSS).

Although many large-scale assessments, like TIMSS, assess some conceptual knowledge, they are limited in providing insights as to how students understand and explain scientific

phenomena (NRC, 2012a). A costly overhaul of most science assessments would be needed to assess students in meaningful ways. Although the outcomes of TIMSS are limited, there are challenges in providing quality science instruction in elementary and middle school grades for students of color. A science gap exists between Whites and Asians and other races/ethnicities. In 2015, the average score in science for fourth-graders in the United States was 546, ranking eighth (down from seventh in 2011) out of the 38 education systems that take the TIMSS, compared to a score of around 600 for the highest achieving countries. The score for eighth-graders was 530, which placed the US eighth among participating countries, the same as 2011. Since 1995, the scores have been relatively stagnant (Provasnik et al., 2015). However, when we take race into consideration on the fourth-grade TIMMS science assessment, on average, Black, Hispanic, Native Hawaiian/Pacific Islander, and American Indian/Alaskan Native students scored significantly lower than the U.S. average (See Table 1). On the other hand, Asian and White students in the US scored at the level of Japan—the third highest science score for fourth grade.

Table 1: Average Science Scores of U.S. 4th-Grade Students, by Race/Ethnicity: 2015 TIMSS

Race/Ethnicity	Score	Comparison to Average Score of Whites
American Indian/ Alaskan Native	530	-40
Asian	598	+28
Black	501	-69
Hispanic	518	-52
Multiracial	571	1
Native Hawaiian/ Pacific Islander	530	-40

Similarly, if we look at the scores for eighth grade (See Table 2), Black, Hispanic, Native Hawaiian/Pacific Islander, and American Indian/Alaskan Native students were all found to score significantly lower than the U.S. average. The White-Black gap in fourth grade is -69 points and in eighth grade is -88 points, while the White-Hispanic gaps for those grades are -52, and -55, respectively. This is a problem. This research raises attention concerning this science gap that exists within the United States and the implications to actively counter this narrative.

Table 2: Average Science Scores of U.S. 8th-Grade Students, by Race/Ethnicity: 2015 TIMSS

Race	Score	Comparison to Average Score of Whites
American Indian/ Alaskan Native	497	-60
Asian	573	16
Black	469	-88
Hispanic	502	-55
Multiracial	536	-21
Native Hawaiian/Pacific Islander	498	-59
White	557	0

According to the TIMSS data there is a distinct difference between the performance of White students and that of marginalized populations. This is problematic, and therefore more information must be sought to better understand how context matters. According to Reardon, Robinson-Cimpian, and Weathers (2015), by the time students reach the third grade, socioeconomic factors account for just a portion, 60 percent, of the math and reading Black-White gaps. The authors went on to say, “This observation has significant implications for understanding the role of schooling in producing or exacerbating achievement gaps” (p. 14).

Based on their findings, understanding what is happening at the school level will provide insights into the factors creating the other 40 of the Black-White gap.

Next Generation Science Standards: Goals, Development, and Adoption

The NGSS were developed based on *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC, 2012a), known informally as the *Framework*, which identified the three dimensions of learning science: core ideas, crosscutting concepts, and practices that students should learn during their K-12 experience. The goals of the *Framework* are to focus engagement of students on what scientists do, to bridge key ideas across science disciplines, and to scaffold learning to deepen students' understanding of scientific ideas and essential practices over their educational career. The NGSS are based on the National Science Education Standards from the National Research Council (NRC), the American Association for Advancement of Science (AAAS) Benchmarks for Science Literacy, the Science Framework for the 2009 NAEP, and the Science College Board Standard for College (NRC, 2012a). The *Framework* (2012a) was also written considering educational research, how students learn, and how to better prepare students to enter a global economy in science-related fields (NRC, 2012a).

Twenty-six states were involved in the development of the NGSS, and 48 states have adopted standards aligned with the Framework thus far. The NGSS were developed by Achieve, Inc., which is a self-proclaimed "independent, nonpartisan, nonprofit education reform organization" (Who are we, 2018). Achieve, Inc. was also affiliated with the development of the Common Core State Standards. Although the NGSS are not federally mandated, they have been described as the "de facto national standards" for science (Slater & Slater, 2015). While the NGSS are not without criticism, the goal of this research was to capitalize on the current science

policy environment to examine the systemic challenges of implementing a science curriculum, with specific attention to the school principal. In today's post-NCLB policy environment, in many cases, science has been minimized or dropped from the curriculum. The NGSS have the potential to draw the attention of school administrators and principals back to science, though principals and administrators are not likely prepared to do so. With science policies back on the table for discussion, the adoption of the NGSS allowed me to examine how science policies were negotiated based on stakeholder goals and obligations and the resources available within their social network.

Stakeholder interests impact the implementation of science policies in schools (McDonnell & Weatherford, 2016). Given policies are not implemented within a "vacuum," but are rather "layered" on the pre-existing context of policies, histories, and interests—there are a range of factors that impact the implementation of policies (McDonnell & Weatherford, 2016). The implementation of the Michigan Science Standards (a slight variant of the NGSS) in the state of Michigan is a valuable case study given its recent adoption of the NGSS. The state of Michigan, districts, and partners (such as local Intermediate School Districts (ISDs) and the Michigan Math and Science Centers) have initiated the beginning stages of an infrastructure to support school districts. However, given the lack of attention to science in recent years, the administrative support network is disjointed and varied. Information on what the current infrastructure looks like is therefore needed. This information will be pivotal as schools begin to adopt and transition to NGSS-aligned curricula.

Purpose of the Study

This multiple case study investigates how school principals in a low-SES/high-minority district negotiate various policies (e.g., local, state, and federal), that impact the distribution of

resources (e.g., staff, physical, and financial) for science policy implementation. I am specifically centering the role of elementary principals given they are key decision-makers for resource allocation (e.g., professional development, time spent on science instruction, time spent in science classrooms), and make decisions in regard to program implementation based on their experiences and social encounters within the field. Essentially, they determine how a policy will ultimately be implemented. However, decisions may also be impacted by the race of the principal (Evans, 2007; Winn, 2016), which in turn impacts their critical consciousness of events (Evans, 2007).

Given the adoption of the NGSS over the last few years in 18 states, this is a pivotal time for science education reform. Specifically, unlike in past years, teachers are finding time for science curriculum and instruction, and decisions are being made about that curriculum and instruction, as well. The policy changes have now initiated conversations, and schools, districts, and states must now understand what their needs are to comply with their newly adopted standards. As schools and districts prepare, they must first address and be attentive to the deficits in science capacity of both teachers and principals, and how instructional decisions are made based on both contextual and neoliberal factors. Principals essentially serve as boundary spanners (Star, 2010)—individuals who go beyond their role and context to collect and share information with others (Honig & Hatch, 2004)—between the schools they serve and their district administrations. With recent science education reforms such as the NGSS, it is essential to consider in what ways school principals should be supported to better inform their role as instructional leaders as they make sense of these policies.

Given the intra-school and inter-school connections principals have, there are many teachers, content experts, district curriculum personnel, and organizations that are both internal

and external to the school district that impact the understandings principals have on policies. Examining the interactions between various actors is complex, yet necessary to disentangle both the challenges and opportunities school principals encounter when science education policies (standards in this case) are being implemented, given principals' role as boundary spanners. Drawing on sensemaking theory, I examined how school principals made sense of science education policies and how contextual factors (e.g., low-SES/high-minority school, resources, time) contributed to whether science was prioritized in their schools. I was also interested in how (1) social capital may vary between different school principals and how (2) race may play an instrumental role in one's network or in how different principals make sense of policies.

Theoretical Framework

This work is grounded by sensemaking (Weick, 1995; Coburn, 2005) as well as social capital theory (Borgatti, Everett, and Johnson, 2013; Coburn, 2001). Social capital theory and sensemaking are related when we consider that the network a principal has determines the access the principal has to various forms of capital. Therefore, the capital the principal can draw from the network then impacts how the principal makes sense of science related policies.

Sensemaking

Sensemaking accounts for both the individual and social activities involved in decision-making as "situations are progressively clarified" (Weick, 1995, p.11), meaning that understandings are developed over time and are contextually based (Weick, 1995). According to Weick (1995) the messages received and understood by an individual ultimately depend on what the person already knows, which in turn means that information is pieced together, and those ideas are then essential to how the individual will ultimately make sense of newly received information. Spillane and colleagues (2002) added to this conversation by speaking specifically

to the sensemaking of policies, which they described as highly complex. Like Weick (1995), Spillane and colleagues (2002) also identified both the individual (cognitive processes) and the social (situated cognition) as relevant factors in sensemaking, specifically when investigating the cognition of an agent implementing reforms. Related to the individual and social cognition, the race of a school principal has also been found to be an instrumental factor in how principals make sense of information (Evans, 2007). In some cases, although principals describe race to be a non-factor when discussing events or decisions (Evans, 2007), colorblind practices or one's racial identity (Gooden, 2005; Lomotey, 1989) may factor into how they make sense of science education policies. Therefore, the actions of the principal demonstrate a difference from what is culturally accepted versus what is actually enacted in schools (Lewis, 2001), which is better understood through principal sensemaking.

Winn (2016) examined the role of school leaders as instructional leaders in science classrooms. Winn found that Black principals demonstrated a higher level of instructional leadership behaviors. Winn (2016) argued that more work needs to be done to better understand Black principals' engagement in science classrooms, and I believe this research that incorporates principals' sensemaking addresses Winn's concern. Sensemaking provided a lens that allowed me to consider the progression of principal understanding over time and the specific information received from colleagues (e.g., central office administrations, science experts, ISD personnel) that may have contributed to the conceptions of science that school principals had.

Social Capital Theory

Social capital theory allowed me to consider the relationships that principals have with their colleagues and to quantitatively and qualitatively analyze their networks. Because of this methodological approach, I was able to recognize the interactions of key stakeholders that

influenced the implementation of science policies in elementary schools. Principals do not decide on all policies taken up by districts and schools. Rather, principals make key decisions as to what implementation entails and how the policy is framed to teachers, which impacts participation by teachers (Coburn, 2005).

Social capital is a property of the relationships that people have with one another within a social system (Coleman, 1988). There are two factors that have the potential of creating high levels of social capital. The first is whether there is social network closure, which promotes a high degree of connectedness between the individuals within a network. The second, "dense relational ties," influences the level at which people communicate. Strong bonds would promote individuals communicating expectations and would encourage a degree of accountability, trustworthiness, and secured benefits because of an established relationship (Portes, 2000).

Social capital theory, then, illuminates that the connections one possesses are also related to one's access to resources. Frank, Zhoa, and Borman (2004) discussed that ideas that teachers need to draw on social capital in order to effectively implement innovations and that information is diffused through systems. The people who make up a principal's network impacts the information a principal makes sense of, thereby indirectly impacting decisions made by the school principal. These decisions could be concerning curriculum, how to spend finances for resources, or even when to begin complying with policies. These frameworks together helped me to better understand how networks matter when considering how science policies are implemented in schools.

Research Questions

Although there is research that unpacks some facets of science education policy (Blank, 2013), the sensemaking based on information from various stakeholders that results in attainment

and activation of resources by school principals (Spillane et al., 2002) is not well studied. I am interested in examining the systematic approach to implementing school-level science curricula, specifically the role of the school principals. Thus, the research questions guiding this study are:

1) How do elementary principals make sense of post-NCLB science education policies? How does that sensemaking impact decision-making? How does race impact principals sensemaking?

2) As elementary principals make sense of post-NCLB-era science education, who do elementary principals seek? Which organizations do principals seek concerning post-NCLB-era science education? What social capital do these individuals and organizations offer school principals?

Significance of the Study

The results of this study will inform researchers, practitioners, and policymakers. With recent reform efforts, such as the NGSS, it is pivotal to understand the social networks of principals, as those social networks influence principals' decision-making concerning science policy. Utilizing case studies and social network methodologies, this study sheds light on the current state of elementary science education in the United States, which has been minimally discussed in the literature. Race was under explicit consideration in this study, which provides insight into how sensemaking related to science policy is positively or negatively impacted based on racialized sensemaking. Now more than ever, elementary principals are paying attention to science education policy and are scrambling to figure out what these new standards will mean for the teachers and students they serve. It is pivotal to better understand the challenges these principals face as they negotiate a multitude of reform efforts and the need to demonstrate educational success. This research offers a perspective on how principals receive information

from intra-school and inter-school sources, providing researchers and curriculum designers leverage toward enhancing the capacity and resources for teachers via school principals.

Positionality Statement

I write this as a Black woman who had the opportunity to study science from elementary school through college. In elementary school, I was encouraged to both ask and answer questions about the world around me by my parents. My parents also gave my first microscope—I always understood that I could pursue any field I desired. However, this was not the reality of many of the students that I worked with as a teacher or that I have encountered over the years. For instance, I was once on a panel for some students from Flint schools. An African-American girl asked me, how did you know you could do science? For me, this was never a question. This was a point of clarity for me. I realized that many of our students do not believe they can do science, which means our schools are given them the message that they are not able to do science.

I was a science teacher in a low-SES/high-minority school where I experienced the lack of resources and the pressures to prioritize certain students and not to teach science, and I witnessed the moments when my students of color recognized their capacity to be doers of science. I also wanted assistance from my principal. He always gave me high marks after observing me because he saw and heard what he believed science to be, but I knew I could be better with more support.

I believe that my own educational experiences and background frame how I go about collecting and analyzing data and influence what my diverse participants are willing to share with me. My background in science and previous experience as a science teacher provided leverage in the field. I identified with the experiences of my participants. They wanted to teach science, but with various accountability pressures and local policies, they found it a challenge to

do so. However, my background could also potentially yield bias, which I attempted to mitigate. I positioned myself as a nonparticipant observer during the study; I recorded notes and did not become involved in the activities (Creswell, 2012). However, there were times I stepped into a coaching role to support principals and network members in making next steps concerning science. I also recognized my privilege as a member of the academy at times, and strived to focus on how to support principals, paraprofessionals, and central office administrators in obtaining the information they needed to make informed decisions concerning science.

Principals and paraprofessionals also expressed that simply due to my presence, they knew science would be implemented and that their questions about science would be answered by the central office. I did not take this trust lightly. I do this work because I believe that all students, especially those from marginalized populations, should be afforded the opportunity to be exposed to and authentically engage in science. I strive to examine systemic factors impeding the implementation of science in elementary schools. All students deserve equitable science and to know that they too can do science.

CHAPTER TWO

Literature Review

To consider how principals make sense of science education policies, I reviewed literature that examined the role of the principals, with specific emphasis on their role as instructional leaders and in science. I then examined how their role has been impacted since the adoption of NCLB. Next, I reviewed literature related to principal sensemaking and how race may contribute to how principals make sense of policy and curriculum implementation. Lastly, I reviewed literature on the social networks of school principals. My review of literature demonstrated the limited role of school leaders in science education, highlighted the current state of elementary science, and noted the social relationships of school principals to better understand who influences (in school and out of school) the conceptions elementary principals have of science education. For educators in elementary schools to effectively implement science education policies such as NGSS-aligned curricula, school principals must be amply prepared. This underscored the need for an approach to supporting school principals.

Principals as Instructional Leaders

This study centers the role of school principals as science instructional leaders. Principals are the focus of this study, given that the goal of a principal as an instructional leader should be to engage with teachers on their practice to enhance student understandings. Actions we see undertaken by principals concerning science may be a direct result of sensemaking of science policies. Principals have many responsibilities and are obligated to various actors. Principals are viewed as managers, instructional leaders, and the visionaries of their schools. Principals also hold a unique position of being beholden to various stakeholders such as students, school board members, parents, and central office workers, among others (Mangin, 2007; Muse & Abrams,

2011). Instructional leadership has many definitions, but it centers on the role of principals supporting teachers in classroom instruction (Leithwood et al., 2004). Instructional leadership takes intensive, deliberate work that may involve examining student work as evidence of learning and quality instruction (Blase & Blase, 1999), orchestrating human capital (Casey, Dunlap, Brown, & Davison, 2012; Printy, 2010), and actively engaging, collaborating, and consulting with teachers on instructional decisions (Casey, et al., 2102; Marks & Printy, 2003).

When building human capital as an instructional leader in one's school, principals are expected to make recommendations on practice and to model what good instruction looks like (Blase & Blase, 1999). 'Instructional coach' is a new position in many schools. They are there to support the role of the school principal by relieving the time spent on content by the principal. However, the principal still plays a significant role in impacting the delivery of content in classrooms. Effective instructional leadership requires an understanding of each position supervised, support for teachers based on their strengths and potential, and explicit direction on the expectations of coaches/teacher leaders, individuals charged with supporting teachers (Printy, 2010).

According to Honig (2012), principals need support in their role as instructional leader. Instructional time, curriculum, and personnel choices are all key decisions made by school principals who are charged with interpreting policies, so that policies at the federal, state and local level are appropriately addressed, while aligning those policies with local ideals. Taking all these responsibilities together, principals are charged with being able to translate a vision into practice. However, principals may need assistance in doing so.

The role of elementary principals as instructional leaders provides key understandings of the actions that define this role. This study will expand on these ideas by understanding the role

of elementary principals as science instructional leaders. Gaining this understanding matters because many principals do not have science backgrounds and may therefore need support to fully activate the potential of new science standards through resource allocation. Because one of the roles of an instructional leader is to develop human capital within a school, this study illuminates how a principal fulfills this expectation while not having an explicit background in the sciences.

Increased Pressures Caused by NCLB

No Child Left Behind (NCLB) legislation has led to a shift in how principals must make sense of policies and therefore in the decisions they make concerning science. The adoption of NCLB in 2002 led to an increase in public scrutiny on education and shifted focus from the inputs, or resources, to outputs, or academic performance (Lugg, Bulkley, Firestone, & Garner, 2002; Printy, 2010). NCLB is often described as a top-down "attack" on teaching as a profession (Wieczorek & Theoharis, 2015, p. 293). Given the emphasis on high-stakes testing in schools, the principal's role as an instructional leader has, in many ways, been co-opted to produce short-term outcomes. Principals are now responsible for interpreting the ways in which policies are interpreted, amidst many other responsibilities, which principals find to be challenging to navigate (McDonnell & Weatherford, 2016; Knapp, Feldman, & Yeh, 2013). This reality has ultimately led to a greater toll on teachers (Wieczorek & Theoharis, 2015), which principals also need to be supportive of. Reforms and policies at the district, state, or federal level can potentially provide guidance or support to school principals, but they may also inhibit the efforts of school leaders (Knapp et al., 2013). Oftentimes, policies are found to be contradictory in nature, leaving school principals to maneuver this "puzzle," which leaves the interpretation of the policies to be challenging (Knapp et al., 2013). Recent federal education policies such as

Race to the Top (RT3), NCLB waivers, Teacher Incentive Fund grants, and the Every Students Succeeds Act (ESSA) have focused on principal evaluation systems that recommended student achievement be considered (Fuller, Hollingworth, & Liu, 2015). Out of 50 states, 35 are using principal evaluation data to make high-stakes decisions concerning pay, job advances, and continued employment (Fuller et al., 2015). Overall, student performance is now a pivotal factor in determining principal performance given post-NCLB policies, which will drive greater attention to supporting the needs of principals as instructional leaders.

Shifting Role of Instructional Leaders

Instructional leadership requires collaboration and engagement with teachers on their practice (Printy, 2010). However, NCLB resulted in discussion between principals and teachers concerning the pressures, fears, and vulnerability they were experiencing as a result of high-stakes accountability. This further impacted how principals made sense of science policies. Wieczorek and Theoharis (2015) investigated the social, cognitive, and emotional factors that shape how principals at four urban middle and high schools made sense of accountability-driven reforms. In response to the implementation of programming funded through RT3, the principals in one state found that the teachers with whom they worked were anxious and suffered from high levels of stress. Principals found their roles included being supportive of teachers to help them "resist the pressures of victimization" (Wieczorek & Theoharis, 2015, p. 289). Teachers became fearful of the unknown, possible removal, and the pressures of testing. They responded in ways that mirrored fight-or-flight— being scared and in shock. Principals were required to be responsive and in-tune to the needs of their teachers by establishing trust and developing relationships because of NCLB. The principals who participated in the Wieczorek and Theoharis (2015) study saw the policies as leverage to ignite organizational change and did not view the

reforms as problematic. Although this article strived to address how principals use social, cognitive, and emotional problems in their practice, there was little discussion on *what* aspects of practice were changed. The emotional responses of teachers as articulated in this article are important to consider. The challenges experience by principals therefore illuminate that post-NCLB legislation resulted in greater accountability for teachers within a larger context, not only their school or district. High-stakes accountability resulted in a greater level of pressure on teachers given the national attention on education (Lugg et al., 2002; Printy, 2010).

Reitzug, West, and Angel (2008) found that the implementation of NCLB legislation resulted in greater understanding of the context in which teachers practice. The scholars found instructional leadership presents in many ways depending on the values, practices, and goals of a principal. Reitzug and colleagues (2008) sought to determine how principals understood their role in improving instruction during the high-stakes testing era. Their study included interviews with 20 elementary, middle, and high school principals. There were four themes that arose from the data. Principals were classified as relational, linear, organic, or prophetic in regard to their understanding of their role as an instructional leader. Principals that were found to practice relational instructional leadership focused on improving relationships and inspiring beliefs in both students and teachers that they indeed possessed the capacity to do the work. Linear instructional leadership was driven by conceptions of cause and effect. In other words, the implementation of systems yielded a specific outcome, which resulted in another outcome, all of which could be monitored by feedback loops. The authors noted that all the principals who classified as having a linear leadership style discussed the need for pacing guides and data driven instruction, which is distinct to post-NCLB logic. Principals who practiced organic instructional leadership centered the need to respond to one's societal context. Lastly, principals engaging in

prophetic instructional leadership aimed to lead a school toward a "higher calling" (Reitzug et al., 2008, p. 706) and did not accept top-down efforts but rather questioned the assumptions of schooling and pushed teachers to consider their role within the community context.

Being an instructional leader transcends instruction itself. Being an instructional leader also involves motivating and supporting teachers to provide instruction that results in the academic success of students, no matter the political climate. This means taking care of human needs in addition to instruction. Principals must consider the personalities of their staff, the needs of their students, and the various policies and standards that must be taken into account to yield in-sync efforts. What is prioritized depends on how the principal identifies as a leader (Reitzug et al., 2008) and the immense pressures they are experiencing (Lugg et al., 2002). This work engages how characteristics of a principal may impact the implementation of science.

Instructional Leadership in Elementary Science

Instructional leadership for science in an elementary school may differ from that in a middle school or high school given that elementary teachers have had limited exposure to science (Winn, 2016). This leaves principals to be a key decision-maker concerning science and science policies. The literature on the role of principals in science revolves around three themes: principal experience in science, the role of principals as science instructional leaders, and how race may factor into science learning (Casey et al., 2012; Winn, 2016; Youngs, 2007). Most elementary principals have limited formal instruction in science (Winn, 2016), in addition to their past experiences, which may impact principal support for science (Youngs, 2007). Winn (2016) investigated the science backgrounds of elementary principals, the indicators that predict elementary principals' engagement in science, and the role of self-efficacy in being an effective instructional leader in science. Data was collected from 667 elementary principals in 13 states

that adopted the NGSS. Of the teachers surveyed, 21% of elementary principals had formal science degrees; however, as many as 76% had not had recent experiences in teaching science. These findings indicate most principals have limited experience in science, which may in fact limit their capacity to serve in the role of instructional leader of science.

Principals that have served in schools that performed well in science have been found to be supportive of the development of human capital within their schools, specifically around science (Casey et al., 2012). In a survey of elementary school administrators in schools that performed high in science, Casey and colleagues (2012) inquired about the role of principals in science instruction using a rating scale on how the science program was organized, factors principals used to make decisions on science, the influence of several factors on science instruction, and how principals perceived their role in science education. The authors found that principals understood their role to involve encouraging collaboration, aligning the curriculum, implementing practices that support teacher strengths, and developing professional development (Casey et al., 2012).

Lastly, Winn (2016) found that the race of the principal being Black, the number of years of teaching experience, administrative experience, how recently the principal had received science instruction, their experience as a science teacher, and their self-efficacy all correlated with instructional leadership behaviors. However, principals that served in a suburban setting were found to express a lower level of instructional leadership in science.

It may be challenging to be an instructional leader in a content area that had not been initially prioritized, especially considering new standards that do not center content but rather reconceptualize science instruction. This study examined whether these standards are prioritized and how signals are then relayed to elementary teachers. These signals matter, especially in this

high-stakes environment. Although standards have been adopted, unless they are strategically prioritized or there are signals that the changes matter within a given context, they may not actually materialize in substantial ways in the classroom

Sensemaking of Instructional Leadership by Principals

One critical consideration for how principals make sense of policies is via their role as mediators of policy messages, in which they ultimately decide what should be prioritized (Coburn, 2005; Matsummura &Wang, 2014; Spillane et al., 2002). Based on the implementation of reading policies, Coburn (2001/2005) and Matsummura & Wang (2014) sought to understand how principals influence teachers' interpretation and adaptation of reading policy in each of their studies. Coburn (2005) specifically looked at both the content knowledge of principals in two urban elementary schools, and that how content knowledge then influenced the implementation of the reading policy. Both Coburn (2005) and Matsummura and Wang (2014) found principals were responsible for the prioritization of certain signals, interpretation of the policies, and making meaning of the reading policy. According to Coburn (2005), principals both directly and indirectly impacted the ways instructional policies were implemented at the school level. "Direct" involvement was described as the messages enabled by principals, given that they serve as a filter or bridge sifting through and connecting the messages that reach teachers. Considering school principals attend district meetings, are responsible for state-level policy guidance, and make key decisions on which materials and resources are utilized, their understanding is instrumental to policy implementation. "Indirectly," school principals were key in both the social construction of meaning of the reading policies and in developing a professional community that supported teachers in discussing practice.

Researchers have also found that how reforms are framed can potentially impact how

those reforms are then accepted by teachers (Coburn, 2005; Matsummura & Wang, 2014). Coburn (2005) utilized sensemaking and frame analysis (Benford & Snow, 1992) to investigate the social processes of problem-framing at a school in California that adopted reading policies. Although the data for this study is from the time before the adoption of NCLB, the notions raised by Coburn (2005) are essential when considering the pressures of standardized testing and the need to improve performance. Coburn (2005) stated that frame analysis (Benford & Snow, 1992) is not considered in sensemaking theory, which therefore means sensemaking does not account for the "strategic aspects" (p. 346) of making meaning of cues concerning policies. Depending on how problems are presented by school principals, certain messages may evoke certain responses and therefore teacher participation. Essentially, principals can use their higher-ranking positions to evoke frame alignment (Snow, Rochford, Worden, & Benford, 1986) through actions to establish a "conceptual hook" to connect the understandings of participants to the problem, which can ignite "resonance" (Coburn, 2005, p. 347). Therefore, the way in which a policy or problem is framed can move people to action.

The most successful forms of framing defined the problem in ways that allowed people to connect personally to the problem and were not accusatory in nature. Coburn (2005) found that if framing involved blaming teachers for a problem, teachers were not likely to buy in to new policies. Policy-framing based on context is also strategic. Coburn (2005) found that the school principal was able to promote change in school policies in ways that distanced the responsibility from the teachers, which resulted in teacher participation. Given this finding, school leaders could be supported in wordsmithing policy and be empowered to address problems in ways that positively resonate with teachers and yields engagement with and interest in the policy.

Principals' beliefs related to the potential effectiveness of a reform effort have also been found to impact how policies are framed and advocated for and how resources are distributed (Matsummura & Wang, 2014; Patterson, Eubank, Rathbun, & Noble, 2010). In a three-year, randomized, controlled trial, Matsummura et al. (2014) sought to understand how principal sensemaking impacted the implementation of Content-Focused Coaching (CFC), a multi-year comprehensive literacy-coaching program. The authors found that in schools where the program was not readily valued by the principal, more of the coach's time was spent serving in administrative capacities. Ultimately, the human capital was not utilized to its full capacity (also see Mangin, 2007).

Post-NCLB policy implementation can be described as a puzzle that administrators are responsible for navigating (Knapp et al.; 2013). Policies and reform efforts are essentially prioritized (Coburn, 2005; Matsummura & Wang, 2014; Spillane et al. 2002) based on: the principal's personal understandings (Weick, 1995; Spillane et al., 2001); social (Weick, 1995; Spillane et al., 2001) and emotional factors (Wieczorek & Theoharis, 2015; Knapp et al., 2013); contextual (Spillane et al., 2001), moment-to-moment decisions that lead to the perceived practical actions made by principals; and the identity of the principal (Brown et al., 2004). Although it is unreasonable for principals to be experts in every content area, teachers expressed that they do not necessarily value the guidance provided by principals if they do not have some level of competence (Spillane et al., 2001). These competencies impact the managerial obligations of a principal concerning resources related to curriculum, time, and external resources (Matsummura & Wang, 2014).

Principals are ultimately the filters of various policies within schools. Although they may not decide on all policies that are implemented, they make key decisions on what the

implementation entails and how the policy is framed to teachers, which in turn impacts participation by teachers (Coburn, 2005). Studies conducted in urban settings found some of the same overarching findings (e.g., policy-framing impacts implementation, increased responsiveness of teacher emotional needs and external factors to the classroom) (Brown, Anfara, & Roney, 2004; Knapp et al., 2013) as those conducted in non-urban contexts with regards to the factors considered by principals as they made sense of reform efforts. As was the case for principals in non-urban schools, the time allocated to being an instructional leader at urban schools was minimal, not because school leaders did not want to devote the time but because of the many day-to-day demands of their roles (Brown, et al., 2004; Knapp et al., 2013; Spillane et al., 2006). Instruction was also found to be driven by standardized testing, more so when test dates approached (Knapp et al., 2013). In schools that were not necessarily urban but had a large demographic shift in population, the limited level of critical-consciousness of administrators was discussed. In many ways, because school principals are often forced to focus their attentions on matters external to the classroom, teachers were left to fend for themselves (Brown et al., 2004; Knapp et al., 2013; Spillane et al., 2006).

How and what school principals are making sense of as they frame policy implementation to their team of educators is essential to knowing what is prioritized. This research specifically centers science, which has not been specifically centered in the literature. Given our understanding of the potential interdisciplinary nature of science, policy signals concerning different content areas may conflict. Unpacking this reality provided insights into how policies are being understood, which has implications for eliminating this conflict.

Sensemaking of Instructional Leadership in High-Needs Schools

The context of this study is a low-SES/high-minority school. Given this context and given the many competing priorities of principals, sensemaking may vary. Top-down decision-making was found to be instrumental in contexts serving high-minority, low-SES districts (Patterson, Eubank, Rathbun, & Noble, 2010). In lieu of principals being the primary decision makers, central office personnel made many instructional decisions concerning science (Patterson et al., 2010). Principals were "left out of the loop" (Patterson et al., 2010, p. 234) when the implementation of a literacy reform for adolescents occurred in an urban district. Principals were also bypassed when instructional decisions were made, and therefore the policy was not implemented with any level of fidelity. Because principals were not consulted by central office, understandings by central office staff of the realities and feasibility of implementation of the curriculum were limited. Patterson and colleagues (2010) expressed that principals found themselves feeling conflicted about the decisions made by central office concerning the reform for the schools. The authors also noted that there is a need for deeper understanding by school administrators of initiatives in order to work towards a coherent vision and to support the professional identities of teachers. Because this policy was implemented by bypassing the principal, the structures to support the program were not in place for the initiative to be implemented authentically.

One plague that is commonly evident in high-needs schools is limited resources (Spillane et al., 2001). Through interviews and fieldwork, Spillane and colleagues (2001) examined school leadership for elementary school science teaching in Chicago and how principals facilitated the use of limited resources. This was part of the Distributed Leadership Project, which is a 4-year longitudinal study sponsored by both the National Science Foundation and the Spencer

Foundation. Spillane and colleagues (2001) focused on school leadership instead of instructional leadership. The defined the work of a school leader as "the identification, acquisition, allocation, coordination, and use of the human, social, and material resources necessary to establish the conditions for the possibility of instructional innovation" (Spillane et al., 2001, p. 919). According to their study, it was not enough for principals to identify material resources; it was important for them to "activate" those resources. Activation is defined as "how school leaders bring resources together to enhance science instruction" (Spillane et al., 2001, p. 919). Activation of resources proved to be pivotal in urban contexts in at least one other study (Matsummura & Wang, 2014), as well. The findings from Spillane and colleagues (2001) indicate that science appeared to be devalued because it was believed by study participants that students from low-income families did not have the capacity to learn content beyond the basics, which is essentially a deficit mindset (Delpit, 2006) regarding said students.

The work by Spillane and colleagues (2001) raises concerns about equity in science education. Their findings reveal that the mindsets of those serving students in certain contexts have led to instruction that is lower in quality, a concern which has been raised both by scholars (Spillane et al., 2001) and in the Framework for K-12 Science Education (NRC, 2012a). Additionally, policies that center language arts and mathematics have prioritized these content areas. Therefore, top-down accountability systems filter out the instructional areas that are perceived to not be of priority and often these areas, such as science and social studies, "fall through the cracks" (Spillane et al., 2001).

Understanding sensemaking in high-needs schools is essential for understanding the additional challenges experienced by school principals. Many high needs schools are also Title I schools. Title I schools are provided with additional funding because the school serves a high

percentage of students who are from low-SES households (U.S. Department of Education, 2015). There may be additional pressures impacting sensemaking and the actions of principals in these schools. Therefore, by examining sensemaking in a Title I context, this study offers insight on the motivations driving decisions concerning science content.

Sensemaking When Serving Marginalized Students

School leaders within high-minority/low-SES contexts may have different experiences when implementing top-down reform efforts (Knapp et al., 2013; Spillane et al., 2001), including those related to science. When a principal was provided specific training/knowledge about a reform, the information conveyed how the policy was to be interpreted, which was then instrumental in guiding principals as they supported teachers in implementation (Knapp et al., 2013). Knapp and colleagues (2013) expressed a need for professional development for administrators and district leaders. However, when resources such as opportunities for professional development or information on specific policies were limited, the principals sought the guidance of teachers in the school (Knapp et al., 2013; Spillane et al., 2001) or narrowed the curriculum to accommodate standardized testing requirements (Knapp et al., 2013).

Knowledge of a reform does not necessarily correspond to decisions or actions taken by a principal (Matsummura & Wang, 2014). Instead, accountability was prioritized. Evans (2007) took a different approach to investigate the sensemaking of school principals. Evans (2007) argued that sensemaking is related to the local context as well as the principal's race, which influences the principal's conceptions of their capacity to counter the status quo of social structures inside of the school. Evans's (2007) investigation involved three suburban high schools that experienced at least a 25 percent increase in the African-American population between 1990 and 2000. The data was gathered from a larger study in which at least eight

teachers at each of the schools were interviewed, along with the principals. Beyond the interviews, archival data was also analyzed to identify how programs and policies were modified in response to the increase in the African-American population. At one school, Evans (2007) noted both the curriculum and the accepted ways of knowing that were dominant were based on White norms, which marginalized specific ways of knowing. Stereotypes also framed the decision-making of administrators. For instance, at another school, block scheduling was adopted due to the "sociable" (p. 174) character of African-American students. One event described in the article was when White parents kept their children home out of protest of the implementation of a Black history program at the school. These events can be viewed as attempts to white-wash the schooling experiences and indicate the prevalence of deficit-thinking within the district. The principal, a White male, was conflicted in his decision-making to counter the ideals of some of the families in the school community. Evans (2007) argued that the principal's identity as a White male may have hindered him from identifying the events with White families as racialized matters. Thus, Evans (2007) contributed to the conversation about principals' sensemaking by focusing attention on the race of the principal and the principal's ability to recognize the social hierarchies within school settings, as well as their capacity to effectively counter structural hierarchies. White administrators demonstrated their lack of willingness, or possibly capacity, to recognize racialized matters and this lack contributed to their decisions which in turn impacted the school climate and therefore instruction.

Deficit mindsets (Delpit, 2006) were also observed in a multi-site case study by Brown, Anfara, and Roney (2004), where teachers had preconceived notions of students in low-performing schools. Brown and colleagues (2004) sought explanations for the differences between high-performing suburban schools (HPS) and low-performing urban schools (LPS). The

researchers conducted semi-structured interviews with 24 participants and utilized purposive sampling, wherein the teacher participants had completed at least one year of teaching. The interview protocol covered five categories: structural, attitudinal, skill, climate, and instructional features. On curriculum, the teachers at the HPS reported that theirs was advanced and that they played a role in developing and planning implementation of the curriculum and felt as though they were participating in a team or a network. Conversely, the LPS teachers expressed that the curriculum was "imposed," and they were concerned about the students achieving the standards with the provided curriculum. The LPS teachers also felt that their administrators had limited time to support them. McKenzie, Skrla, Scheurich, Riche, and Hawes (2011) found there are specific needs in LPS. What was instrumental in the discussion by McKenzie and colleagues (2011) was the necessity for a school to have the social, physical, and human capital to cope within their specific context. There was also a distinct difference in how the LPS teachers spoke of the community. Brown and colleagues (2004) revealed there was obvious deficit thinking about the families of their students. The HPS teachers talked about what they did for the community and discussed their outreach, and they viewed the community as a fluid entity with the school.

Although the experiences of teachers in high-performing schools and low-performing schools, the responsiveness of principals may also vary by their race. It is essential to better understand how race may impact the understandings Black principals have of their position in schools, yet there is minimal work on how race impacts principal sensemaking in any context. It is also important to consider how principals in minoritzed contexts may serve in other capacities in addition to those discussed thus far. School leaders may take on the role of community leader, establishing rapport inside and outside of schools (Khalifa, 2012). They may view their charge as

preparing marginalized students to enter the workforce as agents of change, dismantling social hierarchies (Dantley, 2005), and possessing compassion for and understanding of the lives of their students (Lomotey, 1993). Culturally Responsive School Leadership (CRSL) provides a framework from which to consider the actions of a principal serving in a school that serves minoritzed populations or is experiencing demographic changes. Khalifa, Gooden and Davis (2016) conducted an exhaustive literature review (51 books and 108 articles/chapters) of works on CRSL. They described CRSL as influencing "the school context and address[ing] the cultural needs of the students, parents, and teachers" (p. 3), given the belief that school leaders must counter the oppressive nature of schooling (Khalifa et al., 2016). Examining the nature of principal networks and principals' motivations for serving marginalized populations is a relevant component of this study's data analysis.

The race of principals is a factor in their sensemaking (Evans, 2007), their motivation for leading (Dantley, 2005; Lomotey, 1993), and how they embrace their role as a school and community leader (Khalifa, 2012). However, this work specifically examined how the race of the elementary principal factored into the decisions made concerning science content. In particular, this study investigated the factors (e.g., the desire to counter hegemonic systems and to improve representation) considered in conjunction with policies on science, specifically the NGSS.

Social Networks of Principals

It is essential to better understand the unique role that principals play. Principals serve as boundary spanners between the school they serve, their district administration, and the state. They are also at the center of key decisions that are at times politically motivated (Jennings, 2010). School principals must make decisions based on in-school and out-of-school factors, serving at the intersection of organizations that have differing priorities and political

considerations. Given a principal's social network, and therefore their social capital, they may have access to differing degrees of information. To understand who principals seek concerning science education, we must first better understand the role of principals as boundary spanners. The following sections of this review of literature focus on whom principals seek for information to inform their decisions: central office staff and principal colleagues.

School Principals as Boundary Spanners

School principals can be described as boundary spanners, the individuals who go beyond their role and context to collect and share information with others (Honig & Hatch, 2004). Essentially, principals serve as buffers and bridgers. Buffers limit the impact that external factors have in causing a disturbance in the functioning of the school by regulating, processing, and transmitting information (Goldring, 1990). Bridgers represent their institution and receive resources, serve as political representatives, and legitimize the functionality of the organization (Goldring, 1990).

One reform effort adopted by districts that has enhanced the degree of boundary spanning has been instructional rounds (City et al., 2011). Roegman, Hatch, Hill, and Kniewel (2015) examined the implementation of instructional rounds (City et al., 2011) and how rounds contributed to the development of relationships among principals with the hopes of enabling a community of practice (Lave & Wenger, 1998). Rounds were viewed as a way to institute "boundary crossing," which Akkerman and Bakker (2011) define as "differences that give rise to discontinuities in interaction and action (p. 139)". Roegman and colleagues (2015) hypothesized that an increase in information through the instituted opportunities to discuss instructional practice would yield an increase in interactions. However, the authors found a statistically significant decrease. This may be a result of institutionalization of practices, resulting in a lesser

need to interact with those within their network. This may mean that when practices are viewed as static, there is lesser desire to interact with those within one's network.

Central Office Support for Principals

There has been a shift in the role of central offices over the last few years from simply focusing on policy compliance and acting as building managers toward providing tools to school principals in order to support district-wide initiatives on teaching and learning (Rigby, 2016). Honig (2012) utilized a conceptual framework drawn from sociocultural and cognitive learning theories in order to investigate the role central office has in implementing instructional leadership support through central office leaders, specifically Instructional Leadership Directors (ILDs). The data from this study included 283 interviews, approximately 265 observation hours, and 200 documents from three urban school districts. The author found that the ILDs were able to support principals in several capacities: tools used to engage teachers in new ways of thinking, broker information, and support as principals thought about how to engage teachers with data. In addition to enhancing specific capacities, district leaders were also found to support principals by limiting the distractions of principals as they engaged in instructional leadership. For example, as a result of conversations had between a principal and the instructional coach, the principal's school was exempted from administering a specific assessment in their building in order to free up time. Although there were several substantive supports provided within this study, Honig (2012) noted there was little information on how the ILDs were trained and supported for their roles and that most ILDs provided supports to the principal based on their own past experiences with schools. Therefore, the human capital within central office may not be standardized and rather the product of the knowledge people gained within their own work experience.

Honig (2014) also conducted research on the implementation of the Principals in Professional Learning Communities (PPLC) initiative, which supports principals in developing their capacities as instructional leaders. Central to the enhancement of practice is the opportunity, in the form of available space/time, to develop common talk (Horn & Little, 2010) in order to grapple with strategies (Honig, 2012; Honig, 2014). The district leaders spent time brokering information (Honig, 2012), while the main goal was to develop a community of practice (Lave & Wenger, 1998). However, when there are tensions between central office and the school, information dispersed from central office to the schools may be limited (Finnigan, Dally, & Che, 2013). In addition, there are times when principals do not value the opportunities to engage with others, and prefer to be told what to do (Honig, 2014). Although time to collaborate was provided, some principals were not interested in having more to do (e.g., attending additional meetings). This illuminates the need to develop a culture in which principals are collaborators of knowledge in partnership with other leaders and central office personnel rather than the recipients of bureaucratic and procedural functions, which is the more traditional relationship with central office.

Principal Colleagues

Principal colleagues also impact how principals make sense of reform efforts. The structure of a principal's network and the strength of the network's ties influence the spread of instructional leadership ideas, ultimately impacting the type of information principals make sense of (Rigby, 2016). Rigby's (2016) work focused on what takes place within the mesolevel— organizational level— between the policy and the implementation of a policy by the agent, in this case, the principal. She specifically examined how the "logics" belief system and practices and the informal social networks of the new principal influenced access of the first-year

principal's instructional leadership logic. In another study, Rigby (2015) acknowledged that the principals' conceptions of their role will shift as they spend more time in the field.

In order to better understand how school principals responded within their environment to various cues, Rigby (2015) studied principals in the first year of their principalships and examined how their teacher preparation network impacted their instructional leadership logic and social network. Rigby (2015) found that preparation programs mattered in regard to how principals understood their role as instructional leaders. In addition, programs that provided ongoing support demonstrated greater influence on the new principals. Individuals within the social network of the principals were often individuals that were peers of the participants during their program or who held the same logic as the participant.

School principals are situated in an interesting position of boundary crosser, which also means they are beholden to various individuals in the school, the district, and the state. This understanding sheds light on the complexities of their position and how it factors into sensemaking. The majority of the scholarship on this topic speaks to the relationship of school principals and their connections within or outside of the school. However, most scholarship does not consider both or all of these relational ties.

Summary of the Literature

Taken together, I found no research that directly spoke to whom principals seek for assistance on science educational policy implementation. Because of the limited research on this topic, I centered my review on the development of instructional leadership and the implementation of reforms. With the adoption of the NGSS, there is a specific need for instructional supports for school principals. In fact, I found that the majority of studies centered around the influence school principals have on teachers, which is limiting when analyzing

organizational questions given there are external actors who impact schooling through their knowledge and access to resources. From this review of the literature, the people that influence principal's understandings of post-NCLB era policies are: central office workers (Honig, 2012; 2014), teachers (Spillane et al., 2001), other principals (Rigby, 2016), and those in principal preparation programs (Rigby, 2016).

Central office support is framed in the literature as shifting from centering policies and procedures to providing human and social capital, which can then support instructional changes in schools (Honig, 2102; Honig, 2014; Rigby, 2016). However, there is little information on how information is funneled to principals or on the specific information that is available at central offices for principals. There is also minimal understanding of central office workers who are in positions to support school principals (Honig, 2012). Central office provides information concerning policy interpretation and makes decisions on how principals need to be supported to do their job well. Principals also obtain knowledge from their principal colleagues. However, as with traditional communication with central office, talk with principals often centers procedures and policies, rather than instructional change (Honig, 2014). Principals supported each other in digesting policies and reforms (Jennings, 2010) and in professional communities (Honig, 2014).

Reform efforts such as instructional rounds attempt to engage principals in a learning community, however, without a change in culture, or beliefs, or drive to change, there may be limited impact on the behaviors of principals (Roegman et al., 2015). In some ways, principal preparation programs indoctrinate participants into a specific way of thinking, "logics," that forefront specific ways of knowing (Rigby, 2016). Thus, principals adopt that mindset during preparation programs and those of the same mindset are likely to then associate with one another throughout their professional careers.

Systemic capacity is essential when considering the ability to effectively implement policies. Honig (2006) found that central office staff were better able to fulfill their job responsibilities, as determined by policies, when they had strong institutional supports with role models, as well as job security. This is likely true of school principals as well, though this may not be the case given high-stakes post-NCLB policies. There may also be a need for systematic support from ISDs and, potentially, external organizations (e.g., professional organizations, state agencies), which did not appear in any of my searches. Support for science is being provided between districts, ISDs, and Math and Science Centers, but in what ways? Who takes advantage of the resources? What is key in my work is that school principals can no longer be treated as bystanders that serve on the periphery of learning, especially by researchers. School principals are a point of power in schools that leverage resources and people. No, science is not perceived as a priority in most schools, but part of my interest in this research is leveraging school science so it is seen as a means for literacy, critical thinking, and as a potential for providing the tools so all individuals become engaged citizens within their everyday environment. There is a need to change the narrative about principals in science classrooms; the ways by which students engage in the world depends on it.

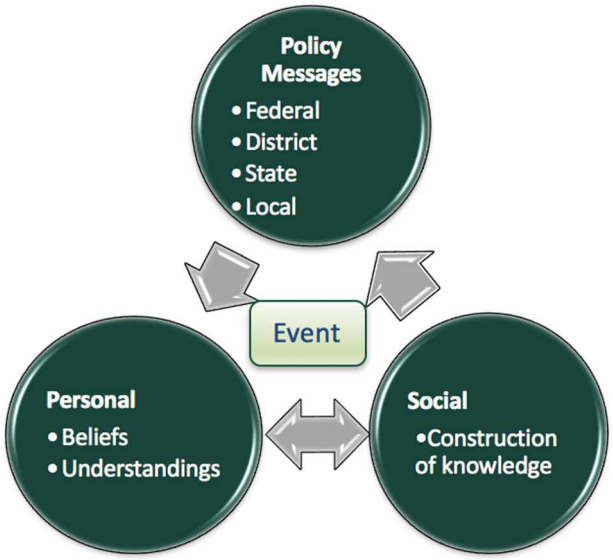
Although there is scholarship on the role of African-American/Black principals (Dantley, 2005; Khalifa, 2012; Lomotey, 1993; Tillman, 2004), there is little on how the principal's race may impact sensemaking. Evans (2007) sheds light on how race shaped administrative decision-making concerning racialized events. Sensemaking concerning content, specifically science, may also be impacted by the racial identity of the principal. This makes my work distinctly different from Evans (2007). Whom one seeks out for information may also vary based on race. If race is not considered in sensemaking, the policy adoption and curriculum implementation are

essentially being treated in a colorblind manner (Bonilla-Silva, 2004), which may potentially promote Whiteness (Blaisdell, 2005). Such behaviors would then continue to facilitate the status quo of inequitable science practices, which continue to marginalize students of color in the sciences.

Application of the Sensemaking Framework to this Study

Coburn (2001) used a sensemaking framework to examine how reading policies were made sense of by teachers. I use a modified version of this framework, shown in Figure 1, to critically examine and to code how these specific components potentially interacted. This framework therefore is used in Chapter 5 to hone in on the relationships elementary principals have concerning science.

Figure 1: A modified sensemaking framework for examining principal sensemaking of science (Coburn, 2001)



Policy Messages

Principals play a pivotal role as the collector, sharer, and synthesizer of various policies they are to consider and prioritize to achieve the greatest academic outcomes of students (Fuller et al., 2015; Knapp et al., 2013). Within my conceptual framework, my goal is to identify the specific policy messages (i.e. federal, state, district, local) concerning science to which the principals believe they are required to be responsive, as indicated through various forms of data (interviews, observations, field notes, survey data). Once a policy message is identified, I then provide insights as to what factors contributed to how the principal situated the policy message and therefore how this situatedness contributed to the principals' sensemaking related to a specific science event. Depending on the message, there were more or fewer opportunities for sensemaking, given that a message may be "self-evident" and thus perceived to be straightforward and not requiring determination of what the specific policy would entail (Coburn, 2001).

Personal

Elementary principals generally have limited professional experience in science (Winn, 2016) and also traditionally have limited experiences in science as a teacher (Nadelson et al., 2013). Principals therefore draw on their personal understandings, beliefs, experiences, and personal identities to shape their actions, their 'worldview' (Weick, 1995), in their teaching and leading of science efforts. I drew from the data to understand how principals personally identified with science.

Social

In this study, the social aspects of sensemaking were revealed through interviews, conversations with the case study principals, and in network surveys. According to Wenger

(1998), individuals participate within communities of practice that are "so informal and so pervasive that they rarely come into explicit focus" (p. 7). In the case of elementary principals implementing science in schools, the social relations of the principals contributed to their understandings of the policy via the principals' account of the conversations, which then may or may not interact with the principals' personal beliefs and understandings. The social interactions individuals have with those within their environments impacted the personal understandings and beliefs held by an individual principal. This then leads to the cyclical nature of the relationship between personal and community-held understandings, as one's personal understandings can then contribute to the understandings of the community (Coburn, 2001; Porac et. al, 1989), or in this case one's network.

Conclusion

From the literature, we know that principals have various relationships with central office workers (Honig, 2012; 2014), teachers (Spillane, 2001), other principals (Rigby, 2016), and those in principal preparation programs (Rigby, 2016). However, this literature does not focus on those who are central to supporting principals in making sense of science policies: ISD science specialists, paraprofessionals, and central office staff. The sensemaking framework provides a means to analyze principal sensemaking and therefore compare the two case study principals in this study. Taken together, based on Coburn's (2005) work with teachers, there are factors (personal, social, and policy-related) that then impact sensemaking. This work examines how these factors (definitions modified for this study) impact sensemaking for elementary principals when considering science.

CHAPTER THREE

Methodology

In this multiple comparative case study (Yin, 2009), I investigated how school principals in low-SES/high-minority elementary schools made sense of the implementation of science curricula, with specific interests in how they negotiate both conflicting policies (e.g., local, state, and federal) and resources (e.g., time, financial capital, limited human capital), given the makeup of their social network. I also considered how the race of a principal contributed to the principal's sensemaking and to the makeup of their social network. This study employed a mixed-methods multiple-case design to gain an in-depth understanding of the day-to-day experiences and negotiations made by school principals. This work will inform the role schooling plays in "exacerbating achievement gaps" (Reardon, Robinson-Cimpian, & Weathers, 2005), specifically in science.

This study is exploratory in nature and there has been no research that has addressed network development and sensemaking around a content area in this specific way. To understand whom principals and members of their network might name as members of their science network, I interviewed two researchers and two state employees who are described by one or more of the following: (1) provide professional development to science teachers in the state of the study, (2) work with science teachers on elementary science research projects, and (3) work at the state level providing support to schools and science specialists. I used surveys to understand the elementary principals' social networks (in-school and out-of-school) concerning science curriculum and instruction. This told me from whom elementary school principals gain information concerning science education. In conjunction with the survey, I also conducted semi-structured interviews to gain an enhanced understanding of the elementary principals' social

networks. The interviews also provided insights as to how principals spend their time daily, as well how conflicting policies (e.g., local, state, and federal) are negotiated and how these prioritizations then impact the distribution of resources (e.g., time, financial capital, limited human capital). In each case, policies either constrain or enhance the sensemaking of elementary principals concerning science policies. To better understand the context being studied I wrote daily detailed field notes.

This was a pivotal time to conduct this study given the newly adopted NGSS-aligned standards, the federal adoption of ESSA, as well as the central office administrations' deliberate attention to prioritizing science education within the district. Given this pivotal time, I was able to capture the change in the network before the implementation of a science curriculum compared to three months after implementation. This chapter includes the purpose of this study, the research questions guiding this study, further description of the design of the study, and introductions of the principals and key science decision-makers in the district of my study.

Research Questions

The following questions guided my research:

1) How do elementary principals make sense of post-NCLB science education policies? How does that sensemaking impact decision-making? How does race impact principals' sensemaking?

2) As elementary principals make sense of post-NCLB-era science education, whom do elementary principals seek concerning science education? Which organizations do principals seek concerning post-NCLB-era science education? What social capital do these individuals and organizations offer school principals?

Study Design

I utilized case studies in this study to examine how principals make sense of science curriculum policies (standards) within specific contexts (Yin, 2009). Case studies enabled me to examine multiple individuals within the case, recognizing that different sites and people offered contrasting outcomes (Yin, 2009). Case studies also allowed me to examine various forms of data (e.g., interviews, field notes, archives, policies) to understand the phenomenon taking place. I also hoped to gain an enhanced understanding of the culture of each case, and therefore I employed ethnographic practices (Creswell, 2014). Regular time in the field with the two case study principals was essential to capturing the daily experiences of elementary principals and to understanding their current reality in a post-NCLB, neoliberal reform environment. A qualitative approach shed light on the various obligations, stakeholders with whom principals collaborate, and experiences of the principals within the elementary principal network.

The quantitative component of my study employed selection models, which were done in conjunction with qualitative interviews to better understand the ties between people, relationships, and shared resources. Winn (2016) found that of 667 principals in her study, which included states that adopted NGSS-aligned standards, 21% of principals earned a science-related degree, meaning 79% had no formal science background. Given this understanding, it was essential for me to understand from whom principals obtained information in regard to science instruction and content.

This study was centered on one district and involved key individuals within and outside the district who were central to supporting principals in making sense of science policies or curricula. Although the state in which the study took place adopted science standards aligned with the Next Generation Science Standards in 2015, actual implementation is not yet required.

Therefore, the research site for this study was a district that was at the beginning stages of implementing a new science curriculum with minimal oversight or repercussions in the short-term.

Mixed-methods is a means to investigate and better understand research questions by mixing quantitative and qualitative methods within a single study (Clark & Creswell, 2011). The larger study will consist of survey data collection from the principals and staff of the five elementary schools in a district, as well as administrators and individuals, external to the school and district, named as central to science within the networks of the principals. Two schools served as case studies to gain a better understanding of the day-to-day role of elementary school principals and the various considerations that contribute to how they make sense of and therefore frame policies (Coburn, 2005), their administrative roles (Honig, 2012), and how teachers (Spillane et al., 2002) contribute to principal sensemaking.

Data Collection

Investigating one school district enabled me to gain an in-depth understanding of both the specific context, and how the principals made sense of the uptake of science policies. I captured the implementation of science curriculum in the Great Lakes Schools by analyzing: (a) semi-structured interviews with principals and other central individuals named by the principals as sources they seek for science support, (b) field notes of site visits to each school meetings (over 200 hours in the field), (c) field notes of relevant science meetings, (d) network sociograms, and (d) survey data.

Semi-Structured Interviews

Semi-structured interviews provide an opportunity to gain an understanding of the participant's perspective about science education. Semi-structured interviews also enable one to

confirm information from the study or insights from the literature. Ultimately, semi-structured interviews allow one to dig deeper into the experiences of principals and science education (Yin, 2009). Face-to-face, 30-to-60-minute interviews (see Appendices A &B) were conducted with elementary principals and individuals named by the principal as those who support their understandings of science instruction, content, and policy (e.g., ISD professionals, central office staff). The information gathered in the preliminary interviews informed the development of the survey instrument as well as the selection of individuals and organizations to contact and to ask to complete the survey. I first conducted initial interviews with the five case principals to: (1) establish whether a network existed from which principals sought advice, (2) learn the names of individuals and organizations within their networks, and (3) gain an understanding of principal perceptions of elementary science. After three months of implementation, the final interview was conducted with each of the principals as well as key science figures within the district. The final interviews ranged from 30 to 60 minutes.

Card sort. During the interview, each principal was provided a stack of cards that indicated specific positions (e.g., principals, teachers, paraprofessionals), organizations, and curriculum developers from whom they might seek support concerning science. This provided opportunities for principals to consider various options, as well as to eliminate specific people.

Surveys

The survey allowed me to gain information about the individuals within the principals' network. That information included specific characteristics about these people (e.g., race, gender) and how often the principal talked to the individuals named. On the survey, I explicitly named individuals within that particular principal's school, as well as central office staff who may contribute to the principal's understandings of science. I also named any organizations and

individuals within those organizations, as identified in the initial interviews. The rationale behind explicitly naming individuals was to support the memory of the principal, in essence supporting their recall in order to gather the most accurate information concerning the network. This is based on data collected for Cognitive Social Structures (CSS) (Krackhardt, 1987).

Field Notes

Field notes allow the researcher to record what is being observed in the field (Creswell, 2012). My field notes included time stamps, a description of what was taking place at the noted time, and a transcription of what was being said about science and by whom. Field notes were collected March until November 2017 for 200 hours. This process lasted until the data was saturated, which enabled me to take note of the impact various factors had on the sensemaking of the school principal. Each case study site was visited on average once per week based on key meetings that would inform my study and on days that would allow me as the researcher the ability to understand the essence of what each school leader's 'typical' routines were. I scheduled full days to be on site, which allowed for informal conversations with principals and their colleagues. Due to my extensive field notes, I was able to recognize in the data the factors that impacted sensemaking of science policy. I also interviewed key science figures within Great Lakes schools to gain their insights on science within the district.

Observations

I attended meetings pertinent to science as well as two principals' meetings in Western School District. I also attended relevant meetings sponsored by the Michigan Department of Education (MDE) and School Improvement meetings. Because of these observations, I gained insights into what matters are prioritized by the school administration, the school district, and the community.

Data Analysis

Qualitative Analysis

Interviews were conducted and field notes were developed. The first round of qualitative data collection, organization of the data, and analysis took place simultaneously so that iterative analysis informed further data collection. Once interviews were transcribed and field notes were cleaned, the notes and transcripts were uploaded to Dedoose. I then coded based on: (1) the literature reviewed in chapter two and (2) new codes not established in the literature that were not anticipated at the outset of the study and were created through open coding. I developed a qualitative codebook in which codes were defined and themes were clarified through patterns within multiple sources of data during analysis. I used multiple levels of coding so that codes could continually be defined and themes understood based on the interviews with principals, network members, administrative staff, and paraprofessionals.

Once surveys were distributed, I continued to collect data at the two case study sites. I axially coded the data to determine the overarching themes that were emerging (Creswell, 2012). Axial coding allowed me to establish themes by relating codes, concepts, and categories to one another (Creswell, 2012). This information was informed the second round of data collection.

Quantitative Analysis

I developed an initial survey instrument for principals to demonstrate the type of questions I would include in the subsequent survey, as well as its format (See Appendix D). The survey was disseminated through Qualtrics. Essential to this survey was learning from the principals whom they sought for science information and resources. The survey was organized by intra-district categories as well as by organizations. According to Henry, Lubell and McCoy

(2012), a survey instrument that provides prompting with targeted subsets (e.g., central office staff, second-grade teachers, ISD staff) can improve reliability.

In my survey instrument for principals, I first sought to gain general background information about the elementary principals, as reflected in the model. The categories for organizations included: the school district, professional organizations, the local ISD, and other organizations named by principals or researchers.

Social network analysis. To gain insights into the network itself, I employed a social network survey. Using this data, I utilized KliqueFinder to develop sociograms (See Figure 2 and Figure 3). A *sociogram* is a visualization of the network at a specific point in time. A *tie* indicates a relationship between two individuals, *actors*, within the network. The direction of the *arrow*s (See Figures 2 and 3) in the case of this study indicates those who were sought for information. Those who participated in the network survey were all *nominators* of those from whom they sought information about science, *nominees*.

Selection models. I utilized two selection models to better understand the network that is developed as a result of whom elementary principals sought for support regarding science education policy and curriculum in terms of certain attributes (e.g., race, gender, information, position). This process helped me to determine the basis for homophily, or whether there was a preference for elementary principals to associate with those who were similar to them. From model (1), I was able to determine the likelihood that principals would associate with specific types of individuals within the district based on their characteristics and taking into account the various factors included in the model: experience in science, gender, age, position of individual providing information. Model (2) enabled me to understand the type of organizations elementary principals in Great Lakes School District seek for information on science and science standards. I

specifically looked at the size of the organization, the tendency of the organization to provide help, and the length of time the organization has existed. I used StocNet to run the models. Netdraw (Borgatti, 2002) was used to generate the network structures before and after the implementation of science curriculum.

The following model was developed based on a review of the literature considering whom principals seek out for information. The model therefore informs my question of whom principals are most likely to seek based on specific nominator characteristics (i.e., experience in science and teaching, time in district, gender, and age) as well as nominee characteristics (i.e., the person's position, experience in science, gender, and race).

$$\log [p(w_{ii'})/1-p(w_{ii'})]= \theta_0+\theta_{0i}+\theta_{0i'}+\theta_1|v_i-v_{i'}|+\theta_2|x_i-x_{i'}|+\theta_3|y_i-y_{i'}|+\theta_4|z_{ii'}|+\theta_5|v_i-v_{i'}| |x_i-x_{i'}| + \rho w_{i'i}$$

Sender level (i) (nominator) tendency to make nominations

$\theta_{0i}=\gamma_{0i}y_i+u_{i'}$

- Experience in Science (low)
- Experience teaching
- Time in district
- Gender
- Age

Receiver level (i') (nominee) tendency to receive nominations

$\theta_{0i'}=\gamma_{0i}y_{i'}+v_{i'}$

- Position (e.g., teacher, principal, instructional coach, central office staff)
- Experience in Science (high)
- Gender
- Race
- Proximity

$\mathbf{w_{ii'}}$ = represents whether i gets help from and i'
i=elementary principals
i'= who elementary principals seek information from
v= race (same=0, different=1)
x= gender (same=0, different=1)
y=district rank (same=0, different=1)
z= proximity (changed this- to in district=1, out of district=0)

In the following section, I will provide context and background information for each of the principals and other key individuals in science education in Great Lakes Schools.

Research Context: Great Lakes Schools

I began working with Great Lakes Schools (GLS) because of general conversations I had about science with the now-superintendent. It was the fall of 2015 and Superintendent Jackson (who served in the role of Special Education Director at the time and later also as the Assistant Superintendent for Curriculum in GLS) and I were members of the same cohort of an educational policy professional development program. The goal of the program was to bring mid-level educational leaders together to discuss, network, and build capacity to potentially lead in the realm of educational policy. During one of our initial meetings, we introduced ourselves and what our goals were for being in the program, and I discussed my interests in science education policy. It was not long after one of these initial meetings that Mr. Jackson came to a meeting and appeared to be alarmed and disturbed when he asked if I could believe that his district was no longer teaching science in the elementary schools. The former curriculum director in GLS had given directives to the school principals that a specific source of informational texts was to be the sole means of teaching science within the district. This was not a surprise to me. This turned out to be just an initial conversation—we went on to have many discussions about science in elementary schools and about the NGSS. In January 2017, Mr. Jackson took on his new role as superintendent, and soon after, we discussed the potential of me working with his district administrators as they began to make sense of what science should and could be in GLS.

Although I began this study as an observer, my role in the study largely depended upon with whom I was interacting. With some participants who valued my perspective, I was a participant-observer, while with other participants, I served as an observer throughout the entire

study. Given my background as a former science teacher and my experience with leadership training and doctoral studies, some participants (e.g., Superintendent Jennings, Principal Loper, Ms. Donaldson) viewed me as a resource and trusted my insights as we navigated their sensemaking of elementary science policies together. There were also times when I recognized differences in power given some participants' jobs within the district. When I was able to leverage my positionality and privilege, I supported those who had limited social capital by providing them space to voice their challenges. At the same time, there were individuals who received me as simply an observer, and I stayed in this role. My participation within the study did not impact the results. I supported bridging gaps between paraprofessionals, principals, and central office—individuals who became central to this study. I did this through supporting sensemaking and engaging in moments of coaching. I expressed to each individual in this study that I was not coming to this research with answers, but rather was hoping to learn with them.

This section serves as a means to more deeply share the richness of Great Lakes City and the individuals who participated with me in this study. To maintain confidentiality, pseudonyms are used for the people participated in the study (including those named above) as well as for the name of the district/city. The individuals highlighted in this section are either: (1) principals, or (2) people who were named by participating principals as instrumental in making decisions about science during the duration of this study. For this section, interview data, local newspaper articles, and field notes were used to write descriptions of both Great Lakes City and the individual cases. This section serves to provide greater insight on Great Lakes City and the individuals (and their motivations) with whom I was honored to study. I first provide background on Great Lakes City. I then present profiles of key players in science education who are discussed with two levels of depth in Chapters 4 and 5. Principal Connell, Principal Loper, Ms.

Donaldson, and Superintendent Jackson are most reflected in this study given the richness of the data collected from spending many hours in the field at their two schools and the high level of contact I was able to maintain with these four individuals. The profiles for Principals Connell and Loper are also more in depth given they will be central to understanding principal sensemaking in Chapter 5 of this dissertation. In Chapter 4, I examine the network ties within the science network, and to best understand the interactions of those within the network, I include brief background information on three GLS elementary principals who are discussed in Chapter 4 and not Chapter 5. I conclude by providing background on the history of science education in the district.

Great Lakes Schools

During the 2017-2018 school year there were 1,500 students in the district of Great Lakes Schools. The demographics of Great Lakes Schools are: Black: 56%, Latino: 10%, Native American: .8%, White: 30% (based on district data, October 2017). The district has a history of Black/Latino students and poor students underachieving across content areas.

Profiles

This section describes the administrators and those who provided support in GLS to administrators concerning science. Table 3 includes background information for each individual reflected in this study.

Table 3: Participant Background Information

Name	Science Experience	Experience Teaching	Time in District	Gen	Age	Race
Connell	No College Coursework	20	20	F	47	White
Cook	Certificate in science	14	0	F	39	White
Donaldson	None	0	25	F	65	White
Grant	College coursework	9	1	M	44	White
Hill	College coursework	22	7	F	49	White
Jackson	College coursework	5	3	F	43	Black
Loper	College coursework	6	10	F	43	Black
Matthews	College coursework	12	10	1	39	Black
Thomas	College coursework	12	1	1	50	Black

Principal Connell

Background

Principal Connell is a White woman in her 40s who has been in the field of education for over 20 years. She is proud of her accomplishments as an educator and as a mother of two girls. Most recently, she served for three years as an instructional coach in the district, and she was in her second year as the principal of Concord Elementary during the 2017-2018 school year. Principal Connell has served her entire educational career in GLS and is from Great Lakes. Although she is from the city and spent part of her schooling in GLS, she also attended the school nearby, which is simply referred to as 'Catholic.' She noted, "I remember even though I went to Catholic, I also went to Great Lakes. I was a Big Blue in kindergarten, first, and part of second…" (Interview 1). Being a Big Blue is a point of pride in the Great Lakes community, as Big Blue is the high school mascot. All students in GLS are referred to as being a Big Blue,

especially when they are deemed to be model students. When walking down the hall with Principal Connell on my second day of field observations, I saw a White teacher and her class stopped in the hallway. The teacher called one student, a Black child, out of the line, as we approached, the teacher bent over with her finger in the child's face and waved her finger as she yelled at him. Principal Connell then went over to the student, bent down, and asked, "Did you hear Ms. [teacher's name]?". Her tone was firm. I was deeply disturbed but understood that I was a visitor in that space.

The next day, I was scheduled to conduct my first interview with Principal Connell. I started with the protocol, but was still disturbed by what I had witnessed. During the interview, I was able to ask Principal Connell about her take on the tone I witnessed from a White teacher speaking to a Black child and about her approach to responding to underlying beliefs some teachers may have about teaching students of color (Delpit, 2006; Emdin, 2016). The following excerpt is from that interview with Principal Connell.

> And you're not telling me anything different than when the class measures group came in to do a school quality review. Several times they said to me, if I were - one of the girls was black, Antoinette and the other was white, so 2 women coming through. Both of them, color aside, both of them picked up on the same thing you did and were like, if I were in that teacher's classroom I would be a pile of mush right now. It's not because she said anything - she didn't say you suck but her tone. How she interacted with them, how she spoke at them not to them or with them. It had to do with that and you're right it's in the tone and body language and how do you change that except try over and over again to bring it up and revisit it? (Interview 1)

In this quote, Principal Connell shared that a school climate report had been done and the concerns raised in the report mirrored what I observed, validating that she was aware of the treatment of students, as were outside specialists. She also asked an important question, "how do you change [the tone and body language of teachers] except try over and over again to bring it up and revisit it?" What Principal Connell did not raise was addressing the deficit mindsets (Delpit,

2006) of her teachers as the school leader. In reference to teachers who talk to students with a demeaning tone, Principal Connell stated:

> That's the kind of mentality that needs to be fixed because I really don't want that person in my building if that's really how they feel. They don't deserve to be working with these kids because now these kids, here at Concord, are my kids. They're mine. I don't want people talking to them like that. (Interview 1)

I share this experience and portions of this interview because I found it challenging as a researcher to witness the oppressive environment experienced by students as discussed by Delpit (1988), Emdin (2016), and Nabokov (1991), amongst others. We ended the interview by talking about texts that Principal Connell could potentially read and possibly one day read with her staff. Principal Connell discussed my recommendations with Superintendent Jackson, who later purchased the texts for Principal Connell.

Principal Connell recognized that Great Lakes Schools is preparing students to be active and engaged citizens in a city that is now different from the city in which she was raised. However, she was challenged when discussing how the population of Great Lakes had changed. When asked if she could speak to the needs of the specific population Concord serves, Principal Connell stated,

> Okay our demographics, our student population has changed a ton in the last 8 to 10 years and even if you talk to Mr. Cook, he would even say this, factory jobs went away. The hands on blue-collar jobs are going away and Great Lakes City used to be huge. We had the paper mill here, we had factories, we had tons of industry here… [The paper mill] I mean they're all gone. So, our students that would come to school who maybe they're not on a path for graduation. We had other things to offer them. (Interview 1)

Here response established that the schools used to be a place that could prepare students to be viable citizens within the community. However, those jobs are no longer available. It was not clear to me how the population being different related to jobs no longer being available. When inquiring about what was meant by "change," Principal Connell stated,

> So, what I'm saying is our demographics have changed for a number of reasons. For technology, for what's going on in the home and what kids are actually coming to school with and what they're not. They've also changed because of not segregating our students based on their abilities and putting them all in the general population and our practices, we haven't been good at changing those. Because like when you've been teaching for 20 years doing the same thing the same way, and it's been okay and all the sudden now it's not okay because kids aren't performing then - you can't just say well this kid can go to the shop school or this kid can... You can't just pigeon hole kids like that anymore. We don't have opportunities to do that anyway so what do we do to help get kids where they need to be? (Interview 1)

In this last passage, Principal Connell did not necessarily discuss the change in demographics, but she did discuss that there have been limited changes in instructional practices over the last 20 years within the district, even though the population has changed. Previously, students were segregated between schools, rather than in schools (Chambers, 2009).

Reflections on Science

Principal Connell has neither recent professional experience nor any experience during her college career in science education. During our conversation, science was discussed as a content area to be implemented and deemed valid and successful based on standardized testing performance. According to Principal Connell,

> Science is important to learning and anything that we're teaching with nonfiction texts, nonfiction subjects is so important because that's how kids are tested…If we take that away and we don't teach them the reading skills and the strategies because you read nonfiction very differently than you read a fictional text…I think we're at a pivotal point as a district of really possibly turning things around by bringing science more as a focus. (Interview 1)

Principal Connell viewed success in science as based on how students performed on standardized testing. In a conversation about whether or not science was being taught by teachers at Concord Elementary, Principal Connell explained to me that teachers just did not have time to teach science because the priorities were math and reading, and asked me if I agreed with her. At that

time, I discussed with her the goals of the state to shift practice towards seeing the isolated content areas as interdisciplinary (Field Notes, June 2017).

Principal Loper

Background

Principal Loper is a Black woman who has been an educator for over 20 years. Principal Loper started her teaching career in Alabama but returned home to Great Lakes City after five years upon being offered an assistant principal position in a neighboring district. Principal Loper was recruited to Leonhard Elementary after the last principal, who was White, was not able to establish a positive culture within the school or to work well with the families of Leonhard Elementary. Principal Loper prides herself in creating a school climate with the familial and supportive environment of her revered Historically Black College and University (HBCU) alma mater. Principal Loper hopes that her presence as a principal inspires her students—she believes she is called to be an educator. She stated, "I think that my experience in school and not having seen an African-American other than the custodian—as a teacher, a sub, a principal, I can be that role model for our kids and I think that's just why I'm here. I think that's just where God has me" (Interview 1). Principal Loper has been working in Great Lakes Schools for 10 years, with the last two years at Leonhard Elementary. As one walks down the hall with Principal Loper, students stop her to show her their work, have a quick chat with her, or to get on her schedule to have lunch with her. It is evident that she is loved. Principal Loper describes her relationships with the children at Leonhard and with their parents as good and says that she can be "candid" with the parents. She described the parents in her school community as doing "the best they can…[parents] send you the best that they have and that's their kids." She went on to say that, "I

connect with the kids to encourage them to think outside the box and let them know there is a world outside of [Great Lakes]."

Reflections on Science

Concerning science, Principal Loper recalls having some coursework on science education, but she has not had any professional development in science since a science education college course. Principal Loper believes that elementary teachers should be comfortable in teaching everything, though she is explicit about the fact that she has spent a lot of her time focusing on reading and that much attention is afforded to literacy at the elementary level. However, when discussing her comfort in supporting science, Principal Loper stated that she believes that she can "manage." When reflecting on her own science experiences, she remembered taking high school biology with Mr. K where she experienced dissecting a frog, a worm, and other animals. She believes students "eat that stuff up" and that if students do not like science, it may be because they have not been exposed to the right experiences. Ultimately, Principal Loper would love for Leonhard to become a STEM school. To Principal Loper, science is a means to future opportunities for her students to be active participants within their community. She said, "You look at the engineering positions, that's where [the students] are going to be able to have a good life if they can acquire those skills and that's through science…" (Interview 1). However, she sees schools resorting to focusing on the content areas that are most heavily evaluated—reading, math, and writing—because "no one wants to be a priority school." She went on to say, "The state coming down to meet these expectations causes us to really zoom in closer in on those content areas. So [educators are] not really allocated that time to do a whole lot with science because we want our kids to be 'successful' (Interview 1)."

There is recognition here that there is an accountability system that prioritizes reading/writing and math. However, science also has a place. When I spoke with Principal Loper before the implementation of the science curriculum that was piloted during the 2016-2017 school year, I asked her what she is looking for when she observes a science class. She responded:

> I look for vocabulary, I look for engagement, I look to see if it's an actual hands-on activity, if the students are engaged? Are the materials ready? I look to see how - doesn't have to be a perfect lesson because as teachers we can model, I'm not quite sure let me go back and review. If they're up teaching. Usually they'll have their teaching guide. It's not until they have taught something over and over and since this is so new, I'm not looking for perfect. I expect them to have their guide handy referring to that throughout the instruction. Checking for understanding and making sure that the kids are a part of the conversation. (Interview 1)

Principal Loper has specific ideas about how to go about reviewing science when she enters science classrooms, as I observed in field observations. Principal Loper wants her teachers to try implementing the new curriculum, and recognizes that it may be challenging and take time to comfortably teach the units.

Superintendent Jackson

Background

Superintendent Jackson is an African-American male who has served in education for over 21 years at the elementary, middle, and high-school levels. He began his career as a special education teacher at a middle school where he taught students who are now classified as Emotionally Impaired (EI) and Cognitively Impaired (CI). He then worked in special education at the high-school level and taught kindergarten for a year.

After teaching for six years, Superintendent Jackson worked as an educational programmer for an afterschool non-profit program. After obtaining his master's in educational leadership, he served in various leadership roles including: dean of students, dean of discipline,

assistant principal, principal, assistant superintendent, and special education director. Beyond teaching and leadership, Superintendent Jackson has also served in the capacity of student activities and athletics director. Although Superintendent Jackson is new to the superintendent position, he served in the role of Assistant Superintendent of Curriculum with limited experience in science and with limited support to principals. Principals expressed their understanding of the many "hats" Superintendent Jackson wore within the district and of what he has initiated as far as science education within the district. According to Principal Hill, another elementary principal in GLS, "what's happened in our curriculum and with administration downtown, there were a lot of hats poor Justin had to wear…". Principal Loper said, "Justin was our curriculum director, so he did bring in those new materials. So that's kind of where we are." She referred to Superintendent Jackson as their "superman" and said that she could not "imagine" taking on all the many roles he has had in the district.

Reflections on Science

It was Superintendent Jackson's daughters who raised concerns about the inequities in science, initiating the superintendent's desire to shift the district's attention to dismantling the science inequities between Great Lakes and other districts. Superintendent Jackson has a 17-year-old daughter, Macey, who during the 2016-2017 school year was a junior in high school. Macey was accepted into a program at a state school designed to enhance the interests of high schoolers to pursue healthcare careers. What recently struck Superintendent Jackson is a conversation he had with Macey about science and the preparation she is receiving to pursue her career goals as an aspiring physician.

> [Macey] asked, why don't we have honors biology, why don't we have AP biology because those are the things that a student like me wants to take but I can't take them… because sometimes in education we cater to the middle or we cater to the low and we end up missing our kids who are high flyers who want to ... I mean

> she's a student, that I know because she lives in the house with me, but since the 7th grade I knew she wanted to go into science. Before it was she wanted to go into forensics now she wants to go into a different area of science but for her there hasn't been any growth. (Interview 1)

Principal Jackson then recalled superficial science experiences he had had beginning in the sixth grade with Mr. A. He recalled combining vinegar with baking soda, a demonstration from which he learned essentially nothing. He contrasted his experiences of learning some general science content (e.g., photosynthesis, pollination) with what his expectations are for his students: "we really want [students] to get hands-on [experiences] of what this looks like, how it affects you, careers, and that area and start building..." Jackson went on to share that his high school science and math teachers both had degrees in social studies and that he then supervised these teachers when he became a principal at the same high school where he went to school. Once No Child Left Behind was adopted, his high school math and science teachers were not classified as highly qualified. The teachers who taught him could no longer teach the content areas they had been able to teach for many years. Superintendent Jackson's goal was not to be "critical" of these teachers he himself had in the 1980s, but rather to shed light on the fact that many of the teachers who were and currently are teaching science should not be doing so, because they are not highly qualified.

Ms. Donaldson

Background

Ms. Donaldson is a White female and the science paraprofessional at Concord Elementary. She has been working in the district in various capacities for over 25 years. Twenty-five years ago, Ms. Donaldson and her husband, a former school board member, decided to send their children to Great Lakes Schools. Ms. Donaldson then decided to get involved in her oldest son's classroom. Within a few years, an overload aide position became available and she was

offered the position given the work the principal saw her doing with students. She later took on other positions, including working with parents to support them in reading to their children, and she eventually became a science paraprofessional after the district decided to pilot a hands-on science program because she was thought to be a good fit for the role.

Ms. Donaldson as a Science Paraprofessional

The support that Ms. Donaldson provides each teacher is based on the teacher's needs, requests, and as she states, the "comfort" the teacher has with science. During the 2016-2017 school year, Ms. Donaldson held science "classes" with 23 out of 26 classes once or twice per week. Given that fourth-grade classes have been historically tested on the M-STEP in science, she met with fourth-graders twice per week. Teachers were not required to schedule sessions in the science room or to utilize Ms. Donaldson. All of the teachers who did not utilize the science lab during the 2016-2017 school year were in higher grades. One teacher was a fourth-grade teacher who previously served in the role of Math and Science Coordinator for the district but was demoted under the previous administration. Two other teachers also did not utilize Ms. Donaldson, one of whom was a sixth-grade teacher who taught two sections of science as a team teacher with her grade-level partner. In the 2016-2017 school year, Ms. Donaldson the percentage of teachers within one school that Ms. Donaldson was serving was the greatest it had ever been throughout her twenty years of serving as a science paraprofessional.

Ms. Donaldson understands her role is to provide support to the teacher by gathering materials and setting-up labs for students, which she is able to do under the directives of the teacher. However, she also recognizes that many teachers are not comfortable with science, and she wants the lessons to be successful for students.

> I have found that a lot of teachers are very hesitant to do science. They're not comfortable, they're either not comfortable with these things - living things. A lot

> of people aren't comfortable with living things. Or they're not comfortable just with the curriculum itself. They don't understand it, they never excelled in science or they don't have a science brain or they don't think they do. I always try to say you know elementary science isn't that difficult. It isn't. (Interview 1)

Ms. Donaldson wanted teachers to take the lead; however, there was limited guidance from administration on how to effectively utilize the science room.

Ms. Donaldson was viewed as the science expert, and many teachers would defer to her, even arriving to the science lab without reviewing the lesson, thus demonstrating the reliance some teachers had on Ms. Donaldson. This became challenging for Ms. Donaldson, as support staff, given some teachers would exclusively do science in the science room with her rather than doing science lessons in their classroom. In fact, prior to working with Principal Connell, some principals would go to Ms. Donaldson and ask her who was and who was not doing science. However, she recognized a difference in attention to science during the 2016-2017 school year given she did not receive contact from any other schools (e.g., instructional coaches, principals) about science. According to Ms. Donaldson, "either they're not doing science or they're only doing reading."

Teachers commonly call or email Ms. Donaldson to also support them in class science activities, especially those involving living things.

> So just this morning, 'Ms. Donaldson will you come and transfer our pupa into the' -- just simple things because they're just not... I'll talk them through it. It's really pretty easy you know, they start moving, it's because they feel danger and we gather the kids around and we talk about it with the kids. I've had so many of them say I didn't know that. I didn't know that. I didn't know that. A lot of them have done this for many years but I'm not sure if they don't read the information or if the information isn't there for them to read. (Interview 1)

Although Ms. Donaldson is viewed as a resource within the district, she is not viewed as a resource concerning science to the new administration. When Superintendent Jackson rolled out the science pilot, there were talks that the Battle Creek Science Curriculum (BCSC)—the

curriculum that Ms. Donaldson had long been using— could not be considered to be piloted because it was not NGSS-aligned. According to Ms. Donaldson, she informed them,

> That's not true! They have started revising their units to the Next Gen. So, I got with …Mr. Jackson's administrative assistant of curriculum... I said, I'm going, to do up a list here because this is what we need because what BCSC did is if you already had all of the other units; they gave you a way to raw materials from the other units to create a kit so you didn't have to buy the whole kit. They just sent us the new teacher manual. (Interview 1)

Since this interview, BCSC was implemented by all five elementary schools and Ms. Donaldson was included on the committee that reviewed the five science units.

Other Great Lakes Elementary Principals

With the recent adoption of the BCSC, principals were expected to be responsive to their respective teachers. However, each principal has varied experiences in science (Winn, 2016). I will now provide brief backgrounds for GLS elementary principals whose network ties within the science network are examined in Chapter 5

Principal Grant

Principal Grant is a 43-year-old White male. Principal Grant is new to Great Lakes Schools and is in his first year as the principal of Norton Elementary. Prior to working in Great Lakes, Principal Grant served as the assistant superintendent of a small local district, and before that he served as the executive director of elementary and early education in a larger school district in the state. He came to Great Lakes after being recruited by the superintendent, who had previously worked with Principal Grant. Superintendent Jackson described him as someone who will make challenging decisions for kids. He stated, "People may not like decisions Principal Grant makes, it's not personal, it's for kids." Principal Grant was a teacher for seven years, two of which he spent as a science specialist. With 13 years in administration now under his belt,

Principal Grant is experienced in both leadership and in science, but he decided to leave central office roles after missing being in schools daily.

Principal Hill

Principal Hill is a 49-year-old White female. Principal Hill spent the majority of her educational career in a neighboring district that was taken over by a state emergency manager after she had been teaching for over 22 years in the district and serving as a principal for two years. According to Principal Hill, "Anyone that had more than 16 years' experience was not asked to come back and that's when I came to Great Lakes where then last year I became a principal here." She now has four years of experience as a principal. Principal Hill had some coursework in science in undergrad, but while teaching, she does not feel she was provided the resources to adequately teach science. Of her experience teaching science, Principal Hill stated,

> When I first taught science in [a nearby district] and we were told, this is what you're supposed to teach but we had no materials so you would rummage and pillage and find units and things, I mean if you could find a book with transparencies to use on the overhead it was gold! Oh my gosh would I read and read about light because in 6th grade that's what we did. I thought this just does not make sense to me, I just don't get it! (Interview 1)

Principal Hill was excited about lessons from Investigating and Questioning our World through Science and Technology (IQWST) she had been observing in her sixth-grade classrooms. She was amazed that she was understanding the lesson and that even at her age, she was still learning. She stated, "that made me feel really good about having a program that's engaging our kids and making them excited to think." Principal Hill was excited about the potential of the science experiences her students would be exposed to that she never had.

Principal Matthews

Principal Matthews is a Black woman and is the youngest of the principals at 39 years old. Principal Matthews has a background in criminal justice, and after college, she started

working in education as a guest teacher (substitute teacher) in the same neighboring district Principal Hill worked in. She was encouraged by principals to pursue her teaching certification, and the district paid for her coursework. As an alumna of the district, Principal Matthews was appreciative. However she realized she would be obligated to teach in that district for five years of her career if the district completed paying for her education. She therefore completed the payments on her courses and decided to do her internship in Great Lakes Schools to "see how everyone else was doing." At the time, Great Lakes was doing much better than her previous district, so she wanted to learn why it was perceived to be a better district.

Principal Matthews expressed her frustration with having minimal support in the area of science from Great Lakes Schools. In fact, she stated that instructional coaches were provided more instructional training than principals. When asked about her role as an instructional leader for science, Principal Matthews stated, "As a district we're struggling with science. Science is tough…Prior to last year our science curriculum was 15 years old, literally. So, the same science curriculum that we had when I started here as a teacher 10 years ago, is actually the same science curriculum we have now (Interview 1)." Principal Matthews, highlighted a systemic problem that would need to be addressed in Great Lakes Schools.

Administration

In January of 2017, Great Lakes Schools hired Superintendent Jackson, a Black educator, to lead the district. Prior to Superintendent Jackson, the district had a White male superintendent, Superintendent Forest, who was specifically hired to balance the budget, and his goal was to see that the district became financially stable during his tenure. Superintendent Forest was able to garner approval of a 1-mill tax proposal for a sinking fund and the future construction needs in the district (from article about the district). Once this goal was achieved, the district was deemed

to be financially stable. Superintendent Forest named Superintendent Jackson as his successor. At the time, Superintendent Jackson was serving in the role of assistant superintendent of curriculum and special education.

The goal of the new administration is centered on providing quality educational opportunities to the students of Great Lakes Schools, with science being central to these key changes. One challenge for the new superintendent and for the newly hired administration is that Superintendent Forest made some key administrative changes, including the demotion of several central office personnel and two principals who now serve as teachers and as an elementary dean. There are many questions that staff have about these placements; however, the former administration is gone, and Superintendent Jackson is not able to speak to the decisions made during the previous administration. According to Ms. Donaldson, some in the district believe that Superintendent Forest still has some presence in the district, given that he is being paid as a mentor for Superintendent Jackson. However, Ms. Donaldson stated that she is not sure what exactly he could be mentoring on given the administrative state he left the district in, which was a reference to the limited trust in the previous administration concerning both hiring and firing (Referenced in interviews with Donaldson and Jackson). According to Ms. Donaldson, the former math and science curriculum director, who "Sold her house in [in a nearby city], built a house here, [whispering] when most people knew she was not the fit to begin with," is now a teacher at Concord Elementary; in fact, she is described as a strong teacher by Principal Connell.

In this chapter, you were presented with the context of this research study and introduced to the key players. Principals Connell and Loper, Superintendent Jackson, and Ms. Donaldson all served in vital capacities as Great Lakes took up science in a substantive way given the limited attention science had received in previous years.

Systemic Implementation, Influence, and Race in Elementary Science

Sensemaking and social network analysis jointly provided insights into the networks that developed as a result of the adoption of new science standards. The standards reconceptualized what has previously been practiced in science classrooms and required information seeking. By utilizing sensemaking, I was able to better understand the factors influencing the decisions being made in schools by principals as they were charged with implementing new policies and with communicating this information to teachers.

Trustworthiness

To validate the data collected, triangulation was utilized to establish converging sources of data (Yin, 2009). Triangulation of the data involves examining different resources in order to justify themes (Creswell, 2014). Given multiple sources of data, I was able to corroborate information and establish findings and conclusions from said data. I conducted multiple interviews with participants (principals, teachers, central office staff, ISD personnel) to confirm the accuracy of the information discussed in other interviews and of network data, to provide participants opportunities to further explain responses expressed during previous interviews, and to discuss any changes after three months of curriculum implementation (Creswell, 2014). By interviewing school principals, teachers, and other network members, I was able to establish a more nuanced understanding of the responses of the principals regarding policy adoption and as they negotiated the various roles they play (e.g., instructional leader, supervisor, building manager, community leader). Interview responses, survey data, and field notes served as data that illuminated patterns. This triangulation of data confirmed in my analysis what contributed to principal sensemaking.

CHAPTER FOUR

Elementary Science Networks

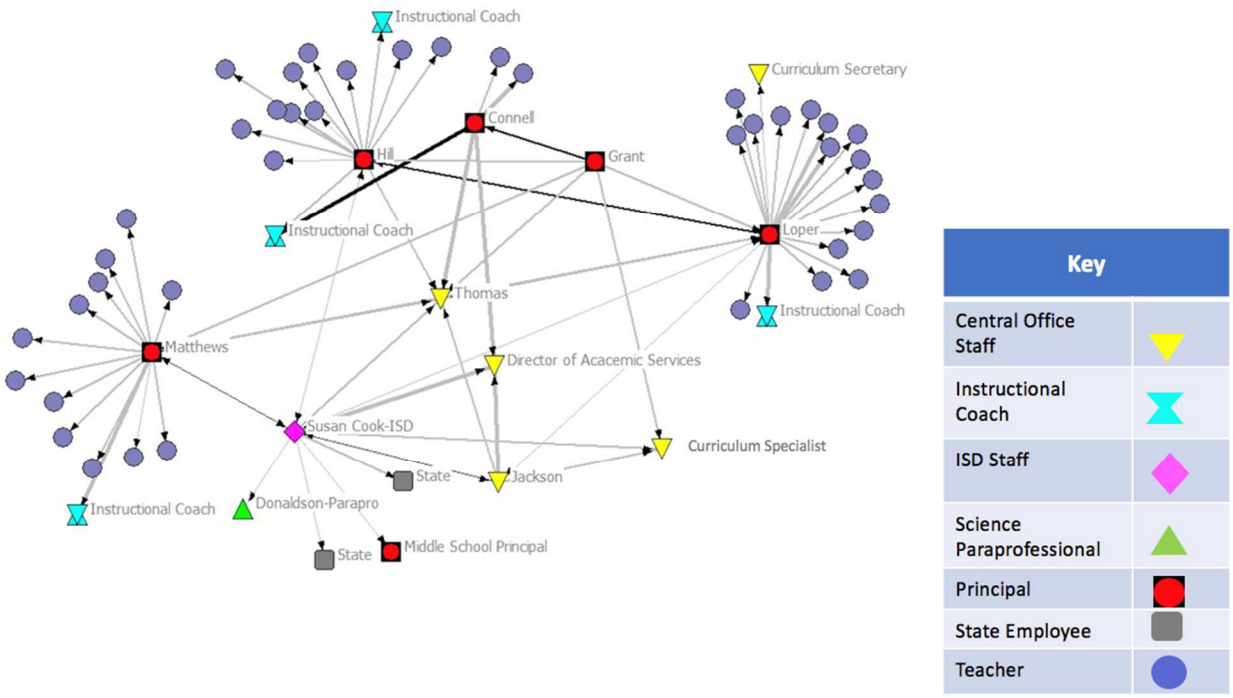
In the study conducted by Winn (2016), the majority of elementary principals did not have professional experiences with science education, often not since their undergraduate experience, while others had no science support even during their undergraduate experience. Given 48 states have now adopted the NGSS or some variation thereof based on the *Framework*, there is a need to understand the resources and information elementary principals have access to in the wake of these new science standards. The transformative nature of instruction the NGSS advocate requires principals to be provided professional development on science instruction. The 3-dimensional nature of the NGSS highlights the practices scientists participate in, crosscutting concepts, connecting sciences across the domains of science (life science, Earth science, etc.), and the core ideas within those aforementioned domains (NGSS Lead States, 2013). Altogether, this is a fundamental shift, and most principals are not aware that they are in need of support because they have yet to be charged with examining the standards, investigating curricula that align with the standards, or developing a curriculum. Examining how a district starts implementing science policies and how the network concerning elementary science begins to develop may provide insights as to who in the network is framing these policies and thus impacting how they are then adopted by the those in schools (Coburn, 2005). My examination offered insight on who was in the greatest need of training within districts. My examination revealed that investment in key individuals with the greatest network ties may have the greatest impact on the adoption of science curriculum aligned to the NGSS. Understanding the key individuals within both the district's leadership team and within outside organizations can guide the development of capital.

By developing capital within one's network through relational ties, information could filter through the network, depending upon the connectivity and density of the network. One's ties therefore determine the type of information and resources one has access to (Lin, 2001). Schools and districts have leadership teams responsible for various operations within a school, which Spillane and colleagues (2001) referred to as distributive leadership. Coordination of the activities while taking into consideration the human capital of the leadership team is instrumental in successfully managing schools (Sun, Frank, Penuel, & Kim, 2013). In the case of implementing new science standards, principals are in position to draw upon their network to guide their staff as the science instructional leader. This chapter aims to shed light on where information concerning science is coming from to guide science instruction in one urban district.

Elementary Science Network in Great Lakes Schools

During the 2016-2017 school year, each Great Lakes elementary school piloted a different science curriculum, which was decided by the then-curriculum director, now-Superintendent Jackson. After the pilot, principals were administered a network survey to understand from whom they were receiving information about science, including content, curriculum, instructional support, and resources. Based on the information I collected, there were 84 ties, or connections named, between all principals, administrators, teachers, and ISD staff members (See Figure 2).

Figure 2: Sociogram after Pilot I and before implementation of Battle Creek Science Curriculum in all elementary schools



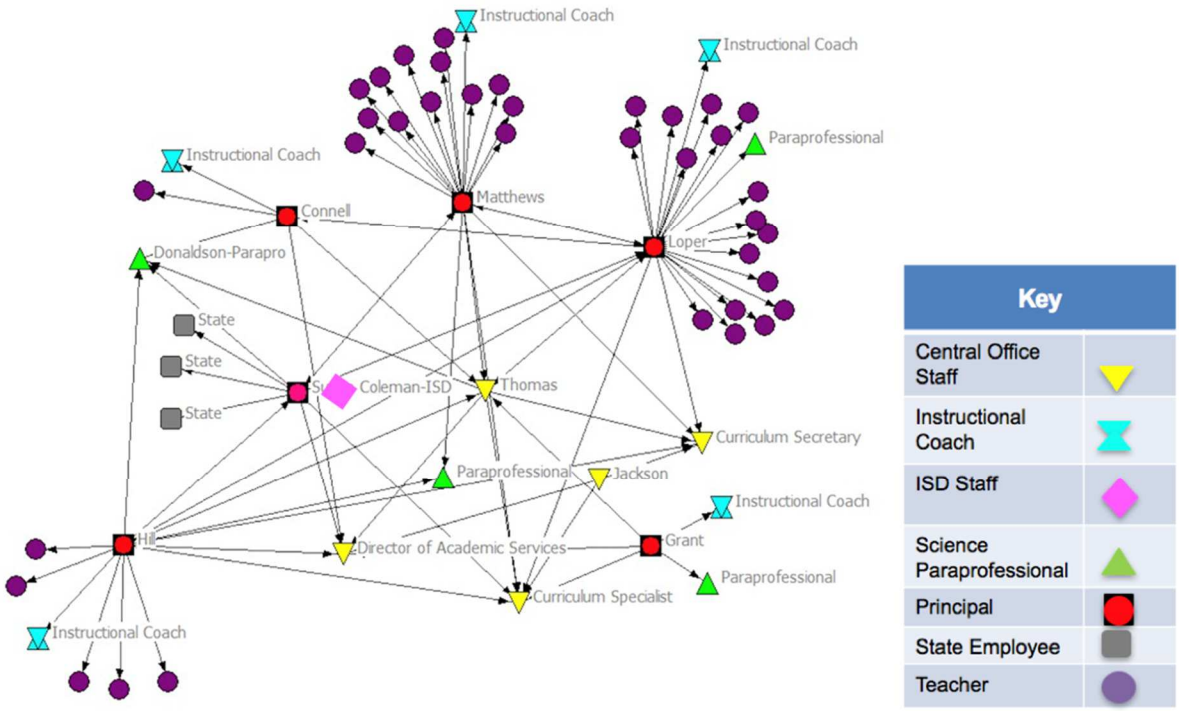
During the summer of 2017, all elementary school teachers and instructional coaches were provided professional development by Battle Creek Science Curriculum trainers. Principals were not able to attend the professional development due to a principals' meeting that was scheduled by central office at the same time. The next set of network data was gathered three months after the implementation of the BCSC. The resulting number of ties were 94, an 11-percent increase of 11 percent in the number of ties across the network. Although there was an increase in overall ties, the negative value of the density parameters for both before the implementation of BCSC and three months after implementation indicates that the probability of a relation is smaller than 0.5 for covariate values equal to zero. The reciprocity parameters are both positive, but not very large. Though the reciprocity is larger for post-implementation, it is still rather small, indicating that advice relations tended to be symmetrical but that this was not a strong tendency (See Table 18).

Table 4: Overall Effects

		Parameter Estimate	Standard Error
Density	Pre-implementation	-1.187	1.091
	After implementation	-2.358	.777
Reciprocity	Pre-implementation	.1229	.894
	After implementation	1.008	.838

The science experiences a principal or administrator has is positively related to their advice being sought. Therefore, more advice is sought from those principals and administrators with more science experience. On the other hand, the level of experience teaching an administrator has is not related to the advice being sought from that administrator.

Figure 3: Sociogram three months after initial implementation of the Battle Creek Science Curriculum in all elementary schools



These connections tell us how people are connected to one another concerning science, based on the perspective of the principals. The strength of the tie is represented by the thickness of the connecting line. When comparing Figures 2 and 3, it is clear that the principals and administrators named each other more often, indicating there were fewer structural holes (Burt, 2002). It is important to note that teachers were not surveyed and that only teachers in a principal's schools were named on the surveys. The initial interviews and the card-sorting exercise (as discussed in Chapter 3) revealed that principals sought different groups of people for varying reasons.

The network survey data analyzed using the selection model shared in Chapter 3 also indicates the network became more directed after curriculum implementation. Before the implementation of the BCSC curriculum, the sender variance was 1.540 and the receiver variance was 1.990 after controlling for the covariates in this analysis. The variances of the sender and receiver covary positively. This means that the more principals or administrators tend to seek information about science, the more likely it is that advice is sought from them about science. Random effects could be seen both before and after implementation of the science curriculum. After the implementation of the BCSC curriculum, the sender variance was 1.8237 and the receiver variance was .3720 after controlling for the covariates in this analysis. The variances of the sender and receiver covary positively, but this covariance was less than the pre-implementation covariance. This may indicate a higher tendency for principals to seek more people for information before the unit implementation (Figure 2), while the principal network became more directed after the implementation of the curriculum (See Table 5 and Figure 3).

Table 5: Random Effects

	Parameter Estimate	Standard Error
Nominator variance before implementation	1.540	1.121
Nominee variance before implementation	1.990	1.487
Covariance between nominators and nominees before implementation	1.328	1.035
Nominator variance after implementation	1.824	1.651
Nominee variance after implementation	.372	.324
Covariance between nominators and nominees after implementation	.3523	.534

In the following section, I will unpack these ties and highlight what was gained by principals from people within their network based on the positions of those people (instructional coaches, teachers, central office staff, other principals) and the challenges in obtaining information about science.

Instructional Coach

Although instructional coaches could take on many roles related to supporting instruction in schools, their role was largely dependent upon the administrative staff in central office. There was tension discussed by principals involving the instructional coaches before implementation of BCSC. According to Principal Matthews,

> The instructional coaches will get the training before we do, and I kid you not, we are expected to be the instructional leaders in the building but again hopefully with Jackson and the new central office staff that will begin to change. (Interview 1)

When asked about the direction of science, Principal Hill also touched on the fact that as an instructional leader, she was provided little information in comparison to her instructional coach:

> Some of those things [about science] were communicated more to my instructional coach than to me as a leader of our building. The other principals feel that way too. So, we

> started having our own meetings because we felt like we were being left out of the loop. (Interview 1)

The elementary principals were largely left out of the conversations about science curriculum as well as other content areas, which led to tension between principals and instructional coaches. According to Principal Matthews,

> … so it's hard to be the instructional leader in your building when you're not always the one receiving the training. We have great instructional coaches here in the district, they are awesome. But in actuality they receive more training than we do. To me, we should be the instructional leaders in our building so we should be the ones going into the classroom if my teacher is struggling then I need to model, or I need to coach the teachers but that's not necessarily happening. I can see the changes that are coming because with Mr. Jennings and the new central office staff, they want us to be in the classrooms more. (Interview 1)

Principal Matthews saw hope in the new administration but found it frustrating that she was not able to support her teachers as an instructional leader because she was not adequately provided the tools to do so. However, one's experiences with instructional coaches may also contribute to how one views the role of the instructional coach in relation to science instruction. According to Principal Grant, "Instructional coach in science is not something." Principal Grant believed this based on his experience in administration and how he saw the role of instructional coaches at the middle- and high-school levels. Principal Grant noted, "When I was in [a nearby large city], we used a coaching model called Content Focus Coaching and we had, this is at the middle and high school, and every content had a coach." The role of instructional coaches varies (Domina et al., 2015). According to Galey (2016), there are three main roles instructional coaches play: supporting practice, enhancing capacity, and accommodating instructional policies. Principal Grant was not familiar with instructional coaches playing a role in science, and therefore did not expect insights on science from his instructional coach. This was a perception specific to Principal Grant. In contrast, according to Susan Cook from the ISD, instructional coaches at GLS

received Next Generation Science Exemplar training (training that was developed to align with and support educators in implementing the NGSS) during the Fall of 2017. The role of instructional coaches at the elementary level did therefore include science support.

Conversely, Principals Loper and Matthews shared that they included their instructional coaches in meetings about science with the ISD representative. Thus, there appears to be at least some degree of partnership around science between the principal and the instructional coaches in their schools. Before the curriculum implementation, principals were asked to indicate the type of information they sought from instructional coaches. Two principals indicated they sought information about resources (Table 6), instruction (Table 7), and policies and standards (Table 8). In comparison, after three months of implementing the curriculum, all five principals indicated they sought information from their coach about science resources, four sought information about instruction, and four sought information about policies and standards. What is important to notice is that pre-implementation (pre), both Black principals sought information from their instructional coach, while none of the White principals consulted with their instructional coach about science resources. However, after implementation (post), all five principals sought information from their instructional coach. It may have become clearer in the district as a whole that the instructional coaches could indeed play a role in science, and therefore White principals named coaches post-implementation.

Table 6: Principals Who Sought Their Instructional Coach on Resources

	Pre	**Post**
Connell	X	X
Grant		X
Hill		X
Loper		X
Matthews	X	X

Table 7: Principals Who Sought Their Instructional Coach on Instruction

	Pre	Post
Connell	X	X
Grant		
Hill	X	X
Loper	X	X
Matthews		X

Table 8: Principals Who Sought Their Instructional Coach on Policies/Standards

	Pre	Post
Connell	X	X
Grant		
Hill	X	X
Loper	X	X
Matthews		X

According to Principal Connell, there was a more centralized understanding about science after systemic implementation of the curriculum. She explained, "…we haven't had science instruction be a focus for our district in so long that right now, it just is important that the instructional coaches, the principals, and the central office staff are all on the same page. We're just all having conversations like that to come together." This may indicate that the role of instructional coaches expanded because of the centralization of instructional decision-making around elementary science.

Intermediate School District (ISD) Consultant

The ISDs had specific roles within the State of Michigan. In Michigan, the ISDs are tightly connected to the Math and Science Centers located throughout the state, and they offer various workshops and support staff to their assigned districts. The three principals within GLS who sought information from the ISD consultant, Susan Cook, sought information about science resources, instruction, policies, and standards. Overall, the ISD consultant for GLS was largely accepted as a science expert. However, the principal and district were largely accountable for the final decisions made in implementing the curriculum. According to Principal Loper:

> I find so often in my time as elementary principal, I've also had a lot of experiences where the ISD consultants will make recommendations and we kind of jump on board and we don't do enough of the action research or the independent reading. So then when it doesn't work out the teachers are upset, or when we move onto something else. Before we try to adopt or I bring things to the teachers, I try to do independent reading to see if it's done in urban schools or what are other teachers saying, or what are principals saying. Then I will talk with my teachers and kind of get their input so when I'm able to meet with other principals then we're having the conversation. (Interview 1)

Here Principal Loper shared that the reliance educators may have on external consultants is great, which may lead to rushed decisions that are not completely vetted. However, the principal is ultimately left to defend the curricular decisions made; ISD consultants are not held accountable for these decisions. Principal Loper indicated she independently reads in order to orient herself with the information she received from the ISD consultant. When asked to further explain how she described her independent reading, Principal Loper stated:

> Going online and surfing and trying to find out what the program is about. What does it look like? So I will kind of start here with the ISD Consultant and just finding more. I usually do that in conjunction with maybe having my instructional coach as part of the conversation when I talk to the ISD consultant. You know, I'll take her suggestions or recommendations and then I'll do my independent reading (Loper Interview 1).

Principal Loper initiative to become, to the best of her ability, an expert, and she largely relied on Susan from the ISD as a starting point for information about science, rather than as a means to an end. Different than Principals Connell, Hill, Loper, and Matthews, Principal Grant considered himself to be relatively confident in science given his background as a science specialist. When asked to do a card sort based on where he received information about science Principal Grant stated, "I don't know about Math and Science Centers [institutions around the state that provide math and science support to schools]…My own professional experience would be the first and foremost as something that taught me." Susan works for both the local ISD and the local Math and Science Center. Math and Science Centers are regional and provide varying level of services. Principal Grant stated in both interviews that he did not know who Susan Cook was and had not

engaged with either the local ISD or the Math and Science Center since beginning his tenure in GLS. When talking to the Elementary Curriculum Specialist, Dr. Thomas, I asked if there were a way to support new staff in navigating science support. When I shared that Principal Grant was not familiar with Susan Cook, her response was she would "need to connect them." There was no systematic way to support the development of a new principal's science network. Also important is that Principal Grant identified himself as one who is relatively comfortable with science given his experiences teaching science as a science specialist. Thus, Principal Grant did not necessarily seek support concerning science. Instead, he accepted the support provided by central office and relied on his own understandings and experiences.

Lastly, something important to note is that both Black principals sought the ISD for either resources, instruction, or information on policies/standards (See Tables 9, 10, 11). However, only one of the White principals named the ISD consultant as someone from whom they sought science support before the implementation (Pre) of the curriculum, and none of the White principals named the ISD consultant as a source of information concerning resources, instruction, or policies/standards after implementation started (Post). This difference between Black principals and White principals is important because it indicates a broader network for information seeking amongst Black principals in this study.

Table 9: Principals Who Sought the ISD Consultant on Resources

	Pre	Post
Connell		
Grant		
Hill	X	
Loper	X	X
Matthews		X

Table 10: Principals Who Sought the ISD Consultant on Instruction

	Pre	Post
Connell		
Grant		
Hill	X	X
Loper	X	X
Matthews		

Table 11: Principals Who Sought the ISD Consultant on Policies/Standards

	Pre	Post
Connell		
Grant		
Hill		
Loper	X	
Matthews	X	X

Principals

Within the GLS network, both before and after the implementation of the curriculum, principals minimally relied on other principals. Although monthly meetings were held at central office, these meetings were often dedicated to the specific agenda developed by the central office staff. Updates about science implementation took place at these meetings, and the principals could ask questions of the central office staff. Yet principals often mentioned what they should talk to principals about rather than what they did, in fact, talk to them about. One principal, Principal Grant, named all the principals as individuals he spoke to about resources (Table 10). This may be because he was new in the district and he was still trying to become acclimated to his role. Besides Grant, no other principal named specific resources they discussed with other principals. In the post-survey, Principal Grant did not name any principals as individuals he spoke to about science. Concerning instruction, Principals Loper and Matthews indicated they talked to one another. Principal Connell named Principal Hill as the individual she spoke to on issues related to instruction (Table 13) on the post-survey, while Principal Hill named Principal Connell as the individual she sought for information about policies and standards (Table 14).

Based on my field notes, when Principal Loper had questions about science, or any other quick question throughout the school day, she called Principal Matthews. When Principal Connell had questions throughout the day, she called Principal Hill.

The relationships between Principals Loper and Matthews and Principals Hill and Connell may parallel what Rigby (2015) found in her research. After principals participated in a principal preparation program, those who became members of each other's social network were often peers during the program and also held the same logic investigated in the study. Based on the network ties and the limited opportunities for principals to talk, the ties within the network were relatively weak, and information was not readily dispersed. Principals often discussed what they *should* talk about with their peers. Ultimately, with weak ties and connections between principals, the information was not dispersed.

Table 12: The Number of Participating Principals Sought by Participating Principals Concerning Resources

	Pre	**Post**
Connell	0	0
Grant	4	0
Hill	0	0
Loper	0	0
Matthews	0	0

Table 13: The Number of Participating Principals Sought by Participating Principals Concerning Instruction

	Pre	**Post**
Connell	0	1
Grant	0	0
Hill	0	0
Loper	1	3
Matthews	1	1

Table 14: The Number of Participating Principals Sought by Participating Principals Concerning Policies/Standards

	Pre	Post
Connell	0	0
Grant	0	0
Hill	0	1
Loper	1	2
Matthews	0	1

Teachers

Teachers were sought by principals for different needs compared to administrative staff, other principals, and instructional coaches. Principal Connell sought a teacher who she would categorize as a science expert (See Tables 15, 16). The teacher taught third-grade science, but previously served as the science and math curriculum specialist for the district in the previous administration.

Table 15: The Number of Teachers Sought by Participating Principals Concerning Resources

	Pre	Post
Connell	0	1
Grant	0	0
Hill	0	3
Loper	16	0
Matthews	1	0

Table 16: The Number of Teachers Sought by Participating Principals Concerning Instruction

	Pre	Post
Connell	1	1
Grant	0	0
Hill	11	3
Loper	16	12
Matthews	2	13

Table 17: The Number of Teachers Sought by Participating Principals Concerning Policies/Standards

	Pre	Post
Connell	0	0
Grant	0	0
Hill	0	4
Loper	5	16
Matthews	13	0

Three out of the remaining four principals named at least 10 teachers as part of their network either before or after implementation of BCSC. Principal Hill named 8 fewer teachers after implementing BCSC than before. I followed up by email communication to learn what she thought may have contributed to her decline in naming teachers as a resource, and Principal Hill stated:

> Before school, there was a lot of conversation regarding the Battle Creek units. As school has progressed, the discussion has significantly reduced. Perhaps because in the current instructional minutes there's so little time for science or social studies. (Personal communication, February, 19, 2017)

This quote demonstrates that if the value of content is a factor of the local and state policies that are taken up in schools, behaviors mirror those beliefs and understandings (Reitzug et al., 2008). Before school starting, there was professional development for teachers. However, principals were not able to attend due to another meeting scheduled at the same time. The teachers who attended the professional development likely had questions and were attentive to understanding the new curriculum, yet they could not use their principals as resources due to their absence from this summer meeting. Although there was an understanding by principals that science would be prioritized, there was tension when it came to implementing math, reading/language arts minutes and science minutes given the local policies with regard to the instructional minutes allocated (See Appendix E). Since more minutes were allotted to reading/language arts and math and since student performance on standardized testing in these content areas determined whether schools were deemed successful, science was not prioritized.

The number of teachers with whom Principal Hill discussed science instruction declined (see Table 14). Additionally, the number dropped by 4 for Principal Loper and increased by 11 for Principal Matthews. As described in Chapter 4, Principal Loper gathered information from her community, which can be seen in the fact that she named 25 people before implementation

and 26 afterwards. However, as for Principals Hill and Loper, most of the information gained from teachers was categorized as instructional (Table 16). Principal Matthews also named teachers as individuals she talked to regarding polices and standards. I did not collect data that described what the policies and standards conversations entailed, as "policies and standards" was not further defined in the survey. This could be a limitation to my study.

Paraprofessionals

One of the major changes within the district was the addition of science paraprofessionals at each of the elementary schools. Before the implementation of the curriculum, only Principals Connell and Hill shared in their network survey that they had conversations with Ms. Donaldson, the science paraprofessional at Concord Elementary. The role of the science paraprofessional during the 2017-2018 school year, as expressed by every administrator and member of central office staff, was to provide resources to the staff. Based on the survey, this is what principals most often indicated they talked to their science paraprofessional about (Table 18).

Table 18: The Number of Paraprofessionals Sought by Participating Principals Concerning Resources

	Pre	Post
Connell	1	1
Grant	0	1
Hill	1	2
Loper	0	1
Matthews	0	1

Table 19: The Number of Paraprofessionals Sought by Participating Principals Concerning Instructional

	Pre	Post
Connell	1	0
Grant	0	0
Hill	1	1
Loper	0	1
Matthews	0	0

Table 20: The Number of Paraprofessionals Sought by Participating Principals Concerning Policies/ Standards

	Pre	Post
Connell	1	1
Grant	0	0
Hill	1	0
Loper	0	0
Matthews	0	0

During a paraprofessional professional development in September of 2017, there was a conversation that took place that indicated some specific challenges encountered by the science paraprofessionals. The following excerpt is from the meeting:

K: I got pulled to sub on Monday, Tues, Thurs, and Friday—

Donaldson: You're getting pulled? That's not supposed to happen

K: What it's saying is the science interventionist is not important.

Donaldson: It's going to put you behind on what you are supposed to do.

K: They said "We want someone who can sub" and the administrator decides to pull me when she wants

Researcher: I think this has to go to Dr. Thomas

Although principals were utilizing the paraprofessional for science resources, in many instances they were also viewed as an extra body that could potentially substitute for an absent teacher or be available at the principal's discretion. Paraprofessionals are part-time employees who work 19 hours per week. The paraprofessionals in this conversation were concerned that they were hired under one job description, but once they got to the school, the principal had different expectations of them. "K" expressed that she had served as an interventionist in the building where she was now working as a science paraprofessional. The principal explicitly told her she was hiring her so that she could use her as a sub. This was very disturbing considering "guest teachers," as substitute teachers are called in this district, are paid less than the hourly rate

of the science paraprofessional. The paraprofessional expressed frustration, and she was concerned that she would lose her job if she said anything. She was essentially hired for one job and was forced to substitute teach for a lesser pay rate than what she was hired at in her paraprofessional role. The exchange I observed was one of the few times I stopped being a researcher and became an advocate. It was clear to me that there was a power dynamic that left the paraprofessional voiceless. I recommended the paraprofessional stop the conversation and wait until Dr. Thomas returned.

Multiple principals interpreted the role of the paraprofessional based on their specific building needs. Principals are responsible for interpreting the ways by which policies are implemented, amidst many other roles (Knapp et al., 2013; McDonnell & Weatherford, 2016). However, it was clear that there was a tension in goals between central office and some principals in the ways they were utilizing the time of the science paraprofessionals. One science paraprofessional was more than happy to sub on her off days, but she stated that she was being pulled in to sub on the days she was scheduled to serve classes. Each science paraprofessional had a schedule for each day they were in the building that they coordinated with teachers to produce. During the professional development, another paraprofessional who was a retired teacher shared that one teacher told her, "once the teachers don't need you, science paraprofessionals will probably be eliminated."

Although central office was working to provide the necessary supports to make sure science was happening in the schools, the mindsets about science had not considerably changed. As Dr. Thomas said, changing how science is perceived will "take time." However, as Principals Hill, Grant, Loper, and Matthews all described to me during their interviews, with such limited time allocated to science each day, science is not viewed as a priority. My observations and

interviews revealed that the science paraprofessionals are in a position that is challenged by the tension of providing a service that is not prioritized but that they are hired to perform for 19 hours per week.

Those who were found to be central to the network were Dr. Thomas, the elementary curriculum specialist, and Susan Cook, of the local ISD. According to the network survey, the science experiences a principal or administrator had was positively related to their advice being sought. Therefore, more advice was sought from those from principals and administrators with more science experience (See Table 21). Those with the most science experience were Dr. Thomas and Susan Cook. However, Dr. Thomas and Ms. Cook also have formal positions within the network, making it challenging to determine whether their science experience was instrumental in their being sought.

Table 21

Table 21: Receiver Covariates

	Parameter Standard	**Standard Error**
Science Experience	1.247	.575
Experience Teaching	.0931	.2383

In contrast, an administrator's level of experience teaching before entering an administrative role was not found to be related to the likelihood that advice would be sought from that administrator.

This chapter discussed the type of information sought by actors within the science social network. There was no evidence that the likelihood of seeking a person for science information is related to race, gender, or position. What is not clear is how individuals may align based on motivations for supporting science. Chapter 6 highlights how race may in fact factor into the motivations principals have for implementing science.

CHAPTER FIVE

Sensemaking Within an Elementary Science Network

Amid this demanding reality, little is known about how science policies are being adopted in elementary schools in the era of both the Common Core State Standards and the NGSS. In Chapter 4, I explored the development of a science network of all the elementary principals in one district as a new science curriculum was adopted and implemented. I also provided insights as to the type of information elementary principals seek out to support science education in their school, which is dependent upon the social capital they have access to within their network. The analysis thus far in this study reveals that principals seek different groups (e.g., teachers, other principals, administration, and science specialists) based on the type of information they can provide. Although not statistically significant, this research also reveals that previous experience in science may contribute to the likelihood of being sought for science information.

To better understand how principals are making sense of science policies within their local context, in Chapter 5 I illuminate specific science-related connections as demonstrated through the network data. I examine how principal sensemaking of science is largely influenced by the interactions of the policy messages received by the principal, the principal's personal understandings and experiences with science, and the principal's social interactions within their network. Specifically, I demonstrate that both race and how a principal personally identifies as an agent of their community/school impacts how that principal then engages within their network.

Principals are responsible for and are held accountable for interpreting and overseeing the implementation of various policies (local, state, and federal) as they are implemented at the

school-level, especially since the adoption of accountability-based reforms (Lugg et al., 2002; Printy, 2010). Considering this policy environment, principals are forced to determine their role as administrator given the specific policy that orients practice towards data-driven instruction and pacing guides (Reitzug et al., 2008). School leaders in urban contexts have incurred criticism, ridicule, and judgement, and they are ultimately being held responsible for low academic outcomes of marginalized populations who have been historically mis-educated by the United States educational system (McGhee & Nelson, 2005).

In this chapter, I examine the sensemaking around science policies of two elementary principals, Principals Connell and Loper, who were introduced in Chapter 3. The goal of this chapter is to highlight the realities of two elementary principals serving in an urban school district. I illuminate the actions of school principals by examining events principals "notice or select," given their positionality. The principals' noticing or selecting then leads to actions based on their understandings, and those actions result in a shift in the organizational culture over time (Coburn, 2001). In the first part of this chapter, I share my analysis of four specific science events defined as a meeting, occurrence, or pivotal moment of sensemaking that centers science implementation or content decisions (Coburn, 2001). These four specific events include two events for Principal Connell, who identifies as White, and two events for Principal Loper, who identifies as Black. Although Principals Connell and Loper have extensive backgrounds in education, 20 years each, they are different racially and have differing beliefs about science. To understand principal sensemaking, I utilize event mapping by applying a modified conceptual frame from Coburn's sensemaking work (Coburn, 2001). There are three components analyzed in the data, depending on the specific science event identified: the policy message, the principal's personal beliefs and understandings, and the social factors contributing to principal sensemaking

(See Figure 1). Finally, I discuss the overall themes that arose based on the analysis conducted, and I address the following research questions: How do elementary principals make sense of post-NCLB science education policies? How does that sensemaking impact decision-making? How does race impact principals sensemaking?

Principal Connell

Event #1: Selection of a Curriculum

A central event identified by Principal Connell, principal of Concord Elementary, was the selection of a science curriculum within the district. While discussing a recent conversation about science in which Principal Connell had participated, she stated,

> My latest conversations [concerning science] are about what curriculum are we going to adopt, is it going to meet the standards we want it to meet, is it going to have all the [NGSS] components, and how is it going to be like or not like Battle Creek [Science Curriculum (BCSC)]. [Also] do we get it because this school has been very Battle Creek-immersed over the past three to four years. (Interview 1)

In this statement, Principal Connell centers recent conversations she had with central office administrators. That conversation seems to have raised many concerns about both what the district must attend to in selecting a new curriculum and how individual schools will need to be responsive to the district's expectations once that selection is made. Great Lakes Schools is also especially attentive to the recently adopted state science standards that align with the NGSS. Concord began implementing BCSC during the 2015-2016 school year and was the only school to do so for two reasons. First, Concord was the only school to continue teaching science despite directives to stop doing so, since the previous principal had allocated school funds to maintain the role of the science paraprofessional who supported science after the original funding from a grant was exhausted. When these monies were exhausted, other schools no longer had a science (or math) paraprofessional (each school had either a math or science paraprofessional depending

on what was selected by the principal at the initiation of that grant). Secondly, the previous principal of Concord also purchased BCSC to be implemented during the 2015-2016 school year, and the program greatly valued by Ms. Donaldson, the science paraprofessional.

Principal Connell described an event where she was the receiver of information, rather than an active participant in determining the direction of science at Concord. Based on the state of science at Concord during the 2015-2016 school year, which was better than at the other elementary schools in the district given the implementation of BCSC and the presence of a science paraprofessional, Principal Connell was not instrumental in solidifying science implementation at Concord. She inherited the school from a principal who had made the needed budgetary decisions to guarantee science would be taught. Science continued at Concord with little insight or direction from Principal Connell (based on field notes and Interview 1 with Ms. Donaldson). Principal Connell's description of the event illuminated questions she had that she viewed as district-level decisions, which did not involve her role in the decision-making process. This is also evident in the wording "get it," implying the decision about curriculum is not her choice, but rather handed to her from district administrators.

Policy Messages. The policy messages received by Principal Connell were largely based on directives from central office and therefore centered the local obligations determined by the district central office administrators. When I asked Principal Connell from where she gets information about science, she responded by stating, "First and foremost…I get my information from central office...then I'm talking to other principals, instructional coaches, teachers, and I'm gathering that kind of information…Personally, this is how my mind operates (Interview 1, March 2017). Principal Connell saw her responsibility as taking directives from central office first and thereafter acknowledged there were new staff members at central office with whom she

could work directly. However, it was also clear the expectations Principal Connell had of administration was based on common features of NCLB. According to Principal Connell:

> What I loved about [science curriculum] in the past was that we had our curriculum and we had a pacing guide and we had assessments. It was just given to you like here this is what we're teaching. This is what our curriculum is, this is our pacing guide… [you] might tweak or change here or there depending on this or that but we kind of had that. When we had Discovery Works (the curriculum adopted 15 years prior) for science we had a pacing guide, we knew which units. Every first grade taught at this time and this unit. Our kids are so transient that they are moving so we have to try and keep our instruction in all our buildings and all our grade levels kind of need to be on page 37 on day 37 but at least in the ballpark so they didn't have the living things unit at one school and then they had to redo the whole living things unit again at the new school. (Principal Connell Interview 1)

What I first want to draw attention to is what Principal Connell stated she loved about previous science curriculum: pacing guides, assessments, versatility, which has been found to be common amongst school leaders post-NCLB (Reitzug et al., 2008). Although Principal Connell rationalized the reason for desiring a pacing guide as means for meeting the needs of a transient population, she began with her "love" for the circumstance of central office telling her exactly what she needed to do. Although one might argue that that level of supervision might be expected of a new principal, Principal Connell was referencing a timeframe which included her experiences in the district as both a teacher and an instructional coach. Later in the interview, Principal Connell went on to discuss the way curriculum was previously selected in Great Lakes. According to Principal Connell, the district sought a free curriculum in the past and phased out their basal reading program and adopted MASA units, which are free, rather than, "what is going to help the teachers have the most impact with students in learning." With the free curriculums, pacing guides "fell apart because there was no structure." Again, Principal Connell stressed the need for pacing guides, structure, and order. She stated,

> That's why I'm excited that we're going back to having a curriculum. *No matter what it is, we're going to have a curriculum*, it's going to be next gen-aligned and we're going to have a curriculum department that's going to help us with pacing guides and aligned assessments and to bring some of that structure back in science but also in other subject areas. I think it's just so important. (Interview 1)

For Principal Connell, 'structure' is based on the need to get science done and be compliant with local, state, and federal policies rather than centering student learning. Altogether, the policy signal foregrounded by Principal Connell is based on central office directives.

Personal. Before beginning her tenure as the principal of Concord Elementary, Principal Connell spent three years as an instructional coach. When asked to discuss the science in elementary schools given her role as instructional leader, Principal Connell responded,

> I mean science is important to learning and anything that we're teaching with nonfiction texts, nonfiction subjects is so important because that's how kids are tested…If we take that away and we don't teach them the reading skills and the strategies because you read nonfiction very differently than you read a fictional text...I think we're at a pivotal point as a district of really possibly turning things around by bringing science more as a focus. (Principal Connell Interview 1)

Although Principal Connell described the district's attention towards science as "pivotal," the importance of science was largely described as a means to enhance student testing abilities. Science is described as "nonfiction text" and therefore categorized based on text type. Therefore, science itself is a means to enhance reading abilities, and consequently to improve standardized testing scores. Principal Connell's ideas of what science is do not align with the framework (NGSS Lead States, 2013) on which the NGSS are based. Science practices and content are not prioritized.

More insights on Principal Connell's personal understandings and beliefs are based on field notes. After collecting field notes at Concord Elementary one day in June 2017, I had a brief discussion with Principal Connell to establish the next dates I would shadow her. Although

I had done this several times before with Principal Connell, on this day, it was different. I had realized that, since data collection had begun, I had not seen her, or taken note of, Principal Connell going into a science classroom or having any conversations explicitly about science instruction. I therefore asked if I could visit the school on a day when she would be observing a science classroom, where lessons were facilitated/supported by the science paraprofessional. Principal Connell explained that my request would be challenging to accommodate because "teachers have to prioritize reading and math," and then asked, "Don't you agree?" At that time, I shared with Principal Connell that science experts at the state level have expressed that, while science, social studies, reading, and math are commonly taught as though they are isolated content areas, they are in fact all interconnected and the science experts would like to see them taught together. I noted that scholars and the science experts at the state level have pointed out that math and reading instruction could incorporate science rather than science being regularly sacrificed to focus on reading and math. Principal Connell then recommended I observe the science paraprofessional or one of the teachers that she knew regularly taught science. I took note of these recommendations but did not reach out to those individuals at that time given the focus of my research was on principals. I was interested in considering an option that would allow me to engage Principal Connell in talking about science with me.

Before Principal Connell's tenure as an elementary principal at Concord, she served as an instructional coach within the district. Instructional coaches in Great Lakes are housed in a single school and serve the needs of the principal and teachers within that school. Instructional coaches may be directly involved with adopting textbooks, developing curriculum, providing ongoing professional development, and mentoring of teachers or principals (Domina et al., 2015). Although the job responsibilities of the instructional coach and the principal overlap to some

degree, each of the principals in GLS was expected to work with the instructional coach as a team. However, the instructional coach's role was largely to coach and mentor teachers. Based on the data, Principal Connell personally identified more as an instructional coach than as the school's principal and instructional leader. According to Principal Connell, regarding her role as the school's instructional leader,

> I like to mentor teachers. Even when I was a classroom teacher I loved having student teachers because I love mentoring. I see this as more of a mentoring kind of position where I want to work side by side with teachers. I want to help them brainstorm ideas, I want to help them come up with great activities that they could use with students for interaction like different Kagan strategies they could try to maybe go in and model and work side by side. I'd like to do a little team teaching every once in a while, I mean I don't want to be totally separate from classroom life… I want to work with my instructional coach because she's curriculum-centered and -focused, instructional practice-focused as well, and we're supposed to be the more academic side of the team working with teachers and building their practice and their skills. (Principal Connell, Interview 1)

The principal's role as the instructional leader does have key instructional responsibilities (Leithwood et al., 2004). However, what Principal Connell described about what she enjoys about the potential of her job is the opportunity to 'mentor,' 'team teach,' and build the capacities of teachers (Casey et al., 2012). However, principals have many responsibilities: building manager, instructional leader, gatekeeper, and policy conduit, among others. According to Printy (2010), the role of instructional leader for a principal requires specific insights into the instructional leadership team to effectively manage the human capital within one's school. The role of the instructional leader should also include the "activation" of resources, which is defined as "how school leaders bring resources together to enhance science instruction" (Spillane et al., 2001, p. 919). Principal Connell largely identified as an instructional coach, rather than the science instructional leader a coherent science curriculum would require her to be in order to support her staff.

Social. Principal Connell named five people from whom she receives information about science content, resources, or standards (See Figure 4): the Elementary Curriculum and Instructional Specialist (ID 123[labels in Table 22]—weekly), the Director of Academic Services (ID 125—weekly), a third-grade teacher at Concord Elementary who formerly served as the Director of Science and Math and was later demoted (ID 3430—monthly), Concord's Science Paraprofessional (ID 3514—weekly), and the school's instructional coach (ID 363—weekly).

Figure 4: Principal Connell's science network based on network data

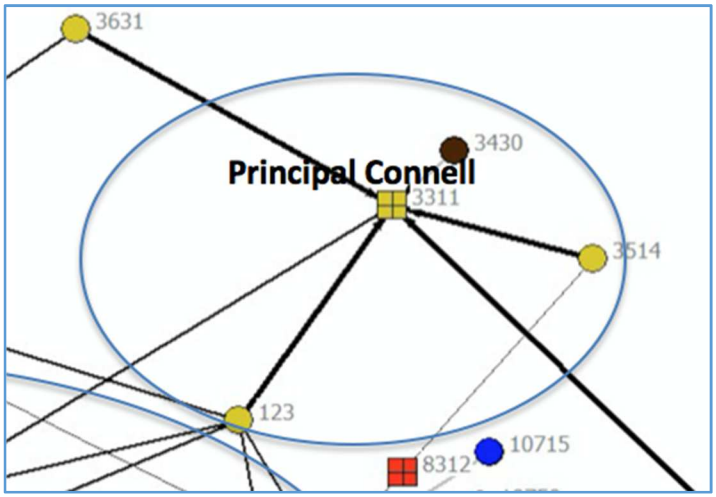


Table 22: Individuals Sought by Principal Connell

ID	Role
123	Elementary curriculum and instructional specialist
125	Director of Academic Services
3430	Third grade teacher at Concord, former Director of Science and Math (demoted)
3514	Science paraprofessional at Concord
3631	Instructional Coach

Individuals sought by Principal Connell for support about science. The ID and role of each of the individuals Principal Connell sought are listed in Table 22. Three out of the five individuals named by Principal Connell work in central office and were hired into the district within the year just prior to the completion of the first network survey and first interview. This is important because three out of five people named by Principal Connell are new to their central

office jobs. Furthermore, these three individuals do not necessarily have a clear understanding of what the expectations for science should be, and therefore their guidance concerning science at that time would have been mainly procedural in nature. Given the need for guidance on selecting a science curriculum, GLS utilized the services of their local ISD science specialist, Susan Cook.

At the time of this principal identified event, selecting curriculum, an initial meeting was held where Susan Cook led a team of central office staff, teachers, and Ms. Donaldson in defining the science needs of GLS. The goal of the meeting was to initiate conversations on selecting a curriculum for the elementary schools. During the meeting, participants discussed the newly adopted state standards, engaged in an NGSS-aligned lesson, and then debriefed their experiences in implementing the pilot study during the Spring of 2016 (Based on field notes). The district was not sure what they wanted to do about science at this point, though they recognized that the curriculum selected would need to be NGSS-aligned.

Beyond alignment, many of the conversations that took place once the Battle Creek unit was implemented focused on fidelity. According to Principal Grant, a new elementary principal in the district, discussions amongst principals about science included the following:

> [S]o the curriculum team met yesterday. We talked about reading, writing, math, science and social studies and so the conversation I'm having with you in terms of what are we going to prioritize, what they know is that came from that meeting. The idea that math is fidelity to Everyday Math; science is fidelity to Battle Creek. (Interview 1)

Although Mr. Grant's statements demonstrated that the focus for math and science is fidelity in implementing the curricula, the priorities of the district were also demonstrated through the instructional minutes for the elementary level (See Appendix E). Out of 395 instructional minutes each day, 25-45 (depending on the grade-level) minutes were to be dedicated to either

science or social studies for Kindergarten through Grade 6, which amounted to 6 to 11 percent of each day (See Table 23).

Table 23: Instructional Minutes for Elementary Science

Grade	Science or Social Studies Instructional Minutes
K	25-35
1	25-35
2	35-45
3	25-35
4	25-35
5	25-35
6	40-50 (only science)

There were few conversations about science instruction when Principal Connell was leading or involved in decision-making. When Principal Connell had conversations about science generally, they either centered around showcasing student work or took place in meetings with central office staff where insights and directives were shared. When I asked Principal Connell about the last conversation she had had regarding to science, Principal Connell discussed a Science Learning Night that had been held. According to Principal Connell:

> Well because I'm here at Concord, [science] has been a topic quite often this year. We had a science of learning night where we did a whole science theme here at our school. We dissected owl pellets, and everything we did was kind of about owls. We had our science fair set up in the gym. We had a group for 21st century earn an opportunity to do a NASA project. It was a STEM project and they went to [the capital] and actually presented it and met astronauts. It was really cool. So, science is a typical conversation.

What is important to recognize here is that other than deciding there would be a Science Learning Night, Principal Connell was not extensively involved in implementing the event or the NASA project, which was a project done that was completed after school by students involved in 21st Century programming—federally funded afterschool programming. Ms. Donaldson was instrumental in deciding what would take place at Science Learning Night. When asked about the support Principal Connell provided for science, Ms. Donaldson stated:

> We've had a science learning night. She asked me what hands-on things would I like to do and I said, owl pellets. Owl pellets are great. Can we order some owl pellets? ...I suggested a few other things. So, she supports me. If I go to her, pretty much she will support me. (Interview 1)

In this quote, we better understand that Ms. Donaldson sees Principal Connell's support as essential for science. Ms. Donaldson was largely trusted to make most of the decisions regarding the set-up of the Science Learning Night, as well as what activities would occur and what would be showcased during the event. There were few times when Principal Connell was leading these conversations. In many ways, science was happening around Principal Connell rather than with Principal Connell.

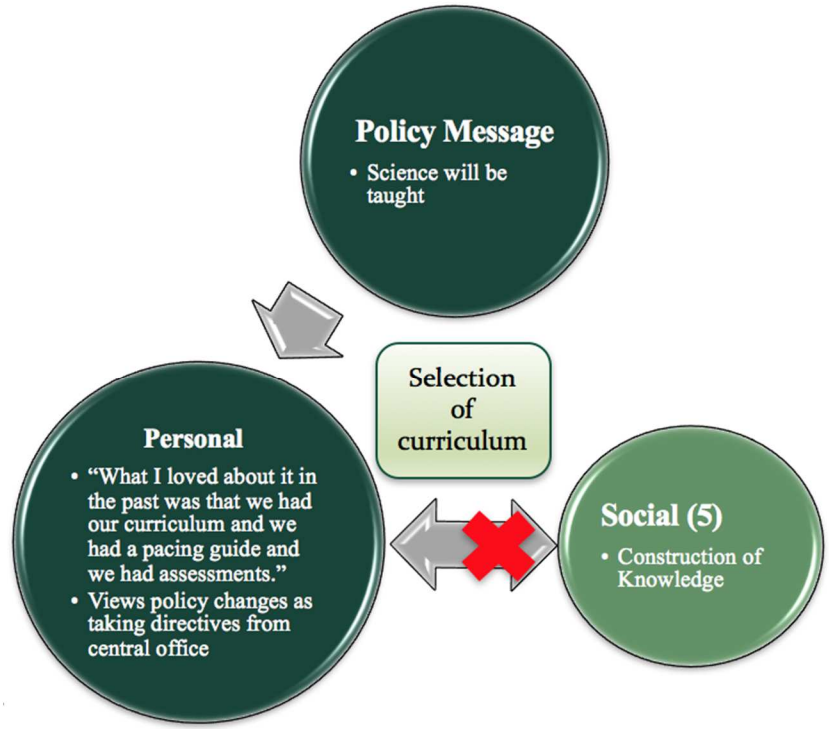
Self and social interaction. Although Principal Connell stated she believed science was important, science received minimal attention from her, despite there being district initiatives to support the implementation of science in the elementary schools. The district's science initiatives were framed by the policy messages, personal experiences, and limited social interactions that Principal Connell had. Science understanding and learning was not prioritized, and implementing science was conflated with the extra-curricular activities done to showcase science. Given that the implementation of science was received as a directive, there were limited spaces created by Principal Connell to advance, support, or encourage the implementation of the science curriculum. Principal Connell's leadership style therefore is more linear in nature—driven by conceptions of cause and effect as described by Reitzug and colleagues (2008). This label fits Principal Connell's leadership style because her practice assumes that implementing directives will lead to a specific academic result, which also aligns with her role as an instructional coach. Given that Principal Connell's view of science was based on her identity as an instructional coach, her main objective concerning science was to follow directives from central office. As previously discussed, the central office staff was new and was actively seeking information on

how to best meet the needs of students. Due to Principal Connell's personal beliefs about science and her own role in science implementation, the opportunities for social interaction were limited, and therefore Principal's Connell's initial beliefs about how science should be implemented remained constant.

According to Honig (2012), the capacity of district administration to support school administrators is largely dependent upon the experiences of those who are serving in central office. Essentially, there is a new direction for central offices to enhance the practice of principals by providing space for grappling with information as well as space/time to develop common talk (Horn & Little, 2010). Although common space is provided in the district amongst central office administrators and principals twice per month, there were limited times where administrators were truly grappling and making decisions. *Selection of a Curriculum* demonstrated that Principal Connell needed those times so that she could witness her peers grappling with, asking questions about, and engaging with policies.

There were no opportunities to co-construct knowledge, and therefore social interactions had limited impact on Principal Connell's personal understanding of and beliefs about science. Also, these limited social interactions resulted in the policy messages received by Principal Connell being viewed simply as directives rather than as policies in which she could actively participate. Active in this case implies that Principal Connell would locate and "activate" resources and support science by enhancing instructional practices through her decisions. As seen in Figure 5, there was no interaction between Principal Connell's personal understandings and beliefs about science and her science network.

Figure 5: Sensemaking framework based on Event #1



[1]

Based on this event, at the beginning of the study, Principal Connell had specific beliefs about science and had limited opportunities to have interactions about the implementation of science curriculum. This is demonstrated as the red 'x' between personal and social in the diagram in Figure 5. Due to having such limited opportunities to have conversations and grapple with topics concerning science instruction, Principal Connell relied on others to make decisions about science. To Principal Connell, these decisions were largely made by central office, and she was doing as was expected of her, mainly out of compliance. However, the person in Concord who had the most face-time with teachers on a regular basis about science was Ms. Donaldson the science paraprofessional. Although Ms. Donaldson was noted as a person who was talked to

[1] The 5 indicates how many people named by Principal Connell as people she talks to about science on her network survey.

about science by Principal Connell during her first network survey, the conversations were largely directed by Ms. Donaldson because she was making the decisions. Ms. Donaldson was largely responsible for Science Learning Night and any instructional decision about science at Concord. Ms. Donaldson's perspective and experience within the district as a science paraprofessional became more vital as the 2017-2018 school year began.

Event #2: 'I'm Just a Parapro'

As noted above, I realized after six months that there were limited opportunities for natural talk about science, meaning discussions about science did not happen unless I specifically asked questions. I then requested a time to observe a science class with Principal Connell. The following discussion that transpired between Principal Connell and Ms. Donaldson resulted from that request. This conversation was about the progress of teachers in completing one science unit with their students in November of 2017.

> **Connell:** So, the students need to be done with the unit by Friday. There needs to be stuff uploaded by Friday. The Unit pre-assessment was given, Unit 1 should be done by Dec 5th. Except for 5th grade, should be done by Dec 20th. The pre-assessment should be given by Dec. 13. Unit 2 is done April 10th. Then that's all they have… [Principal Connell asks Ms. Donaldson how many teachers will not meet this deadline]
> **Donaldson:** 3
> **Connell:** So only 3…?
> **Donaldson:** Well, as far as I have
> **Connell:** So, we are not as off pace as I think we are. Do you think teachers are going to be able to do the pre-test and the uploads? There needs to be some backwards planning... Sandy, you have been working with Ms. Thomas on the science committee [and states that she was not included in any of the conversations]. [Principal Connell then tells Ms. Donaldson she should contact central office and say the following] "In talking with Principal Connell and based on the district calendar, you need to know that we are behind." There needs to be some backwards planning. No one wants to take anything out. So, we can break things into chunks. Teachers need some benchmarks. Then I'm going to follow up with them as well.
> **Donaldson:** I went through the lessons and talked to them about 'this will be in your room, and this will be in the lab.'
> **Connell:** But if [students] are learning science only in here, then that's not okay. The lessons in here should be 1/3 of the science time [per week]. I just talked to Dillon and

asked, when are you incorporating the writing and then covering science in the tree maps? You may have some ideas.
…
Donaldson: The ones who are further behind are the ones who are not really doing [science] in their classrooms...[teachers] need to do it during the day.
Connell: [shaking her head no and Ms. Donaldson looks at me] Ok we can check. They have a science pacing chart in here. They have social studies…We were sent it. There is a form that tells us. Every daily schedule has a time for science or social studies. *It's up to them to make sure they are teaching it at that time. I told them to be really picky if another segment is going over.* I know I used to hate it. It can be embedded into reading, think-alouds. I told them they could double dip their time. If they are starting their writing. The book gives topics, you can incorporate the topic. Our writing program focuses on structure. We can find books, we have a room full of National Geographic.
Donaldson: These journals lend themselves to exactly what you are talking about.
...
Connell: Thanks for the conversation and are you still willing to start that conversation?
Donaldson: I'm really concerned about that too.
Connell: So, what do they need to do, amp it up in their classrooms, or do they schedule a time with you?
Donaldson: But if you look at these Newton's Laws, they can just do this mostly on their own.
Connell: [Cutting off Ms. Donaldson. Principal Connell asks how many investigations the teacher with the fewest lessons done needs to do with his students] I don't care, so how many investigations?
Donaldson: [laughs and looks at me]. He is [counts]1, 2, 3, 4, 5, 6, 7.
Connell: [holds up 7 fingers up at Donaldson] for at least 30 seconds. Are you willing to put the kits together?
Donaldson: Wednesday, are you willing to put this on the schedule for the late start [staff meeting]?
Connell: That's what I'm thinking. I need to work on the schedule with [the instructional coach]. (Field notes, November 2017)

A second event identified by Principal Connell during an interview, and evident in the above transcript, was an approaching deadline given by central office to submit science assessment results. However, as the deadline approached and Principal Connell began to speak to Ms. Donaldson about progress towards submitting these results, it became clear that at least three teachers would likely not meet the deadline set by the district to complete a Battle Creek unit. Based on the district instructional minutes (See Table 22), teachers for grades K-5 were to either teach science or social studies based on the prescribed district instructional minutes for Great

Lakes Schools. Grade 6 teachers were expected to teach science and "academic vocabulary" for 40-50 minutes per day.

Policy message. The message being received by Principal Connell is that someone is responsible for teachers having their science assessments completed, which also indicates completion of the units. Based on these deadlines, Principal Connell believes teachers that are behind, with the support of Ms. Donaldson, have a responsibility to catch up. During the conversation, Principal Connell stated,

> Sandy, you have been working with Ms. Thomas on the committee [and states that she was not included in on any of the conversations]. [Principal Connell then tells Ms. Donaldson she should contact central office and say the following] 'In talking with Principal Connell and based on the district calendar. You need to know that we are behind. (Field notes, November, 2017)

This seems as though Principal Connell is passive aggressively placing blame on the science paraprofessional for some teachers being "behind." She also gives Ms. Donaldson next steps on how to rectify the situation. Although the deadline needs to be met, Principal Connell frames the directives as a problem related to science rather than as her own responsibility as the instructional leader.

One of the challenges involved in making sure science was being taught by teachers was the history of science in the district. Science was not taught in classrooms during the 2015-2016 school year and at Concord Elementary, was only taught in the science room with Ms. Donaldson during that same year. The goal in the district for the fall of 2017 was simply to teach science regularly, with little attention to fidelity. In one interview, Principal Connell stated, "I don't know how much of my conversations are really about how to teach science, or what the content is, because we're not really having those conversations as deeply as we should yet." However, when interviewed, Principal Connell stated that teachers were grappling with how they

were “going to fit [science] in” and not necessarily concerning themselves with the content. In the final interview, Principal Connell noted that “accountability [would] be based on the presence of pre-tests and post-tests,” which, like in Event 1, she seemed to prioritize (Connell, Interview 2).

Personal. During the 2017-2018 school year, Principal Connell struggled to be the instructional leader she aspired to be (as described in Event #1), and felt she was “not ahead of the game” and as though she was “still trying to play catch-up” in serving as an instructional leader. As stated by Principal Connell,

> I think that my biggest struggle right now is that we are in this transitional phase, where we're getting more directions in curriculum. I met with Dr. H [the director of academic services] yesterday to go over my evaluations, and my rubric and where I'm at, we've talked about this. She said, "Nope, we're not there yet," you know what I mean? There are some things we're just not where we need to be, curriculum wise. I think instructionally, that makes it difficult, because we're talking about the system that's working right now, but it's not going to be the system we're going to have. (Interview 2).

Here, Principal Connell indicated that she was obtaining guidance from central office staff on how to proceed as an instructional leader, and that systemically, there was no long-term system in place yet. This quote is indicative of two distinct findings in this study. First, some elementary principals may strongly rely on central office support, although central office may not have the capacity to offer it (yet). Second, principals may sense limited authority to act concerning science, given the uncertainty of central office, and thus set only short-term goals. Systemic capacity is essential when considering the ability to effectively implement policies (Honig, 2006).

Malen, Matlach, Bowsher, Hoyer, and Hyde (2015) stated that when considering a district, the definition of capacity should encompass the “productivity” and “availability” of

resources (p. 136). Ideally, resources should enable the success of students, teachers, and the principal, but physical resources alone do not yield improved academic outcomes (Malen et al., 2015). Time for administrators to learn a reform is also needed (Malen et al., 2015). Over the last decade, central office staff have become personal instructors to principals to enhance their effectiveness as instructional leaders. For instance, Principal Connell described a conversation she had with Dr. H, someone she describes as one of her mentors from central office.

As an instructional leader, Principal Connell stated she did not feel that she was "ahead of the game yet as far as working with teachers on [science]," largely due to the lack of clear, long-term directives from central office. Once Principal Connell and I debriefed about the observation of a science class, which was mentioned earlier, it was clear that our expectations of what we should see during a science lesson differed. Principal Connell saw students "engaged" in an "inquiry"-driven lesson. Although I saw a unit that was inquiry-driven, I observed a teacher who had not prepared for the lesson and largely relied on the science paraprofessional, Ms. Donaldson, to teach the lesson. Principal Connell discussed the challenges she faced as the science instructional leader, including the fact that she had not been trained on what to look for instructionally in a science classroom. Also, teachers go to the science paraprofessional, Ms. Donaldson, for most of their science concerns meaning Principal Connell is minimally required to engage with teachers about science. Although Principal Connell described Ms. Donaldson's role with science at Connell as to "support science instruction," teachers were challenged in teaching science since it had not been viewed as a priority for many years. Because of this de-prioritization of science, limited professional development was provided and minimal follow-up about teaching science took place. Ms. Donaldson's role during the fall of 2017 was to gather materials for teachers and support labs in the science room, not to teach. Teachers had resources,

but limited support was provided towards them developing the capacity to be comfortable in teaching science.

When discussing the interactions between teachers and Ms. Donaldson, Principal Connell stated, "the teachers are used to going in and having Ms. Donaldson run the show," and she said that it would be challenging, based on her past experiences in science, to get teachers to "shift" to teaching science. In many respects, Sandy Donaldson is the science instructional leader in the eyes of many of the teachers when we consider to whom the teachers go for support, as indicated by Principal Connell. However, when I spoke to Ms. Donaldson about some teachers being behind schedule on the pacing guide, she stated, "I'm just a parapro, but [teachers are] going to [do science] if Principal Connell tells them they are behind." Although Principal Connell values her role as an instructional coach for teachers, she distances herself from this role when science is involved. Principal Connell asserted that without a clear structure, she is limited in acting as the instructional leader at Concord. Meanwhile, the teachers have found an instructional leader in Ms. Donaldson, a charge Ms. Donaldson does not desire to accept. Again, under Title I, teaching cannot be one of Ms. Donaldson's responsibilities, but it has been, and based on observations, teachers rely on her to teach their science lessons. As a researcher, this interaction between Ms. Donaldson and Principal Connell caused me to question: if principals do not take responsibility as the instructional leader for science, then is there an instructional leader for science? This is a valid question given the priorities of the principals are many. Science, in many cases, may be implemented out of obligation. However, *'I'm Just a Parapro'* sheds light on the fact that the instructional leader and the science leader may not be the same person.

Social. Principal Connell's science network did not change significantly from the first network survey she completed 6 months prior to completing the second survey. Principal

Connell named six people she received information from about science content, resources, or standards. All the individuals from the first survey were named (See Figure 4 & Table 20) in addition to a Great Lakes principal, Principal Hill, who supported Principal Connell in thinking through reform efforts (Rigby, 2015; Rigby, 2016). Principal Connell would regularly call Principal Hill for a quick conversation or to ask a brief question about paperwork, meetings, and other needs (field notes). Again, Principal Connell's social interactions concerning science were limited. Therefore, I requested a time to observe science with Principal Connell to better understand her interactions both with science and with those within her science network concerning science.

When Principal Connell was asked about a recent conversation she had about science, she chose to talk about the teacher whom we observed teaching, Mr. Douglas. When discussing the conversation, Principal Connell stated:

> I did not have a conversation with Mr. Douglas about that lesson, per se, about the instructional piece. What my conversation was—with him—was about the pacing right now, because to even get the content covered, in order to get the final assessment done by the deadline, I wanted to know, how are you going to adjust and structure your classroom to incorporate it more in the next two or three weeks, so you can cover more of this content? How are you going to embed it? That was more of a conversation with him than his actual instruction that day. (Interview 2)

It is first important to recognize that although this conversation centered district deadlines and pacing, there was also a conversation about science that occurred with the teacher. This is important to note given the current educational environment where science teaching and conversations are not taking place in many schools. The conversation mainly centered deadlines and district expectations rather than science instruction. Next, in this excerpt, Principal Connell discussed teachers "embed[ding]" science into the instructional time for reading, which differed

from her understandings during the 2016-2017 school year. When discussing the instructional minutes allotted to science Principal Connell stated,

> We need more time than that. We can incorporate it into your writing. Writing is a good place to incorporate [science], because they have to do it right from the beginning and beyond, and they are using the different maps to do writing, which falls into nonfiction reading. (Interview 2)

Although Principal Connell's network did not change considerably, it was evident from the data that her ideas concerning science in the classroom had shifted. That demonstrated a stark difference from the conversations during the 2016-2017 school year referenced during *Selection of a Curriculum* when Principal Connell expressed her belief that reading and math should be prioritized and that by default science should not be.

Given that Principal Connell receives messages from central office as static, she does not actively engage central office about what is not working with the newly developed policies and expectations of teachers. However, I received a different message from central office. When I met with Ms. Thomas, the Elementary Curriculum Specialist overseeing the new science curriculum adoption at GLS, about how firm the deadlines for completing the units were, she stated:

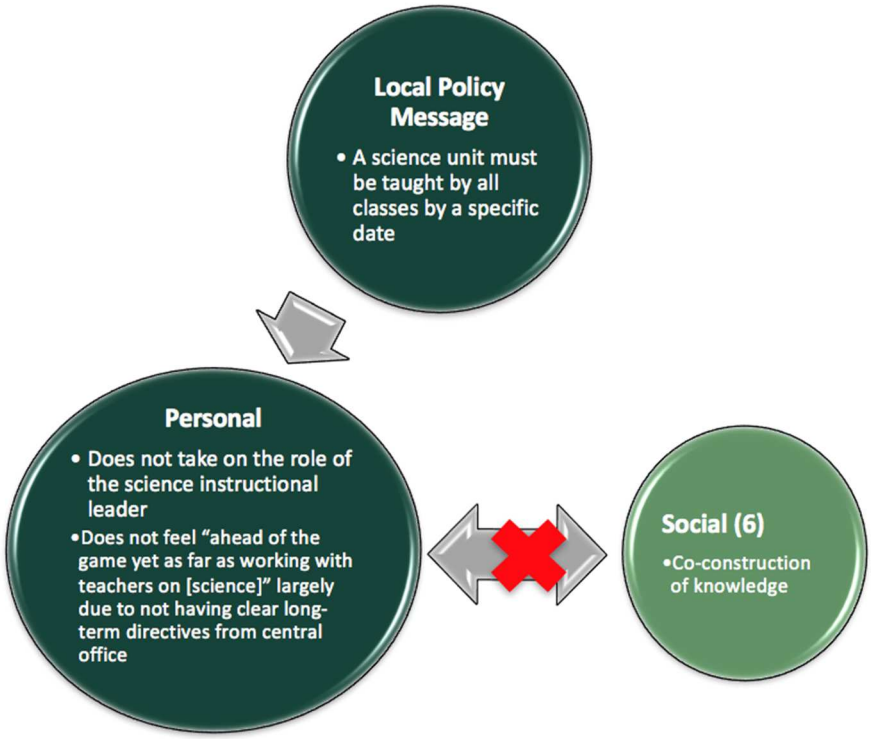
> Because right now, [teachers] are finally realizing that this is coming back. You have to teach it, you have to follow the pacing guide, and do the structure of them, incorporating that into their day, and how they fit in is more of the conversation we're having right now. We're just letting the program guide us as far as content goes at this point. Basically, all my conversations right now about science are, when are you teaching it? How many minutes are you getting it in? Are you only relying on your science education time, or are you incorporating that in your classroom and adding time in there? If you're adding time in there, are you doing it as a separate science block, or are you incorporating it into your writing and your day-to-day lessons? Because those are places you can add it. Those are the specific conversations I'm having.

While interviewing Ms. Thomas, I asked about the pacing guide and the deadlines. Ms. Thomas shared with me that the deadlines were not locked in stone and that the central office team hoped

that if the dates did not work for the teachers, that principals would communicate with them. Central office understood this to be a change from previous years, and that it would take time to change mindsets about science. She expressed that BCBS was a new curriculum being taught in the district and that they were still learning and feeling their way through it. Thus, although there was urgency sensed by Principal Connell to see that science milestones were completed to meet a deadline, if she had served as the science instructional leader she would have possibly contacted Ms. Thomas instead of instructing Ms. Donaldson to do so. If a discussion had occurred between Principal Connell and central office, it may have been clear that the central office staff were interested in teachers getting acclimated to teaching science at that time instead of simply checking science off as completed.

Personal and social interaction. In *'I'm Just a Parapro,'* summarized in Figure 6, we saw that Principal Connell had an opportunity to serve as the science instructional leader but that she chose not to do so. Because of this decision, she gave up important opportunities to share the experiences she and her staff were having related to the local policy directives, as well as to negotiate the terms of the policies. Dr. Thomas shared that this was a learning period for the teachers, and central staff understood this.

Figure 6: Sensemaking framework based on Event #2



Although Ms. Donaldson does not desire to be the science leader at Concord, the teachers respect her as such. District leaders are expected to broker information (Honig, 2012). However, Principal Connell was not comfortable doing this, essentially sacrificing the development of a community of practice (Lave & Wenger, 1998) around science. When there are tensions between central office and the school, information dispersal from central office to the schools may be limited (Finnigan, Daly, & Che, 2013). However, this case demonstrated an avoidance of communication. Although some principals may choose not to engage with others within their network (Honig, 2014), Principal Connell made contact only if she was comfortable doing so or was required.

Principal Loper

Event #3: 'We Want Our Kids to be Successful'

Fifth-grade teachers at Leonhard Elementary School approached Principal Loper seeking science materials because the state assessment would soon begin piloting a science assessment and transitioning to testing fifth grade at the elementary level. Principal Matthews was also approached by teachers on her staff, so Principals Loper and Matthews decided to meet with Susan from the ISD. The teachers did not feel they had appropriate resources to support student learning and specifically to prepare students for the state tests. The curriculum the teachers had access to at the time was Discovery Works, which was at least 15 years old and did not accommodate the newly adopted standards. According to Principal Matthews, teachers asked, "what are we supposed to do? We have to prepare our kids for science and we don't have any materials." During the 2014-2015 academic year, under the previous administration, principals were instructed to tell their staff that science would not be taught. Principal Matthews said, "[F]or a year we didn't even teach science. That was under the direction of central office" (Interview 1).

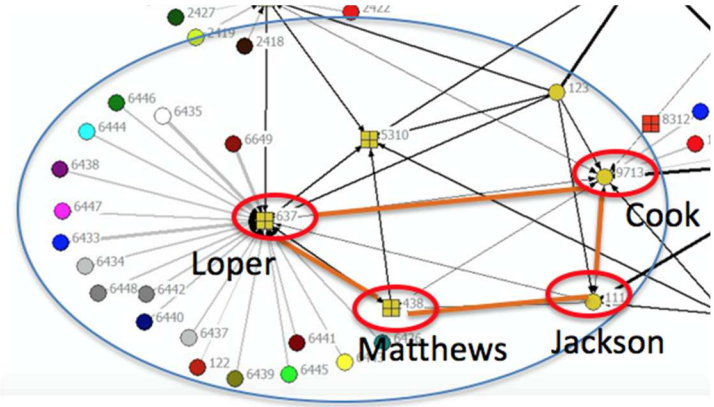
During the 2015-2016 school year, science was to be taught again in schools. However, as stated by Principal Loper, "it wasn't taught in the traditional [manner]…What happened is -- they had Achieve3000" (Interview 1). Achieve3000 is an informational text the district purchased that is a series of articles centering non-fiction content and students follow-up this reading by answering questions. According to Achieve3000.com, the unit allows those who use it to engage literacy strategies while increasing science and social studies knowledge. According to Principal Loper, "The intent was that the teachers teach about the content and activate prior knowledge before they release [the students]." However, because there were no Achieve3000

texts for Grades K-2, science was not offered at the lower grade levels. Achieve3000 has a website for each state so that each page is specific to the standardized testing requirement in each state, for example, the M-STEP in Michigan.

Principals Loper and Matthews did not believe Achieve3000 was sufficiently substantive, given the newly adopted science standards and district expectations that science would be taught, neither of which could be met simply by reading. Principals Loper and Matthews therefore wanted information on supplemental, free materials that were aligned with the NGSS. The central event concerning science for Principal Loper was this search for science resources during the fall of 2016 for her elementary students in response to her teachers' requests.

Principals Loper and Matthews scheduled an appointment with the Science and Math Consultant from the local ISD, Susan Cook. The other person invited to this meeting was Superintendent Jackson, who was serving in the role of Special Education Director and Assistant Superintendent of Curriculum and Instruction at the time of the meeting (See Figure 7). According to Principal Matthews, "Leticia [Loper] and I met with Susan [Cook] because we didn't want to enter the year with nothing for science. So, we met with Susan about different options that we could do for science. So, it really didn't go far because at that point I said, … no, I think you need to talk with Superintendent Jackson before we dive into that."

Figure 7: Principal Loper's science network based on a network data



After I interviewed Principals Matthews and Loper, I was initially under the impression that there were just three people in this meeting—Principal Matthews, Principal Loper and Ms. Cook. During my interview with Susan Cook, I learned that Superintendent Jennings attended that meeting as well, which I confirmed with him. As I discussed this meeting with Principal Loper, I explicitly named Superintendent Jennings, and she also confirmed the superintendent's presence at that meeting. I thought perhaps the meeting in question might have been a separate meeting between Susan Cook, Principal Loper, and Principal Matthews, but Cook stated that this was "the" meeting she had with Principals Matthews and Loper. When asked if she had met Superintendent Jennings, she stated, "I've met [Superintendent Jennings] a couple times but one time I met him was in that meeting with Nia [Matthews] and Leticia [Loper], and he was really supportive and responsive to that idea that we have to teach science..." Later in this chapter I will return to this meeting and explain why I believe Superintendent Jennings may have been left out of the conversation initially by both principals.

Policy message. With Superintendent Jennings at the helm of content in Great Lakes Schools at the time of the meeting, Principals Loper and Matthews believed that science would be implemented. However, it was not clear exactly how. The state-level policies around testing

specifically drive practice. As stated by Principal Loper, “I think we focus on all the things we're evaluated on, the reading, the math, the writing, because no one wants to be [in the lowest five-percent of schools].” Given that the goal is to avoid being named a low-performing school, principals by default lead to protect themselves and the teachers with whom they work. Principal Loper went on to say, “I think the mandates from the state coming down [and] to meet these expectations causes us to really zoom in closer in on those content areas. We're not really allocated that time to do a whole lot with science because we want our kids to be successful.” This idea of what is currently viewed as “successful” was also a finding by Lugg and colleagues (2002) and Printy (2010). There has been a shift in focus in schools from just inputs to outputs, but this study demonstrates that specific outputs are prioritized, not including science. Now that fifth-grade science will be assessed in the future, there is an urgency to begin preparing, even though the fifth-grade assessment will not be fully operational until the Spring of 2020. Principal Loper was therefore being responsive to the needs of her teachers and seeking alternative forms of science instruction.

Personal. Principal Loper believes her role as principal at Leonhard Elementary is her God-given assignment. Therefore, she believes her service is for not only her students but also her community. Principal Loper believes changes in the district are an “opportunity” and that she is called to this work, specifically in an urban context. When asked how she would describe her role as an instructional leader Principal Loper stated,

> I feel as an instructional leader I have to be current and knowledgeable so I do a lot of reading so that makes me credible in providing suggestions to teachers when they see obstacles... We’ve done a lot with mental health this year, but academically I try to give them different solutions. I took cognitive coaching, so I've kind of been doing some coaching conversations—not as many as I want, that will increase next year—but the coaching conversations with them so they can have some self-reflection, especially after observations, but if they're dealing with student behavior I'll go to [my second-grade teacher] and do a coaching

> conversation to see how she felt things went. So, we do those. I talk to parents, try to connect with the staff and the day goes by fast. (Interview 1)

Principal Loper discussed various components that support actual instruction. Principal Loper had many responsibilities to attend to as an instructional leader, from developing the reflective capacities of teachers through cognitive coaching, to helping students prepare to learn given the trauma and mental health challenges that they overwhelmingly face, especially in urban schools. The trauma and mental health challenges were evident in the fact that the district did not renew contracts for half of the district's school counselors for the 2017-2018 school year, and instead hired school psychologists who have experience in supporting student needs related to trauma.

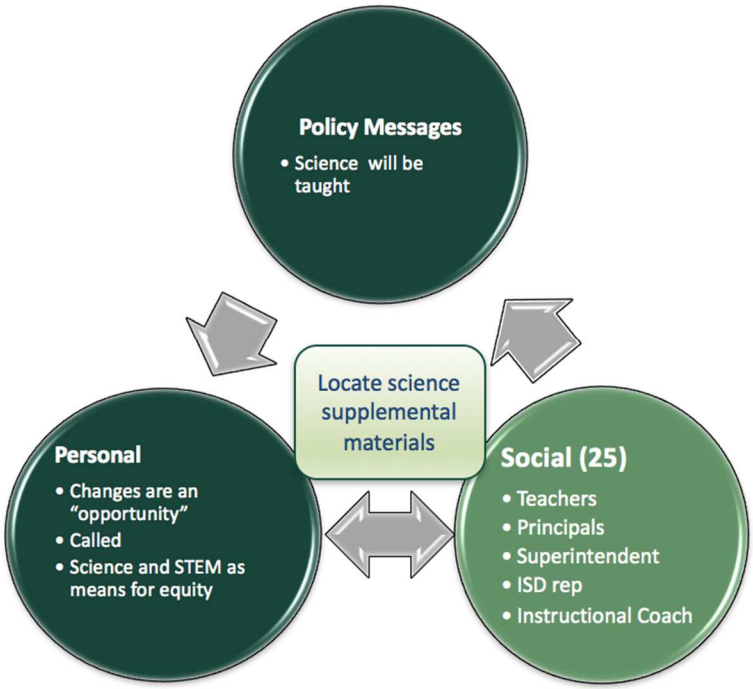
Although Principal Loper is the leader of her building, she recognizes that her role has a far reach. She is preparing students to become contributors to their community and preparing them for the job market they will be entering upon graduation. Principal Loper believes STEM will enable her students in elementary school to one day work in STEM fields that will bring jobs to the community. When discussing what students will gain from science, Principal Loper stated:

> … there's so many different opportunities in science that they could have, but they don't know that's there. The water study and, you know, marine biology and all of that. I'm not a science guru by any means, but I know there are so many opportunities that they could be a part of because they have a watershed study here…Then you have all the hospitals and engineering opportunities … (Interview 1)

For Principal Loper, science in schools is a means of exposure to fields they will be able to pursue after graduating from GLS. It is important to note that Principal Loper said students "don't know" about various opportunities within science, but the presence of science would invite opportunities for an awareness that is not currently present at Leonhard Elementary.

Social. Principal Loper can be described as a community leader based on how she perceives her role as an instructional leader. She does not see her work as limited to the walls of the school, but rather knows that the work she does in the school enables students to go back into the local community and work, serve, and contribute to society. On the first network survey, Principal Loper named 25 people who contributed to her understandings of standards, resources, and other information related to science (See Figure 8). Her network was larger than any other principal within the study. Based on my time spent shadowing Principal Loper and on my field notes, this is not surprising. Principal Loper valued the funds of knowledge (Moll, Amanti, & Gonzalez, 1992) possessed by her staff, whether it was content-related knowledge, community knowledge, or other information that would provide her insights as to how to support a student. Her goal was to ensure that her students were safe and in environments conducive to learning. Principal Loper's response to the needs of a student named Leroy demonstrated how she tapped into her network to serve students.

Figure 8: Sensemaking framework based on Event #3



One morning I sat with Principal Loper in her office as I regularly did, and a mother arrived with her son, a second grader named Leroy, to talk to Principal Loper. Principal Loper greeted the child and the mother as they entered her office. Leroy had been struggling in class, getting into fights, and not doing his work. The situation had become challenging to the point that it was recommended that Leroy not return until a family member could sit with him during each class to make sure his behavior indicated he was ready to learn. Near tears, Leroy's mother expressed her frustration and explained that she could not be with Leroy at school because she works nights in a factory and needs to sleep during the day. She was frustrated, but she talked to Principal Loper and together they conveyed to Leroy that he was a smart young man and there would be many opportunities for him if he applied himself. Principal Loper and Leroy's mother also discussed with him his potential to be anything he wanted to be.

Once Leroy and his mother left the office, Principal Loper called in one of the school nurses. She asked the nurse where Leroy's dad was, and about the father's family. Like Principal Loper, the nurse is from Great Lakes and went to school with many of the grandparents of the students who attend the school, including Leroy's. They discussed some of the challenges that have taken place with Leroy's father and the fact that Leroy lives on the same street as his father yet does not see him. They went on to discuss Leroy's former involvement in a program for young males in the community, to which Leroy's mother had previously been referred by the school social worker. Principal Loper called in the school case worker to contact the head of that program to get an update on Leroy's participation. Principal Loper drew from her community to understand the school and home life of the student and the various supports that were in place, or could be put in place, to further support Leroy. This was a prime example of how Principal Loper responded to all challenges, including science.

Included in the 25 people Principal Loper named as those she receives support from for science were central office staff members, Susan Cook, teachers, and Leonhard's instructional coach. These social interactions enhanced Principal Loper's understandings of the policy message that were consistent with those found by Coburn (2001), Spillane and colleagues, (2001), and Weick (1995). Principal Loper specifically named each of the individuals present in the meeting described for *'We Want Our Kids to be Successful'* to discuss supplemental materials: Superintendent Jackson, Principal Matthews, and Susan Cook. When talking to Susan Cook about this meeting, she expressed one commonality amongst these individuals,

> When I think of the three of them …*it was more than just teaching science. It was about equity for their kids and access for their kids and they realize just how important that is long term*. I think that's really, really a positive thing. It's this idea of we're starting at the needs of the students and looking out.

This quote may point to the fact that principals align around causes they prioritize. In the case of Superintendent Jackson and Principals Matthews and Loper, science as a means for equity for their students was significant. When Susan Cook was asked if she heard this language amongst other principals in the district, those who are White, she stated,

> …I have not heard that word, but I will say that a number of principals have brought me in to do - it's baby steps - but they've brought me in their morning [meeting] to get their teachers started on some of this work. *So, you know they are making an intentional effort but the equity language is really, to me I would tie it really closely back to Leticia [Loper], Nia [Matthews] and Jeremy [Jackson]* ... I think it's really exciting. When I met with them I was really… my heart felt happy that they're really fighting for [science] for their kids.

The ISD science expert, Susan Cook, had differing experiences with two sets of principals. One group, the Black administrators, centered equity in their science sensemaking, and the other did not express indications of being equity-driven, these principals being White. Therefore, how principals self-identify may directly impact how they align with members of their social network and thus how they make sense of policies, specifically concerning science. In the case of Principal Loper, she sought information from her community, who were also her Leonhard Elementary colleagues. Her staff were community members, some of whom were raised with the parents or grandparents of her students. She capitalized on her relationships with these community members and on their insight.

Personal and social interactions. Although Principal Loper has her own beliefs about science, she actively engaged with others within her network about science. Therefore, the policy messages received were not static. Principal Loper's personal understandings were continuously modified as she had interactions with those within her network. Principal Loper therefore engaged directly with policies and sought out individuals to better fulfill the science needs of Leonhard Elementary. It is also important to recognize that she aligned with culturally and

racially similar colleagues to negotiate resources for science with hopes of becoming a science instructional leader for her staff. As Susan Cook stated, these individuals were also equity-driven, which was different from their White colleagues.

Also related to the relationship between Principal Loper's personal and social interactions was the issue surrounding why neither she nor Principal Matthews named now-Superintendent Jackson as being present at the meeting about curriculum with Susan Cook. At the time of the meeting, Superintendent Jackson was the curriculum director. However, it was clear from interviewing everyone in the district that Superintendent Jackson, as Principal Loper described him, was their "superman." During their interviews, Superintendent Jackson's efforts and his role as an educator were mentioned by Principal Loper, Principal Matthews, and Ms. Donaldson. He was there to save the day after the previous superintendent had "checked out" (Donaldson Interview 1), and they recognized that he could not do it all, though they said he was certainly trying. By not naming Superintendent Jackson, Principals Loper and Matthews may have been protecting him. Naming him may have placed blame on him for the initial efforts at science instruction that did not go well. No one blamed Superintendent Jackson for trying. Superintendent Jackson candidly let me know that he had tried a science pilot and that he probably had not made the right decision in rolling it out, but he had known that he had to do something. A meeting with only Black administrators may have also presented, as Tatum (1997) discussed, "sitting together." Tatum (1997) argued that Blacks may sit together in order to protect themselves from racism they experience from Whites, and at the same time this action keeps Whites away. This omission may indicate that people of color may not feel safe in aligning around mutual causes with White colleagues, and therefore may protect their colleagues of color,

including Superintendent Jackson, as they see fit. This yields the question of, are we creating safe spaces for talk in schools, especially for people of color?

Event #4: Code-Switching: Seeking Science Capital

During the Spring of 2017, Principal Loper had a meeting with an ISD representative who supported district administrators in financial budgeting and with her instructional coach to review the Leonhard Elementary budget for the 2017-2018 school year. The meeting began with the ISD representative going through the budget items one by one. Principal Loper nodded and asked general questions. At the end, Principal Loper asked that they return to the line item concerning Title I. She then asked if that line item could be utilized for two purposes: to hold a parent information night for incoming kindergarten students and to hire a science paraprofessional. The ISD representative stated she would get back to her on the matter once she inquired about it with central office. The principal was specific in her rationale for each of these requests, so much so that they seemed very well thought out. Shortly after the meeting, I asked how the principal knew to ask for a paraprofessional from that line item in the budget. She responded, "…it took me three times asking." Principal Loper conversed with members of her network about various topics concerning science to guide her understandings and decisions on science, including those related to funding.

Policy message. With much of resource allocation being directed to Math and Reading/Language Arts and as funding for public education continually declines, school leaders and administrators are required to make the most cost-effective decisions possible, and those decisions must now include science in many contexts. When asked about the changes in science implementation over Principal Loper's ten-year tenure, she stated, "It's been kind of back and forth because there's been a year where we've done a science night and a science fair and then

when they said okay we're going to focus on reading, writing and math" (Interview 1). It is important to see here that the attention to science has been historically limited. The events dedicated to science do not take the place of a substantial curriculum and time every day in class.

Principal Loper further described when she has seen shifts in when and how science is implemented:

> "I think the shift comes with depending on who's in the curriculum office and who guides that focus and then based on the materials, teachers, their number one concern was that we don't have any current materials…Usually it's decided from the curriculum office and then we just implement." (Interview 1)

Like Principal Connell Principal Loper sees the policies for science as based on the information she receives from central office. Principal Loper was specifically concerned with the fact that if there were no materials, then science would not be taught. However, we will see next that Principal Loper views her relationship and interaction with policies differently than Principal Connell.

Personal. Principal Loper described her ability to "code-switch" in terms of her specific cultural background and K-12 experiences, as well as the ways that this ability then allows her to capitalize on navigating policies to best meet the needs of her students. Code switching has been traditionally defined as a linguistic skill in which an individual shifts between speaking two languages or dialects depending on situational appropriateness (i.e. linguistic code switching). It is also a cultural skill used to employ two sometimes distinct ways of knowing how to act appropriately in different social contexts (i.e. cultural code switching/code shifting) (Auer, 2013; Ladson-Billings, 1998; Smitherman, 2000). Principal Loper described this capacity as a product of the fact that she went to the "White school", where most of her classmates and teachers were White, for her K-12 schooling, but went to church in the same mostly Black neighborhood in

which Leonhard Elementary resides. Principal Loper therefore utilizes code-switching as a source of capital to meet the needs of her students in an urban school district.

Cultural capital refers to the assets (practices and dispositions) gained to enhance social mobility (Bourdieu, 2003). Schools affect children in different ways based on their social class. These varying effects are due to schools often reinforcing societal norms and therefore social hierarchies and inequalities (Bourdieu, 2003). According to Chambers & Huggins (2014), White, middle-class norms are adopted systematically in schools and are expected of all students. Therefore, schools are essentially spaces of training for students whose culture does not align to the dominant culture. Scholars have also encouraged centering the assets and culture of students as features that should be capitalized upon in order to best encourage student learning (Moll, Amanti, Neff, & Gonzalez, 1992). Code-switching was found to provide Principal Loper a strategic means to leverage the needs of her students.

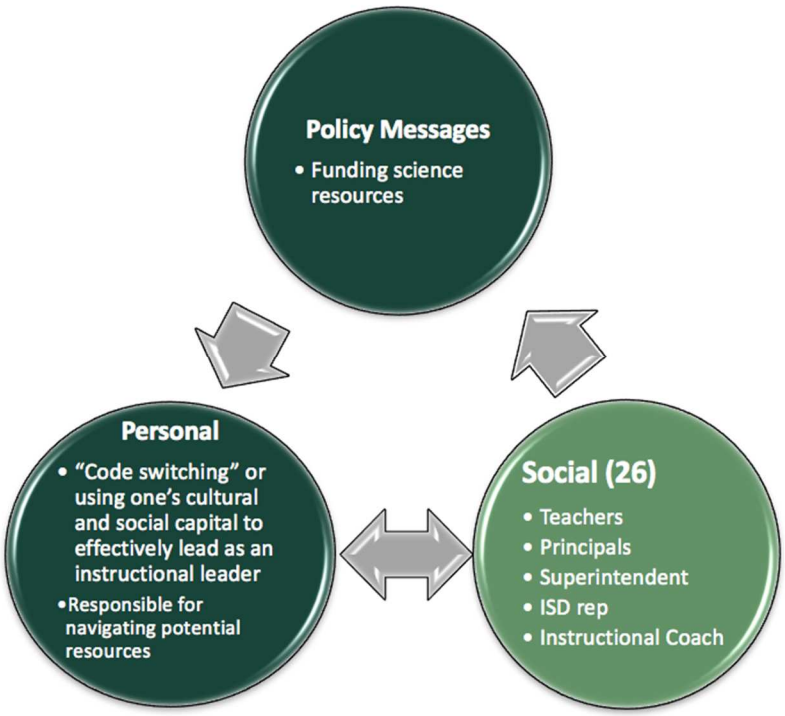
This work acknowledges the personal and cultural experiences of students, and that a principal's K-12 schooling experiences may also inform the principal's leadership style. Although cultural capital is often viewed as an advantage for those of the dominant culture, this work sheds light on how Principal Loper utilized cultural capital to benefit marginalized students. She strategically negotiated challenges of practice and implementation concerning science through "code-switching" in order to meet the needs of marginalized students.

Social. School principals are responsible for navigating reform efforts, and how they negotiate decisions matters to the students and families they serve (Knapp et al., 2013). Not having the capacity to negotiate schooling matters within one's network may result in fewer resources for the community the principal serves. In this case, Principal Loper strategically advocated for science using a skillset she recognized that she had gained at a White school

during her K-12 schooling. In Principal Loper's case she utilized the assets from her own familial upbringing as well as her familiarity with "the game"—that is, knowing how to navigate a predominately White space as a Black woman. This event demonstrated that the moves principals make are strategic and that principals in urban settings may need a skill set that is not learned in leadership coursework, but is rather learned through "church," or "in the neighborhood" of their students.

During the meeting with the ISD representative about the budget, Principal Loper utilized her knowledge of communication skills she gained from attending a White school to engage and strategically inquire about science resources. When I asked Principal Loper how she knew to ask her question in that specific way, she indicated that it was her third attempt, letting me know that it had been a learning process for her on how to effectively obtain what her students needed.

Figure 9: Sensemaking framework based on Event #4



Interactions between policy messages, personal, and social. Principal Loper believed her responsibilities included finding a way to make science happen for her students. In this event, Principal Loper tapped into her experiences in both predominantly Black and White spaces to negotiate on behalf of her students. Recall that Principal Loper was hired at Leonhard because of her ability to develop relationships within the district, but beyond that, she developed relationships across the school and district, demonstrated by the fact that she named 26 people in the second network survey. Policies were therefore negotiable and navigated with colleagues as demonstrated in *Code-Switching: Seeking Science Capital*. What was also pivotal about this case is that central office later located funding for a half-time paraprofessional for each elementary school. I have no evidence that the conversations leading to this decision originated with these questions from Principal Loper, but clearly Principal Loper was asking questions early on to make sure science was supported for her students during the 2017-2018 school year with the presence of a paraprofessional.

Table 24: Summary of Principal Connell's Events

Event #1 Who is leading science?	
Principal	**Instructional Coach:** Principal Connell, **Race:** White, **Experience in education:** 20 years
Policy Message	Science will be done. Driven by district administrators.
Personal	"I mean science is important to learning and anything that we're teaching with nonfiction texts, nonfiction subjects is so important because that's how kids are tested…If we take that away and we don't teach them the reading skills and the strategies because you read nonfiction very differently than you read a fictional text...I think we're at a pivotal point as a district of really possibly turning things around by bringing science more as a focus" (Interview 1).
Event #2 'I'm just a parapro'	
Principal	**Instructional Coach:** Principal Connell, **Race:** White, **Experience in education:** 20 years
Policy Message	District deadlines—science needs to be completed in a timely fashion.
Personal	"I think that my biggest struggle right now is that we are in this transitional phase, where we're getting more directions in curriculum, I met with Dr. H [the director of academic services] yesterday to go over my evaluations, and my rubric and where I'm at, we've talked about this. She said, "Nope, we're not there yet," you know what I mean? There are some things we're just not where we need to be, curriculum wise. I think instructionally, that makes it difficult, because we're talking about the system that's working right now, but it's not going to be the system we're going to have." (Interview 2)
Social and Analysis of Events #1 and # 2	•Principal Connell focused on the maintenance of science. •There were no opportunities to co-construct knowledge, and therefore social interactions had limited impact on Principal Connell's personal understanding and beliefs on science. •Limited social interactions resulted in the policy messages received by Principal Connell being simply viewed as directives rather than policies in which she had an active role in participating. •There was no interaction between Principal Connell's personal understandings and beliefs about science and her science network.

Table 25: Summary of Principal Loper's Events

Event #3 'We want our kids to be successful'	
Principal	**Community Leader:** Principal Loper**, Race:** Black, **Experience in education:** 16 years
Policy Message	Science will be done—limitations do to State and local policies.
Personal	"I mean science is important to learning and anything that we're teaching with nonfiction texts, nonfiction subjects is so important because that's how kids are tested…If we take that away and we don't teach them the reading skills and the strategies because you read nonfiction very differently than you read a fictional text...I think we're at a pivotal point as a district of really possibly turning things around by bringing science more as a focus" (Interview 1).
Event #4 Code-switching: Seeking science capital	
Principal	**Community Leader:** Principal Loper**, Race:** Black, **Experience in education:** 16 years
Policy Message	Locating resources for science.
Personal	Principal Loper described her ability to "code-switch" given her specific cultural background and K-12 experiences, which then allows her to capitalize on navigating policies to best meet the needs of her students. Principal Loper described this capacity as being a product of the fact that she went to the "White school" for her K-12 schooling, but went to church in the same neighborhood in which Leonhard Elementary resides. Principal Loper therefore utilizes code-switching as a source of capital to meet the needs of her students in an urban school district.
Social and Analysis of Events #3 and #4	•Principal Loper saw her responsibility as finding a way to make science happen for her students—science was a form of social justice. •In this event, Principal Loper tapped into her experiences in both predominantly Black and White spaces to negotiate on behalf of her students. •Principal Loper developed relationships across the school and district as she named 26 people in the second network survey. •Policies were therefore negotiable and navigated with colleagues.

Overarching Themes

Based on the analysis and findings in Chapters Five and Six, there are some overarching themes connecting these two chapters.

Theme One

Theme One is as follows: One must have knowledge about the roles and science capacities within the science network in order to strategically draw capital from the network.

Being resource and network savvy—knowing who possesses what—was productive for the advancement of science instruction. Developing knowledge about the science capacities

within one's network resulted in an increased number of ties. However, it also mattered what type of knowledge was being sought by the network member. We saw in Chapter 5 that Principal Loper was a community leader, resulting in her accessing other principals, central office administrators, teachers, and the ISD specialist in order to make sense of science policies. Principal Loper did not seek individuals for an answer on what to do in a given science-related decision but rather surveyed various individuals to make the best decision concerning science and to start a conversation. Principal Loper understood that, ultimately, she was responsible for the performance of students. However, it was her role to activate the resources as discussed by Spillane and colleagues (2001). Beyond accessing information, Principal Loper was also intentional about what information she asked for and how she asked it from key individuals within her science and non-science network. For example, learning how to effectively ask for Title I funds for science support took multiple attempts. Paraprofessionals for science were hired the following year with other funds. The conversations must begin somewhere, and principals who are strategic and intentional will be able to best serve their school communities as science leaders.

Based on findings in Chapter 4, we know that within the Great Lakes network, the more principals or administrators one sought out for information about science within one's network, the more likely that one was sought out by others for information about science. The greatest indicator of being sought for science information was one's background in science. Those within the Great Lakes network who were sought most frequently were Susan Cook, the science specialist, and Dr. Thomas, the elementary curriculum specialist. Both Ms. Cook and Dr. Thomas have defined roles concerning science for Great Lakes Schools, and therefore they were likely also sought for this reason. However, because experience was an indicator of being sought

within the network, we must also consider the need to develop the capacities of individuals in the network. Yet this also yields the question, *how much do principals know about one another to strategically draw from those who are most experienced in science?* The only way individuals in the network could be accessed for their science knowledge is if the network members are aware of the knowledge possessed by the individuals within the network. Principal Grant is one example of a person within the Great Lakes network who was not connected and had the most science experience of the elementary principals.

Principal Grant had the most expertise in science, having served as a science specialist while teaching. However, because he was a new principal in the district, it would take some intentionality for his elementary principal colleagues to learn about his expertise in science. There was also no systemic means of connecting Principal Grant to the network. After three months of implementing the science curriculum, Principal Grant was not familiar with the resources available to him as a principal in the district, including access to the science specialist through the ISD.

Theme Two

Theme Two is as follows: Engaging with one's network about science yielded interpretation of policies as fluid; not engaging with one's network about science yielded interpretation of policies as stagnant.

Principal Loper accessed various people in her network for information and ultimately synthesized the information retained from her network with her findings from her own research to support teachers. Principal Loper's personal understandings were continuously modified as she had interactions with those within her network. Therefore, Principal Loper's many ties served as a benefit. An increase in the number of ties demonstrated an increase in social

interactions about science, as well as information to be synthesized, which enabled participants to make informed science decisions for their context. Each person's expertise (Chapter 5) played a role in guiding Principal Loper to her interpretation of the policy. Therefore, by engaging directly with policy and by viewing policies and directives as "opportunity[ies]" as Principal Loper stated, her capacity to fulfill the science needs of Leonhard Elementary was enhanced.

Because Principal Loper did not see science policies as stagnant, she actively engaged in conversations which continuously modified her understandings of the potential of policies. However, we saw a different case with Principal Connell. Due to the limited opportunities created by Principal Connell to discuss science, she relied on others to make decisions about science. Teachers in her building had a local science expert in the form of the school's paraprofessional. Principal Connell accepted what was decided by central office, and when an opportunity arose for her to make contact about science, she chose not to. Principal Connell sought five people before implementation and six after implementation, mostly central office staff members. Conversations about science mainly involved compliance, which limited opportunities for actively engaging with policies.

Theme Three

Theme three is as follows: Policies can be either transformational or limiting

Both Black principals sought more than 20 individuals about science resources, instruction, and standards. However, there was no specific indication that race factored into whom they sought about science. In Chapter 4, by honing in on specific ties as illuminated on the sociogram, we gained insight into what exactly principals talked about, as demonstrated through interviews and field notes. Principals Loper and Matthews and Superintendent Jackson intentionally aligned based on their social justice orientation towards science, which was also

shared by Susan Cook. In professional development, it is not uncommon for education professionals to be grouped to gain diverse perspectives on topics, but how often are these same professionals grouped based on their orientation towards science? Each of these Black administrators discussed in their interviews what science and STEM could potentially do for their students, and what their students could later do as adults within their community. We saw these principals create a space where they could work with an expert to better understand the potential of science.

We also saw in Chapter 4 that Principal Hill sought information from few teachers after the implementation of the curriculum. She reasoned that this may have been due to the limited time devoted to science during the school day as per the district's instructional minutes requirement. Many of the events in this chapter centered various policies. The way Principals Loper and Matthews went about addressing these policies varied. Principal Loper sought options, researched online, and investigated curricula herself. The policy focused Principal Loper's energies activating the various science resources that were in reach once she talked to the right person. However, Principal Connell delegated conversations about science to the science paraprofessional. This then limited the potential of the science policy at her school.

Theme Four

Theme four is as follows: Principals seek their science network dependent upon how they self-identify as a principal.

We saw in Chapter 5 that a community leader, Principal Loper, drew upon various individuals within her network to consider the perspective they had to offer, which allowed for various conversations to be had. Principal Connell valued her background as an instructional coach and aligned best practices with various reform-based supports. Principal Hill did not

interact with teachers as often after the implementation of the curriculum. Principal Grant was formerly a science expert and was extremely confident in his instructional skills related to science. As demonstrated in his network data, he sought only one administrator about science instruction.

Community Leaders in Science

Although we have surpassed the NCLB era, principals are continuing to respond to federal, state, and local policies with a NCLB mindset, meaning accountability-based reforms are steering the direction of science education. Of the four named events identified by principals as times they discussed science through interview or in observation, each was guided by the need to meet state assessment requirements. In addition to attending to assessment, this analysis also demonstrates the need for a dedicated science leader and an understanding of how one's cultural capital can be strategically tapped to move forward a science agenda.

In this study, we see the differences in leadership between a White and a Black principal. Although this case does not speak to the leadership styles of all White or Black principals, the community leadership aspect of the Black principal in this study corroborates other literature on Black principals (Dantley, 2005; Khalifa, 2012; Lomotey, 1993; Walker, 2000). Black principals often lead on behalf a community and view themselves as community leaders, rather than solely as the leader of a school. What this study contributes to the literature is that when a community leader addresses science, and potentially other content areas, the Black principal is keen on making instructional decisions that would heighten the skillsets of students returning into their community.

As a community leader, the Black principal sought various perspectives of those within her network to inform her decisions about science. We also saw the Black principal aligned with

culturally, racially, and positionally empowered colleagues in the district to negotiate resources for science with the hope of becoming the science instructional leader for her staff that she desired to be. Walker's (2000) research shed light on the role of Black principals in the rural South and how one aspect of being a community leader was meeting the needs of Black and Brown students when this may not be central to other high-level school administrators.

Principal Connell led from a perspective of technical maintenance of the status quo (Fullan, 1997; Larson, 1997). Although Principal Connell discussed the needs of her students, she mainly centered the need to comply with directives. Principal Connell did not perceive her role as being responsible as the leader of science. Instead, her focus was more centered on keeping order and maintaining the perception that the school was successful through meeting deadlines and fulfilling requirements. Ms. Donaldson was a science paraprofessional, yet she was charged with facing central office because some teachers would not be able to meet the deadline for completing a lesson in science. Central office, at that time, mainly required science to take place, which was the only specific expectation Principal Connell deliberately communicated with her staff at the time of this study. However, if she had acted from the perspective of a science leader, she would have concluded that teachers needed more time, and she would have engaged with each teacher to better understand the time they needed given the period of transition and the need for a mindset change. As a community leader, she would have recognized that this knowledge was not to be rushed, as the content itself would be needed by students to develop their critical thinking skills or to inspire their future STEM trajectory. Otherwise, science would become another standards-based obligation.

It is also important to discuss the power dynamics that took place between Principal Connell and Ms. Donaldson. Larsen (1997) stated that principals are also involved in the

"intentional practice" (p. 326) of highlighting only specific aspects of an event, while not being as explicit about others. Principal Connell left Ms. Donaldson with the impression that Ms. Donaldson was responsible for teachers being behind. However, it was not clear how science was discussed in principal meetings as described by Dr. Thomas (Interview 2) and Principal Grant (Interview 2). Ms. Donaldson stated to me that she is "just a parapro" (field notes), and from field note data, I know she is paid a bit more than a substitute teacher for a full day of work, but not by much. Ms. Donaldson may not have a degree in education or science, but she has led science learning in Great Lakes since the 90s. Ms. Donaldson is a key figure in science, but her expertise and position were not respected.

Khalifa, Douglas, and Chambers (2016) highlighted that Whites may have a nostalgia about the past and therefore essentially avoid the racialized histories and perceptions of Blacks. Principal Connell recognized that the demographics of the district had "changed" and began to tell stories of her friendships with people of color thirty years ago when she was a teenager growing up in Great Lakes. However, when discussing the current realities of the Black and Brown students within her school, Principal Connell expressed that she had tried to address deficit mindsets, but some staff members were resistant and therefore struggled. Without being able to navigate these conversations, Principal Connell struggled in advocating for the students and therefore families of color within the Great Lakes community.

What is also clear is that people of color may not feel safe in aligning around mutual causes and therefore may protect their colleagues as they see fit. How often in staff meetings or professional development are staff members grouped to bring together diverse ideas? This study suggests that a more meaningful strategy may be to support collaborations between those who have similar perspectives, identities, or charges like that we saw between Principals Loper and

Matthews and Superintendent Jackson, all of whom were equity-driven. Because information was withheld during the interview concerning Superintendent Jackson being present in a meeting, I question, are we in education creating safe spaces for talk in schools, especially for people of color?

Next, this analysis illuminates how a principal's science schooling and experiences impacts their vision for schooling. Principal Connell received a degree in elementary education and a master's degree in educational leadership. Principal Connell shared that she had no specific science experiences during college. She also indicated on her network survey that she had no coursework in science during her higher education experiences. Principal Loper described that going to a White school enabled her to navigate a White-dominated field of school leadership. She also conveyed that she also has the capacity to sit with Leonhard parents and empathize with their struggle and day-to-day lives because she was raised in the same community as the parents.

Elementary Principal Sensemaking

School leaders within high-minority/low-SES contexts may have differing experiences when implementing top-down reforms efforts (Knapp et al., 2013; Spillane et al., 2001). However, this chapter highlighted that leaders who navigate policies with members of their network may view policies as malleable. In other words, principals who actively engage in conversations about science within their network and their community gained insights on the potential of a policy rather than focusing on the perceived rigid nature of a policy. Therefore, the policy message conveyed to a principal, the personal understandings of that principal, and social conversations/meetings that principal participated in (Coburn, 2001, 2005; Spillane et al., 2001; Weick, 1995) all contributed to how the principal then made sense of science policies. When a

principal relied on their own personal understandings, policies were received as directives and perceived as relatively straightforward, and there were limited opportunities for sensemaking (Coburn, 2001). However, when policies were viewed as "opportunity[ies]," as Principal Loper stated, a principal could utilize their network to strategically navigate how to "activate" resources (Spillane et al., 2001) and how to put the pieces in place that would enable them to best meet the needs of their students, while also fulfilling the requirements of the policy directives from central office.

Principal Loper learned the needed language to strategically negotiate on behalf of students with central office staff, other principals, and with other administrators involved in school/district decision-making. To do this, she first recognized that directives and policies were to be interpreted. Rather than policies happening to Principal Loper, she controlled how the policies were implemented, thus making her a street-level bureaucrat. Therefore, principal sensemaking of a Black principal may differ from that of a White principal, given their intentionality and purpose for conversations—countering the status quo (Evans, 2007). Principal Loper gathered information from many people within her network, but strategically engaged those who possibly had similar ideals around science.

Although teachers and administrators must now operate under ESSA, institutional logic continues to be based on NCLB mindsets and the heightened awareness of accountability via high-stakes testing. As Principal Connell stated, "no one wants to be in the bottom." This study demonstrates that behaviors in such high-stakes environments take time to change. In essence, there was doubt expressed by administrators and paraprofessionals. As Principals Loper and Hill shared with me, my presence in the district meant science would be prioritized. I became a signal that science would be done. Therefore, policy implementation is still tightly connected to past

policies, which may not result in lost jobs, immediately, but rather in low rankings, or in a position on various state lists indicating need for support. These rankings then yield responsiveness to policies in order to counter being deemed a low-performance school.

In Chapter 4 we gained an overview of the district interactions. By honing in on the science social network of this district, we were better able to recognize how a principal's social network then impacts how the principal makes sense of science policies. Personal understandings, as well as one's social ties, are connected to how principals then respond to policy messages. Interacting with one's social network led to policies being viewed as malleable and as a means of providing needed science instruction to students. The social network data provides a snapshot at specific points in time, but field notes, interviews, and district documents provided a greater understanding of how negotiations are made and of the day-to-day social interactions principals participate in that contribute to science decision-making.

CHAPTER SIX

Conclusion

When I think of the three of them [Principal Loper, Principal Matthews, and Superintendent Jackson] …it was more than just teaching science. It was about equity for their kids and access for their kids and they realize just how important that is long term. I think that's really, really a positive thing. It's this idea of we're starting at the needs of the students and looking out. (Susan Cook, ISD Science Specialist)

In this last chapter, I highlight the challenges and the systemic incoherencies that may have prevented the transformative nature of science for which the NGSS advocate from blossoming in GLS. Until these capacities, local policies, and incoherencies are addressed, elementary school administrators will continue to maintain the status quo. In other words, science will not be at the forefront of learning, and will continue to be treated as a secondary content area. Lastly, science professionalism must be reconsidered to encourage transformative practices. This research brings me hope and has inspired the next phase of my career in academia.

The above quote exemplifies the potential of thinking systemically about science within schools and districts. What Susan Cook, a White woman, identified of these Black administrators is that they are thinking about science differently than their peers. Yet, in science education, researchers often do not think critically about the role of school principals and how they can serve as instrumental actors when implementing a science curriculum. Principals are vital in schools and often serve as gatekeepers. We must now consider how we can work with principals rather than around them. As we reconceptualize science, policy concerning leadership in science must also be considered.

Although the NCLB era has ended, there is tension between current federal, state, and local policies to which principals are beholden. K-12 educators are now serving under ESSA at

the federal level, but local policies have not changed considerably. In other words, accountability-based reforms are continuing to steer the direction of science education, thus inhibiting the potential of transformative and equitable science instruction. Notably, content areas are taught in isolation in many contexts and are also assessed in a similar fashion. Although districts like Great Lakes have begun conversations about integrating reading, math, science, and social studies, the focus on reading and math assessments at the state level result in pressure for teachers to focus on these content areas and to spend less time on science (and social studies). This yields an important question: *What if content assessments were integrated?* The four events described in this study were identified by principals as times when they discussed science because of the need to meet state assessment requirements. Principals are tasked with the arduous position of being the gatekeeper of a school. This study indicates that principals may be interested in implementing science to the best of their ability but that often their science capacities are limited, and they are inhibited by local policies and/or limitations within the organizational structures in schools.

Implications

Challenges

This study indicates a need to build science administrator capacities through their social network as well as to develop each principal's science beliefs and understandings.

Science social networks. Social networks impact the perspective elementary principals have concerning policies. This research draws attention to the necessity of considering how principals are thinking collectively. This research also underscores that beyond engaging individuals about content implementation, the field must think systematically about science implementation. This study highlights that how principals engage with various people within

their network impacts how those principals then interact with policies. Race may not be significant in determining whom one seeks out, but it may play a factor in what individuals choose to talk about when a group comes together to discuss science education when that group is racially, and possibly culturally, alike.

The need to address the science social networks of principals suggests that locating allies around science may be instrumental in challenging the status quo for science that is currently accepted in many schools and districts across the country. To locate allies, principals would need to have space to have conversations about science. The principals reflected in this study mentioned their desire to talk to the other elementary principals about implementation, but unfortunately, they had limited time in which these conversations could take place. What if that time was provided systematically in districts so that principals could collaborate in a safe environment and when they are not experiencing any pressures by their administrators? There could be resources to help initiate conversations, including conversations about one's background and experiences in science.

There is also a need to inform network members of the potential capital that exists within their network. Without insights on the capital that exists within the network, individuals may be less likely to tap into the science-related capital within the network, especially when someone is new to the network. When a principal was not strongly connected to the network in this study, the principal's science expertise was not shared with others. Principal Grant had served in the capacity of science specialist when he was a teacher, but because he was not well connected to the network, and there was no specific means of sharing that information about his background and expertise, this resource was left unknown to others in the network. I am not implying that this information was purposefully withheld by Principal Grant, but rather that given his

priorities, he did not see a reason to raise the topic of his science background. Enhancing the science social network for school principals means networks would support information being shared, and provide space for principals to collectively consider ways to counter the status quo concerning science.

Individual science beliefs and understandings. All the participants in this study admitted that science is not prioritized in elementary schools. However, some principals saw hope in the potential of what science could be, while others accepted that science just could not be prioritized given the need to focus on reading and math. Those who saw the potential understood science to be critical to the community. In the case of Principal Connell, she mostly sought information about compliance with the local science policies from the individuals with whom she talked about science. Because she was focused on complying with policies and on implementing the curriculum with fidelity, Principal Connell did not readily seek conversations about instruction or the potential of science. Her understandings and ideas about science were never challenged or disrupted, and she had a relationship with policies in which they dictated her work rather than providing potential "opportunities," as Principal Loper stated.

Principals also expressed that although they were the instructional leader in their schools, the instructional coaches were often provided more training than them. This then limited their capacity to support teachers and left them in the dark on the initiatives being implemented within their schools. There was no systematic means of supporting the administrative staff. Because central office provided professional development only to the staff and instructional coaches, the principals did not have the same insights and were then the decision-maker for science when their vantage point was not adequately considered.

Community leaders accessed resources in ways all principals need to, but many principals may not have the navigational capacities to do so. This work leads us to question, *how do we support those navigational capacities?* This may be an important area to explore to better understand how to enhance the social capital of elementary principals within their network, which could result in a greater capacity to support science education. A principal's capacity to activate resources (Spillane et al., 2001) is also related to that principal's network and understanding of the capital within the network. Principal Loper was not only savvy of the resources available to her, she also understood that the way she asked for these resources also mattered. She knew that how she engaged specific actors within the network was instrumental in locating and activating resources for her students. This also speaks to the bureaucratic system governing schools—in this case, in an urban context. This study demonstrates that the school principal could be the difference between students having the resources they need to be successful in science, or not.

Systemic Incoherencies

This work also highlights that local policies are in direct contention with state and federal policies. At this point in time, 48 states have adopted some version of the NGSS. However, many school districts have maintained pre-adoption policies that have hindered implementation. If local policies hinder the implementation of these standards, little will change concerning students' scientific literacy. Two examples of said policies are instructional minutes and pacing guides.

Instructional Minutes. Although not stated explicitly, the instructional minutes allocated to each subject imply the priorities of the district and therefore the school. There were two days where Principal Loper strategically went to classes where she expected to see science instruction.

In each class, the teachers and students were either covering a content area other than science or were at recess. Given the local policy in GLS was that teachers were required to teach either science or social studies every day for 25-45 minutes (See Appendix D), many would do a unit on science and then alternate with social studies. When I observed Principal Loper, we mostly saw teachers teaching social studies. It could be that Principal Loper and I just happened to only observe social studies. However, other teachers were not teaching either, and occasionally used the allotted time for recess, based on the teachers' lesson plans and what we observed upon entering the classroom. Principal Loper then communicated with the teachers that she needed to be updated when their schedules changed and that each teacher would need to send her their science schedule. When teachers found they had limited time to teach science (or social studies), it was dropped all together.

Principal Connell initially told me that she understood why teachers were not getting to science—she believed there was not enough time to do science. This changed, however, when she was held accountable for teachers completing science units. Instructional minutes are also potentially a hindrance in signaling that science should be taught in isolation from reading/writing and math. Some principals stated that they intentionally asked teachers, when are you teaching science? While others stated the foci in elementary school are reading/language arts and math, and therefore they do not go into classrooms when science is being taught. This then speaks to a need to create social spaces where principals, administrators, and science specialists can talk about their motivations and beliefs about science. When individual principals responded to local policies based on their personal beliefs and understandings, they were more likely to implement those policies in a way that differs from the strict intentions of the district. Therefore, there is a need for local policies to be collectively interpreted.

Pacing Guides. If teachers and principals are beholden to a pacing guide, scientific literacy may not be achieved. For principals who understood local policies to be static, these pacing guides were static documents. In the case of Principal Connell, she did not see her role as one where should could talk to central office about the pacing guide that had been created and question the timeline it outlined. She had not appeared to prioritize science, but when deadlines were approaching, Principal Connell became vigilant about the teachers at Concord meeting specific benchmarks.

Recommendations

Given the findings of this study, there are some key recommendations that can potentially enhance equitable science implementation in elementary schools. These include: promoting community science thinking, creating transformative spaces for administrative learning, and enabling principals to be community leaders. I will now expand upon these recommendations.

Promote Community Science Thinking

School leaders serving in high-minority/low-SES schools have varying experiences, especially when considering how they draw upon their social network for information. Leaders who navigate policies with members of their network may view policies as malleable. In other words, principals who actively engage in conversations about science with members of their community envision science in a transformative way. Two ways by which school leaders and researchers can promote transformational science are promoting opportunities for community thinking through transformative spaces for learning and seeking insights from the school community.

Create Transformative Spaces for Administrative Learning

Principals are in need of spaces where they can collectively work towards transformative education. This would mean that they would have opportunities to express ideas among non-biased and non-judgmental listeners and collaborators. Principals who align around similar causes should have opportunities to work together and co-construct the meaning of policies before implementing them. In the case of Principal Loper, she aligned with other school administrators who were not only Black but also understood science to be a right of all students. Her goal was not only to fulfill requirements, but also to provide potentially life-altering learning opportunities to her students. Principals Loper and Matthews aligned with a science specialist, an expert, to conceptualize what they could offer their students, which would then enable their students to be doers of science within their own communities.

Enable Principals to be Community Leaders

Principals should not make decisions about science in isolation but rather should be encouraged to seek the perspectives of various individuals within their network, including science experts, other educators, and community members. This way, principals with visions for science that are different from those of their community could encounter and develop ideas and beliefs that may shift their preconceived notions about science. Central office administrators could be instrumental in developing community leaders. This may require asking to whom principals talk about science and the type of insights they gain from each group. This could also be encouraged by having principals meet and talk about a vision for science with members of the community at a community meeting. Such a meeting would allow individuals to express their ideas and concerns about science education. Finally, this could also mean talking to various stakeholders in the community (e.g., hospitals, engineering firms, factories) to find ways to draw

on their capital to enhance the learning experiences of students. Given the potential stakeholders' need for a workforce, these relationships could be leveraged by the district.

Building a Science Community

This study indicates that in order to scale up science education, a strong network of science experts must have some connection to communities. However, who are these experts? There is currently a great amount of trust placed in those occupying formal positions in connection with school districts. There is limited information on the training and support of these individuals or on how those at the state and federal levels are inter-connected. Principals and district leaders are in need of various resources. This study indicates a need to go beyond the network data of one district, to gain insights as to the potential network that exists within and between states as well as at the federal level. Right now, it takes considerable time for policies to infiltrate districts. There is a need to develop systems that better organize science leaders with various areas of expertise within districts and communities. As we consider preparing students for STEM-related fields, there are substantial implications for promoting innovations and therefore advancing the economies of communities.

Limitations and Next Steps

This study sheds light on an aspect of science education that had not been previously investigated. I acknowledge that that there are specific limitations to this work. First, the scale of this study only provides insights on one school district. The implementation of a science curriculum in a larger district, where there may be systems in place for the dispersal of information, may be different. Second, I collected data solely on my own. That limited the ability to attend all meetings and be in schools when valuable moments of sensemaking were potentially taking place. This study included five principals (2 black, 3 white; 4 women, 1 man). This study

also took place over a period of 9 months, including the summer. Although there were some indications of changes within the network, network development takes time. Collecting the data by myself did allow me to developing strong relationships in the district. I was told time and time again that my presence indicated that science was going to be done, that I served as a signal some administrators and science network members had been awaiting.

It would be important to continue this work over a longer period. There needs to be more work on network development and a deeper understanding of the resources available to principals. It is also important to examine various contexts while also understanding that districts vary systemically, which may mean that networks develop and evolve in different ways. The future of science education depends on our attentiveness to systems thinking. We must consider development beyond individuals and instead focus on networks that include social capital within them. It cannot be assumed that people within the networks know how to access the capital within their network. This study indicates that individuals will need support in doing so.

Although there is much work to do to improve science education outcomes, this study brought me hope. When elementary principals were presented with a charge to improve science within their schools, they did what they knew to do. For some, there was an innate understanding that they should draw from their network, whereas others relied on their own personal understandings of science. The administrators I worked with were open and available to having conversations. However, they could not do what they either had not been exposed to or had not considered. When a broad network was sought, innovation was possible. However, local policies limited this potential. Therefore, in many ways, policies and one's limited network led to the confinement of the potential of what elementary science could one day be.

APPENDICES

Appendix A

Principal Interview Protocol

1. Please describe, in detail, how your time is spent on a typical day?

2. How would you describe your role as an instructional leader?

3. How much time would you says is allotted to science instruction? Who determines this?

4. In order of priority, where does science fall in elementary school? Do you believe that science is prioritized in elementary schools? (If so) How so? (If not) Why not?

5. Can you share with me a recent conversation that was had about science curriculum or instruction?

    a. Who did you talk to about that?
    b. What did you talk about?
    c. Who else? -
    d. Who else?

6. Who supports you in understanding science standards? Have you discussed the Michigan Science Standards (NGSS) in meetings?
    e. Can you tell me more about that?
    f. Who was in the meeting/ a part of the conversation/etc.?

7. What factors contribute to determining which curriculum is selected for science?

    a. Who did you talk to about that?
    b. Who did you ask for help with that?
    c. What did you talk about?

8. Which content areas would you say you are comfortable in supporting as an instructional leader?

9. What are your beliefs concerning how science curriculum should be implemented?

10. What else would you like for me to know about your experiences implementing science curriculum?

Appendix B

Central Office/ ISD/ Organizations Interview Protocol

1. How would you describe your role in regards to supporting school principals?

2. What resources are provided to principals concerning science instruction by your organization? What is your involvement?

3. How much of your time would you says is allotted to science instruction? What determines this?

4. In order of priority, where does science fall in elementary school? Do you believe that science is prioritized in elementary schools? (If so) How so? (If not) Why not?

5. What factors contribute to determining which curriculum is selected for science?

6. Can you share with me a recent conversation that you had about science curriculum or instruction?

7. Who supports you in understanding science standards? What are your beliefs concerning how science curriculum should be implemented?

Appendix C

Network Survey for Principals

Your Name: _____

School Name: _____

Date: _____

Science Education Principal Survey

A. This section asks general background information about you, the participant in this study
   1. Gender (Please check): ____ Male ____Female
   2. What is your age: ____
   3. How long have you been teaching? _____ years
   4. How many years have you been in your current district? _____ years
   5. How many years have you been a principal? _____ years
   6. What is your background experience in science (Please select all that apply):

      Science Degree:

      - ☐ Bachelors
      - ☐ Masters
      - ☐ Endorsement
      - ☐ Doctorate
      - ☐ Other degree: _____

      STEM Degree (Please specify):_____

      - ☐ Bachelors
      - ☐ Masters
      - ☐ Endorsement
      - ☐ Doctorate
      - ☐ Other degree: _____

   2. When was the last time you taught a science lesson?
      - ☐ 0-1 years ago
      - ☐ 2-3 years ago
      - ☐ 4-5 years ago
      - ☐ > 5 years ago
      - ☐ Never

B. In this section, please indicate the colleagues in Western City Schools whom you seek for assistance, information and/or resources from concerning science education as well as the frequency with which you interact with each person.

Western City School District: The following individuals are people within Western City School District.

Central office:

1. Jane Doe
    a. Do you seek information from this person about science instruction/information?
        ☐ Yes (If yes, go on to 1b)
        ☐ No
    b. What information do you seek from this person regarding science? (Please select all that apply)
        ☐ Resources for science instruction (e.g. lab materials, equipment, curriculum)
        ☐ Information about science instruction
        ☐ Information about standards and policies
        ☐ Other:_____
        _____
        ☐ None

        How frequently do you talk to this colleague?

            ☐ Yearly (1)
            ☐ Monthly (2)
            ☐ Weekly (3)
            ☐ Daily (4)
2. Sue Meyer
    a. Do you seek information from this person about science instruction/information?
        ☐ Yes (If yes, go on to 2b)
        ☐ No
    b. What information do you seek from this person? (Please select all that apply)
        ☐ Resources to do science instruction (e.g. lab materials, equipment, curriculum)
        ☐ Information about science instruction
        ☐ Information in regards to standards and policies
        ☐ Other:_____
        _____
        ☐ None

        How frequently do you talk to this colleague?

            ☐ Yearly (1)
            ☐ Monthly (2)
            ☐ Weekly (3)
            ☐ Daily (4)

White Hills Elementary School

Kindergarten Teachers

3. Eric Stone
    a. Do you seek information from this person about science instruction/information?
        ☐ Yes (If yes, go on to 3b)
        ☐ No
    b. What information do you seek from this person? (Please select all that apply)
        ☐ Resources for science instruction (e.g. lab materials, equipment, curriculum)
        ☐ Information about science instruction
        ☐ Information about standards and policies
        ☐ Other:_____
        _____
        ☐ None

        How frequently do you talk to this colleague?

            ☐ Yearly (1)
            ☐ Monthly (2)
            ☐ Weekly (3)
            ☐ Daily (4)

Organizations

C. Please indicate the individuals within various organization with whom you seek for assistance, information and/or resources from concerning science education as well as the frequency with which you interact with each person.

Local Intermediate School District: The following individuals are people from your local ISD.

4. Ben Ford
    a. Do you seek information from this person about science instruction/information?
        ☐ Yes (If yes, go on to 4b)
        ☐ No
    b. What information do you seek from this person? (Please select all that apply)
        ☐ Resources for science instruction (e.g. lab materials, equipment, curriculum)
        ☐ Information about science instruction
        ☐ Information about standards and policies
        ☐ Other:_____
        _____
        ☐ None

        How frequently do you talk to this person?

            ☐ Yearly (1)
            ☐ Monthly (2)
            ☐ Weekly (3)
            ☐ Daily (4)
5. Other: Name_____
    a. Do you seek information from this person about science instruction/information?

☐ Yes (If yes, go on to 5b)
☐ No

b. What information do you seek from this person? (Please select all that apply)
☐ Resources for science instruction (e.g. lab materials, equipment, curriculum)
☐ Information about science instruction
☐ Information about standards and policies
☐ Other:_____
_____
☐ None

How frequently do you talk to this person?

☐ Yearly (1)
☐ Monthly (2)
☐ Weekly (3)
☐ Daily (4)

State-level professional organization: The following individuals are people from your state-level professional organization.

6. Kathy Williams
   a. Do you seek information from this person about science instruction/information?
      ☐ Yes (If yes, go on to 6b)
      ☐ No
   b. What information do you seek from this person? (Please select all that apply)
      ☐ Resources for science instruction (e.g. lab materials, equipment, curriculum)
      ☐ Information about science instruction
      ☐ Information about standards and policies
      ☐ Other:_____
      _____
      ☐ None

      How frequently do you talk to this person?

      ☐ Yearly (1)
      ☐ Monthly (2)
      ☐ Weekly (3)
      ☐ Daily (4)
7. Other: Name_____
   a. Do you seek information from this person about science instruction/information?
      ☐ Yes (If yes, go on to 1b)
      ☐ No
   b. What information do you seek from this person? (Please select all that apply)
      ☐ Resources for science instruction (e.g. lab materials, equipment, curriculum)
      ☐ Information about science instruction
      ☐ Information about standards and policies
      ☐ Other:_____

_____

☐ None

How frequently do you talk to this person?

- ☐ Yearly (1)
- ☐ Monthly (2)
- ☐ Weekly (3)
- ☐ Daily (4)

The Buck Institute: an organization that provides Project Based Learning professional development for teachers all over the country.

a. Do you seek information from this organization about science instruction/information?
   - ☐ Yes (If yes, go on to 6b)
   - ☐ No

b. What information do you seek from this person? (Please select all that apply)
   - ☐ Resources for science instruction (e.g. lab materials, equipment, curriculum)
   - ☐ Information about science instruction
   - ☐ Information about standards and policies
   - ☐ Other:_____
   _____

   ☐ None

   How frequently do you talk to individuals at this organization?

   - ☐ Yearly (1)
   - ☐ Monthly (2)
   - ☐ Weekly (3)
   - ☐ Daily (4)

Appendix D

Elementary Instructional Minutes

Table 26: Elementary Instructional Minutes

Great Lakes Schools Elementary Instructional Minute Guidelines 2017-18													
		Instructional Day = 395 minutes											
	lunch	Art, Technology, Learn Through	Big Reds Time	Readers Workshop	Write From the Beginning and Beyond	Word Study (phonemic awareness,	Interactive Read Aloud	Shared Reading	Math	Number Talks	Handwriting Without Tears	Science and Social Studies	Recess - yes, recess is considered
Kindergarten	40	40-45	60	35-45	30-40	45-55	25 split between IRA and SR		45-55	10	10	25-35	20
1st	40	40-45	60	40-50	30-40	35-45	25 split between IRA and SR		50-60	10	10	25-35	20
2nd	40	40-45	60	40-50	30-40	25-35	15	10	55-65	10	10	35-45	20
		Instructional Day = 395 minutes											
	lunch	Art, Technology, Music (40 min.),	Big Reds Time	Readers Workshop	Write From the Beginning and Beyond	Words Their Way	Interactive Read Aloud	Shared Reading	Science and Social Studies	Math	Number Talks	Recess - yes, recess is considered	approximate remaining
3rd	40	40-45	60	50-60	40-50	20-30	15 split between IRA and SR		25-35	55-65	10	20	30
4th	40	40-45	60	50-60	40-50	20-30	15 split between IRA and SR		25-35	55-65	10	20	30
5th	40	40-45	60	50-60	40-50	20-30	15 split between IRA and SR		25-35	55-65	10	20	30
		Instructional Day = 395 minutes											
	lunch	Art, Technology, Music (40 min.),	Big Reds Time	Readers Workshop	Write From the Beginning and Beyond	Science and academic vocabulary	Interactive Read Aloud	Shared Reading	Social Studies and	Math	Number Talks	Recess - yes, recess is considered	approximate remaining
6th	40	40-45	60	50-60	20-30	40-55	15 split between IRA and SR		25-40	70	10	20	5

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