The Role of Assumptions in Service Delivery: Exploring minority student participation in educational decision-making

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Abstract

In a diverse society, those who decide how government services are delivered may not be similar to the service recipients, and the assumptions underlying their policies may not apply to those recipients. Scholars have identified how various factors relate to these assumptions and affect service delivery. The first purpose of this dissertation is to explore how these factors may combine to produce inequality in the delivery of government services. The second purpose is to explore how participation by service recipients in decision-making processes can interrupt these patterns. This is done using a participatory, student-centered learning program as a case study in which teachers provide educational services to students. The results have implications for research and practice pertaining to inequality in education and delivery of other services.

The first essay examines how individual, environmental, and contextual factors may lead to assumptions of service providers that result in inequality. This essay describes how factors identified by institutional theorists, representative bureaucracy scholars, and those who study organizational history can interact over time to explain how assumptions may produce inequality in service delivery. Participation by service recipients from underrepresented groups in decision-making is introduced as an intervention that potentially interrupts patterns that produce inequality.
The second essay focuses on the relationship between participation by underrepresented service recipients and achievement of service delivery goals. The Math Coaching Program (MCP), a participatory, student-centered learning program, serves as a case study to explore the relationship between student participation in classroom decision-making and student test scores. Estimates using a cross-classified, multi-level model indicate that the MCP is positively related to black student test scores. The results suggest that researchers and practitioners should further explore programs that elicit participation from underrepresented groups to reduce inequality that arises as the government delivers services.

The third essay explores the relationship between organizational culture and the implementation of participatory programs by analyzing the relationship between teachers’ perceived school culture and their ability to implement the MCP. Results from a survey and teachers’ responses to open-ended questions suggest that teachers who reported belonging to schools with more collaborative cultures were better able to implement the MCP. This research indicates that organizational culture may be relevant to policymakers and administrators who wish to implement participatory programs.

The fourth essay constructs a systems model, based upon the Bass Diffusion Model (Bass, 1963), that can be used to understand the complexity of MCP implementation. The model is holistic and captures interdependencies among its elements, including feedback dynamics. Moreover, the model provides a space for service providers to test their assumptions regarding the best ways to implement the MCP.
To Sasha, Alli, Danny, Loki, and Osiris
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Vita

May 2003 ................................................Upper Arlington High School

2008 to 2010 .................................B.A. Mathematics and Philosophy, Boston University

2010 ..............................................M.S. Mathematics, The Ohio State University

2008 to 2010 ......................................Graduate Teaching Associate, Department of Mathematics, The Ohio State University

2012 to 2014 ......................................Graduate Research Associate, Department of Evolution, Ecology, & Organismal Biology, Project CEOS/ADVANCE, The Ohio State University

2014 to 2016 ......................................Graduate Research Associate, John Glenn College of Public Affairs, Ohio Education Research Center, The Ohio State University

2016 to present ..............................Graduate Student Researcher, Center for the Study of Student Life, The Ohio State University
Publications


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Chapter 1: Introduction

When values and cultural norms are not universally shared, assumptions and values of one segment of society can lead to misunderstandings and inequities when applied to another segment. For example, a survey indicates that most black parents believe that white students receive a better education than their children and many believe that racism is a primary factor (Leadership Conference Education Fund & Anzalone Liszt Grove Research 2016, Klein 2016). Similarly, after a police shooting of a black man in Ferguson, Missouri in 2014, researchers and the government investigated the ways that implicit biases and lack of representation contribute to the unequal treatment of citizens (Hong, 2016; US Department of Justice, 2015).

While many researchers have focused on issues of inequality by examining the perspectives of public officials (Hong, 2016; Jencks, 1998; Meier, et al 1999; Skiba et al, 2011; Glock & Kovacs, 2013; Bakari, 2003), few have looked specifically at the assumptions underlying policy arguments used by those who make decisions or at the ways those assumptions affect their decisions (Toulmin, 1958; Dunn 1981, 1994; You, 1990). Policies arise from group discourse based upon the perceived soundness of reasons that individuals provide for various claims (You, 1990). In order to understand
how decision-making by public officials can lead to inequality, researchers should investigate the reasons given for policy claims and their underlying assumptions.

The first purpose of this dissertation is to develop a framework to explore how implicit and explicit assumptions of service providers affect policy arguments, decisions, and service delivery. A second purpose is to use this framework to help understand how assumptions might be influenced and changed to achieve policy goals. The focus of this research is on changing assumptions through participatory methods involving service recipients whose perspectives are typically underrepresented in decision-making about policies that directly affect them. The third purpose of this research is to test this framework through an exploration of a teacher-training program that uses students as a resource to change teachers’ assumptions with the goal of improving both teacher and student performance.

This is achieved by examining and evaluating an education program that promotes interactions between service recipients (students) and service providers (teachers) that increase opportunities for student participation. The Math Coaching Program (MCP) at The Ohio State University uses students’ own assumptions about problem-solving as a resource. The MCP offers the additional benefit of reducing the impact of teachers’ assumptions by allowing students to make more classroom decisions, thereby giving teachers the opportunity to recognize their unacknowledged assumptions, as promoted by the implicit bias literature (Staats, 2014). In particular, traditional classroom teaching is teacher-centered, but the MCP shifts the balance from having
teachers’ assumptions guide classroom learning by privileging the students’ assumptions as the teachers discover how they learn.

In Chapter 2, I explore how individual, organizational, and environmental characteristics lead to the spread and use of assumptions within service provider organizations. I describe how assumptions that potentially lead to inequality arise by emphasizing that previously acknowledged sources of assumptions interact within a system. I suggest that scholars can better understand sources of assumptions by using systems thinking and focusing on feedback and emergence within a system. I conclude by introducing participation by service recipients from underrepresented groups as a possible mechanism to change assumptions within this system to result in more equal distribution of services.

In Chapter 3, I test the framework developed in Chapter 2 by addressing whether participation in decision-making by service recipients from underrepresented groups reduces inequality in service provision. I use the participatory Math Coaching Program as a case study and examine the association between black student math scores and the MCP. I find that the MCP is associated with higher black student math scores; I do not find a statistically significant relationship between the MCP and white student scores, and the association between the MCP and student scores does not statistically significantly differ between black and white students.

In Chapter 4, I explore the contexts in which participation by underrepresented groups, as in the MCP, is successful. I find that coaches who reported that their school culture was more collaborative were associated with better MCP implementation scores.
Coaches also reported that uncooperative teachers, insufficient time to incorporate MCP ideas into their class preparation, and regulatory constraints inhibited their ability to implement the MCP.

In Chapter 5, I construct a systems model to simulate the consequences of assumptions regarding school culture and effectiveness of teacher training. The model creates an artificial world in which I explore different sets of assumptions in order to understand interdependencies between factors that contribute to MCP implementation over time. This model can be used by researchers and scholars to improve program implementation.

The results described in these chapters have important implications. In Chapter 2, I integrate three streams of research used to explain how assumptions arise within organizations; based upon this framework, I suggest that researchers and policymakers explore the use of participation by underrepresented service recipient groups as an intervention to interrupt patterns of assumptions that lead to inequality. Moreover, this framework provides a context for researchers and service providers to explore how the assumptions that they use to make decisions may lead to inequality.

The results in Chapter 3 indicate that participation by underrepresented service recipients may be related to better service delivery for those groups; in particular, these results provide evidence for the type of participation suggested in Chapter 2 and suggest an approach that can be used by researchers and practitioners to evaluate similar programs.
The fourth chapter identifies factors, including organizational culture, that are related to successful implementation of the MCP; those implementing participatory programs similar to the MCP can focus on these factors to encourage more successful implementation; in particular, if researchers wish to elicit participation from underrepresented groups, they must understand the contexts in which this is successful. Finally, the fifth chapter provides a simulation model to yield insights into MCP policies that lead to more effective implementation. Policymakers can use this model to simulate the consequences of assumptions regarding school culture and training effectiveness.

_The Math Coaching Program_

The Math Coaching Program (MCP) at The Ohio State University trains teachers in a student-centered learning approach in which students guide their own learning. Student-centered learning can be understood in opposition to a teacher-centered approach; the former requires that teachers ask more open-ended questions and stay open to multiple ways of problem-solving. In the case of the MCP, schools can be understood as service provider organizations and students as service recipients.

The fundamental goal of the MCP is to help students become active and informed agents of their own mathematical learning, making learner-responsive mathematics education the core of our work and the framework. In use, the MCP framework enriches one’s view of learner-responsive mathematics education, taking the user from more limited and narrow perspectives to richer and more
inclusive perspectives… (The Mathematics Coaching Program at mcp-coaching.osu.edu)

The MCP provides a case study to examine (1) opportunities to bring teachers’ assumptions to light, and (2) opportunities to raise teachers’ awareness of taken-for-granted assumptions and to encourage them to question their assumptions through more participatory processes.

The MCP was implemented for ten years and ended in 2015. It provided up to three years of support for coaches to work collaboratively with teachers to offer students “novel tasks” using student-centered learning approaches. For example, after giving students a math problem and possible solution, teachers can ask them whether the answer is correct, what they think the person did to get to the answer provided, and whether that method will always work (see Appendix A for specific examples). Coaches were placed in over 240 schools and worked with more than 4000 math teachers and over 100,000 students.

We can examine how the MCP and student-centered learning serve as a participatory process to overcome institutional barriers and improve minority student outcomes. We can also examine how culture and values within a school relate to the successful implementation of student-centered learning.
Chapter 2: Service Delivery, Assumptions, and Inequality

Introduction

As described in Chapter 1, an argument can be understood as a claim with reasoned support (You, 1990; Toulmin, 1958). “In an argument, a ground or datum is transformed into a claim under a series of assumptions (warrant, backing, and rebuttal) with a certain degree of probability (qualifier)” (You, 1990, p.21). “By examining contending arguments and their assumptions, analysts can uncover and critically assess reasoning and evidence that otherwise goes unnoticed” (Dunn, 1994, p. 21), including their own assumptions that are used to make policy decisions about how services are delivered. In particular, these assumptions may underlie policy arguments and thus decisions that result in inequality.

Assumptions can be understood as statements about the world that are accepted by a person or group of people without further evidence or proof. Our assumptions are subject to and potentially lead to either explicit or implicit biases about how we interact with each other, and, in this specific instance, in the way services are delivered. We cannot understand the consequences of our assumptions until we identify them and explain their sources. We can also examine the initial purposes of the assumptions
pertaining to service delivery, including, for example, assumptions about the best ways to teach and their relevance in a heterogeneous society.

Many scholars have directly or indirectly focused on assumptions that underlie our policy decisions and choices (e.g., Staats (2014), Meyer & Rowan (1977)). Consider, for instance, one’s attitudes on race and how that might affect that person’s decisions about and interactions with people from a different race. In particular, studies have shown that a decision-maker’s race or personal characteristics influence and affect outcomes for minority groups (Meier, et al 1999), including student success in education; however, we do not have a proper understanding of how decision-makers’ personal characteristics interact with their training and other background characteristics that, in turn, influence assumptions underlying policy arguments and decisions. We do not fully understand how assumptions arise through the interaction of various cultural and societal factors to produce policy arguments that can lead to inequality.

In this chapter, I present a conceptual framework to address the following question: How do individual, organizational, and environmental characteristics influence the use of assumptions by service providers and thus how they interact with recipients of a service?

Construction of the Framework

Policies arise from group discourse based upon the soundness of reasons individuals provide for various claims (You, 1990). As a result, to understand how decision-making by public officials can lead to inequality, researchers can also investigate the reasons behind policy claims and the assumptions that underlie their
claims. The purpose of this framework is to create a space where we can explore the consequences of changing particular assumptions or simply making them explicit, which, in turn, allows us to classify the kinds of actions and assumptions that favor some groups and marginalize others.

In this framework, I explain how five factors interact and lead to assumptions used by those who provide government services. By understanding how assumptions arise that may lead to inequality as services are delivered, decision-makers can find ways to change these assumptions to better meet their goals. In this chapter, I suggest using service recipients, especially those from underrepresented groups, as a sixth component to the current framework; in particular, service recipients can serve as a vehicle to changing assumptions through their interactions with service providers.

First, I explain why a framework that describes how assumptions arise is important and why such a framework can serve as a space to understand how changes to assumptions can improve service delivery to underrepresented groups. In this section, I use institutional theory to describe how assumptions can prevent decision-makers from acknowledging or questioning perspectives that, in turn, influence how various groups receive a service.

Second, I introduce the five components of my framework and explain how they can be used to understand how assumptions arise. Third, I illustrate how the components in my framework interact. I acknowledge that the components interact within a system and that they together produce assumptions that may not be attributable to a single component. Finally, based upon the framework, I suggest adding to the system and
interrupting these patterns by using participation by service recipients, especially those who are underrepresented, as a means to change assumptions in order to improve decisions and thus the delivery of services.

*Institutions and the Need for a Framework of How Assumptions Arise*

As described above, assumptions influence the policy arguments used by service providers about the best ways to provide services that, in turn, influence decisions and actions. Institutions place boundaries upon the types of assumptions used to create and evaluate arguments; more specifically, institutions guide the assumptions used by decision-makers as they consider or question arguments about the best ways to provide services.

Institutions are the “shared concepts used by humans in repetitive situations organized by rules, norms, and strategies” (Ostrom, 2010, p.263). Our perceptions of our world(s) are socially influenced, constructed, and constrained; for example, a society’s history and language delineate the concepts formed and used by its members (Berger & Luckman, 1966; Quine, 1960; Raadschelders 1998; North, 1990). These concepts and institutions allow for “a conception of reality whose validity is seen as independent of the actor’s own views or actions but is taken for granted as defining ‘the way things are’ and/or ‘way things are to be done’” (Scott, 1987, 496).

While some parts of institutions, including formal rules, are easy to identify, other parts are implicit rather than explicitly shared, and they are often taken for granted (Ostrom, 2011; Schein 1991; Scott, 1987). Scott (1987) emphasizes the power of
institutions and that ignoring their presence can cause us to “misspecify our causal models” (Scott, 1987, 508). By definition, institutions constrain the decisions of their members because they place limits on the concepts used to make these decisions and on the approaches to decision-making that are considered relevant or appropriate. Institutions influence the perceived validity of assumptions that underlie decision-makers’ claims and decisions, especially about the way they define and understand problems related to service delivery. Institutions also influence decision-makers’ assumptions about the ways in which knowledge and information are acquired, processed, retained, and used (Ostrom, 2011).

Thus, in order to understand how decisions are made within service delivery organizations, one must examine the “basic assumptions and beliefs that are shared by members of the organization, operate unconsciously, and in a ‘taken for granted’ fashion, that define the organization’s view of itself and its environment” (Schein, 1991, 6). These assumptions may become particularly relevant when decision-makers are unsure of the process needed to achieve desired outcomes or when the technological means-end relationship, through which an organization effectively turns inputs into outputs, is or has become ambiguous (Meyer & Rowan, 1977; DiMaggio & Powell, 1983).

*Five Components that Explain How Assumptions Arise*

This framework incorporates five components to explain how assumptions arise. Institutional theorists have focused on three primary factors that lead to the creation and use of assumptions within organizations. These assumptions may be due to members of an organization observing the practices of other organizations (or people within an
organization) that are perceived as successful, to the professional organization or formal training of service providers, and to pressure from other organizations upon which they depend (Meyer & Rowan, 1977; DiMaggio & Powell, 1983; Scott 2001).

Scholars have focused on two other factors that influence assumptions and policy arguments. Assumptions may also arise because they have been passed on among members of an organization over time (Schein, 1991; Raadschelders 1998; North, 1990). In addition to organizational components, service providers may have beliefs or assumptions that reflect their personal experiences outside of their profession (Selden, et al., 1998; Meier, et al., 1999; Hong, 2016).

*Description of the Five Components of the Framework*

I construct a framework using the five components listed above to explain how assumptions arise and, in turn, influence decisions about how groups receive a service. To illustrate how this framework applies in a particular setting, I focus on education in the United States in which teachers are service providers and students are service recipients. The five components influence the delivery of educational services; more specifically, teachers’ assumptions about teaching are influenced by their professional training, their personal experiences, mimicking or watching other teachers, pressure from other organizations, and the assumptions used by previous teachers and staff at their schools and in other educational organizations.

*Training*

Teachers, administrators, or policymakers may embrace certain practices due to their own training, regardless of whether that training is relevant to their current situation
or current students. For example, teachers are often trained at historically white
universities, and Bakari (2003) provides evidence that pre-service teachers (meaning
students enrolled in teacher education programs) from black universities and colleges
have more positive attitudes toward teaching black students than those from traditionally
white universities (Bakari, 2003; Glock and Kovacs, 2013).

Implicit bias scholars note that members of minority groups are also negatively
influenced by stereotypes about their own group, suggesting that the nature of training, as
opposed to simply placing minority teachers in the classroom, can influence teacher
behavior (Staats 2014). The NAACP and the National Women’s Law Center addressed
the importance of training in a report on black girls and recommended educating teachers
about stereotypes (NAACP & NWLC, 2014).

Scott (2001) has described this influence by professional organizations as a type
of normative pressure about how one should act. Training and professional organizations
can often encourage similar and uniform action among service providers who operate
within different organizations (Meyer & Rowan, 1977; DiMaggio & Powell, 1983).

**Personal Experience**

The personal experiences of service providers can also influence their
assumptions. Representative bureaucracy scholars have studied how the match between
teacher and student backgrounds and characteristics, like ethnicity, are associated with
student outcomes. Black students are often taught by white teachers, a mismatch that
scholars have suggested is associated with lower black student achievement or

More broadly, representative bureaucracy scholars have suggested that black citizens and administrators have different attitudes than white citizens and administrators about the relative opportunities for black and white Americans (Bradbury and Kellough, 2008). These and other scholars have emphasized that individuals’ social origin or background may affect their behavior within an organization (Kinglsey, 1944; Mosher, 1968; Meier & Nigro, 1976).

**Pressure from Other Organizations**

Regulations not only limit discretion service providers have to make their own decisions, but also can dictate perceptions of correct or legitimate ways of behaving (Meyer & Rowan, 1977). Chubb and Moe (1988) argue that too many regulations in education may arise because of competing interest groups vying for control over educational policy. They argue that these regulations can limit teacher discretion and their ability to serve the individual and unique needs of students (1990). Chubb and Moe (1988, 1990) argue that these types of regulations may be especially likely to arise in highly politicized environments.

**Mimicking Other Service Providers**

Meyer and Rowan (1977) and DiMaggio and Powell (1983) argue that organizations “mimic” each other in order to appear legitimate and culturally acceptable. While many argue that tests used in classrooms favor white students due to group norms,
values, and exposure (Jencks, 1998), their use persists because they have become widely accepted and considered legitimate.

Selden et al (1998) have argued that, due to these processes, one may predict service provider’s behavior from their tenure within an organization. Moreover, Selden et al (1998) have argued that who one is surrounded by within an organization likely affects these processes. For example, being surrounded by service providers from a particular group may increase the likelihood of addressing that group’s needs (Selden et al, 1998).

**Organizational History**

History influences decisions as assumptions are passed on from one group to another. The public education system in the United States was originally designed to serve white students; assumptions about the best way to teach, the best books to use, and the best ways to solve problems are passed on and taken-for-granted, despite the large number of minority students attending public schools. Student textbooks are expected to work not just for white students, but for all students (Martin, 2011b) regardless of historical and cultural differences.

The term *path dependency* is used to describe why past organizational context influences current organizational decisions. Raadschelders (1998), in his discussion of Putnam (1993) and North (1990), remarked, “Path dependency not only connects the past to the present but highlights the fact that the past limits the range of choices in the present” (Raadschelders, 1998, 570).

Berger and Luckman (1967) emphasized, “It is impossible to understand an institution adequately without an understanding of the historical process in which it was
produced” (Berger & Luckman, 1967, 54-55). In particular, people may use certain processes because of their relevance at a specific time and environment; however, these processes can persist long after that environment has changed, even if they are no longer relevant (Marquis and Tilcsik, 2013).

Additionally, Scott (2001) has suggested that organizations resist change and new assumptions because of what population ecologists refer to as organizational inertia (Hannan & Freeman, 1984). Organizations that are created with new, less established operating procedures are not as sustainable because they are less likely to be given the benefit of the doubt when error occurs (Hannan & Freeman, 1984). Because those who receive services from organizations value reliability and accountability, they are resistant to changes in their operating procedures (Hannan & Freeman, 1984).

Table 1 provides a summary of the five factors described above that contribute to assumptions used by service providers.

Table 1. Factors that Traditionally Contribute to Assumptions Used by Service Providers

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Experience</td>
<td>Personal characteristics and experiences of service provider</td>
</tr>
<tr>
<td>Organizational History</td>
<td>History of the organization in which the service provider is employed</td>
</tr>
<tr>
<td>Training</td>
<td>Professional training provided to service provider</td>
</tr>
<tr>
<td>Mimicking Others</td>
<td>Actions of those who work close to the service provider</td>
</tr>
<tr>
<td>Pressure from other Organizations</td>
<td>Pressure from organizations upon which the service provider’s organization depends</td>
</tr>
</tbody>
</table>

1 Marquis and Tilcsik (2013) explain that this process mimics the imprinting process described by Stinchcombe (1965) and Spalding (1873)
The Interaction Among the Five Components

The five components of the framework interact and influence assumptions individually and jointly. A systems approach encourages decision-makers to focus on interdependencies and interactions among the five factors. In order to understand how inequality emerges, policymakers need to take a holistic, as opposed to a reductionist, approach (Ackoff, 1994). Emergence allows us to understand broader phenomena through the interaction of smaller, micro-level, and sometimes simpler entities (Desai, 2012). In particular, certain types of inequality may emerge in service provision due to interactions between the factors discussed above even if individual factors alone would not create inequality. For example, the history of an organization and the context in which it was formed frame the ways that training, regulations, and mimicking others influence decisions. Best practices and assumptions are passed down from one generation to another through those and other processes as an organization learns to cope with its surrounding environment and solve problems (Schein 1991). Moreover, the personal experiences of service providers and those they regularly encounter influence how they interpret and react to practices as they make decisions (Ostrom, 2011). On the other hand, training can lead one to act against assumptions acquired from personal experience.

Systems perspectives also allow for feedback. For example, if most teachers use assumptions about teaching that favor white students, new teachers who come into contact with them and learn new teaching methods may be more likely to also acquire assumptions that favor white students.
Using the Framework to Explain the Creation of White Space

This framework can be used to explain why education in the United States has been described by scholars as a ‘white space’ (Martin, 2011a; Moore, 2008; Feagin, 2000). In particular, even though a component may appear to contribute little to inequality on its own, through its interaction with other components, it can invisibly create, and even reproduce, a space that favors white students. For example, assumptions that favor white students may, over time, lead to even more assumptions that favor white students. Martin (2011a), quoting Moore (2008), who draws on work from Feagin (2000), explains that, while appearing neutral, a white space “has the power to project ‘meanings and symbols that are associated with the dominant culture, thus reproducing an ideological framework that rationalizes and reproduces structures of inequality’” (Martin, 2011a, p.390; Moore, 2008, p.17).

In the case of law schools, Moore (2008) emphasized that various mechanisms can converge in invisible ways and reproduce structures that favor white students. For example, if the educational system was originally designed to serve white students, “best practices” that are passed down may be practices that only favor white students. Therefore, the purpose of this framework is to create a space to capture the interactions among sources of assumptions that influence rules, meaning, culture, language, and values that guide decision-making, and how information is acquired, processed, and valued.

Figure 1 below shows that the five components of the framework discussed above act separately, but also interact, to produce assumptions used by service providers that
influence how services are delivered to service recipients. These assumptions influence the policy arguments used by service providers and thus their decisions. These five factors interact with one another over time, sometimes in invisible ways, and can reproduce patterns that result in only certain types of assumptions used in policy arguments and thus decisions. In education, for example, a space in which decisions that favor white students can emerge.
Figure 1. Sources of Assumptions Traditionally Used in Service Delivery

- Personal Experience
- Training
- Organizational History
- Pressure from Other Organizations
- Mimicking Others

Assumptions

Policy Arguments

Decisions
Adding a Sixth Component to Change Assumptions

Many scholars and practitioners have noted that we must focus on improving the relationships between teachers and students. However, teachers’ decisions emerge from interacting factors that lead to assumptions that influence and potentially defeat desired educational outcomes. Improving these relationships requires encouraging teachers to reevaluate their assumptions and perhaps use different assumptions. In particular, we must encourage change in the pattern of interactions to enable teachers to do what they could not otherwise do (Ackoff, 1994).

Understanding the mechanisms by which service providers acquire assumptions may allow them to change those assumptions in order to better serve underserved groups. While assumptions can be changed in many ways, one way to change service providers’ assumptions is through introducing them to assumptions held by service recipients, especially those from underrepresented groups; this type of change may reduce inequality in service delivery by interrupting the pattern of assumptions used by teachers that can result in white space.

Service providers can improve service delivery by learning of assumptions held by service recipients. Service providers can benefit from understanding how minority service recipients conceive of their need for a service and assets (Altschuld 2015), the solutions that they believe are best, how they experience receiving a service, and how they will react to various policy solutions (Walters, et al., 2002). The incorporation of their assumptions may also legitimize the process for service recipients (Walters, et al.,
Some scholars have referred to this contribution to the production of goods and services by those outside of an organization as *co-production* (Ostrom, 1996).

Opportunities for service recipients to share this knowledge with service providers may increase service providers’ and other decision-makers’ awareness and recognition of taken-for-granted, and potentially ineffective, assumptions. This knowledge is unique if service recipients are from a different culture, particularly from an underrepresented group. Similarly, Scott (2001) and Oliver (1992) have suggested this incorporation of new participants’ assumptions into decision-making as a means to “deinstitutionalize” or change assumptions used by an organization; in particular, Oliver (1992) suggested giving decision-making power to new participants with different beliefs in order to change assumptions.

For these reasons, deLeon and deLeon (2002) have emphasized that top-down policies created by those at the top of a hierarchy, who are far removed from service recipients and are sometimes affected by other interests and objectives, may disappoint, especially in a complex environment (deLeon and deLeon 2002). In addition, bottom-up, participatory approaches to service delivery allow decision-makers to look beyond the immediate needs of service recipients in order to focus on their assets and the resources they bring to improve service delivery and to reach organizational or public goals (Altschuld and Kumar, 2010).

Table 2 provides a brief summary of the factors that contribute to service providers’ assumptions, which are the same as those included in Table 1 except a sixth factor, service recipients, is added. In order to address the issue of inequality in service
delivery, decision-makers must be able to conceive of actions that favor the minority group and have the discretion to act upon these solutions. Understanding the culture of a group one is trying to serve can bring to light unquestioned, in appropriate, and ingrained assumptions that inhibit one from achieving policy goals. Therefore, a sixth component, participation by service recipients, can also be added to the system to change assumptions.

Table 2. Factors that Contribute to Assumptions Used in Service Provision, with the Addition of Service Recipients

<table>
<thead>
<tr>
<th>Personal Experience</th>
<th>Personal characteristics and experiences of service provider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational History</td>
<td>History of the organization in which the service provider is employed</td>
</tr>
<tr>
<td>Training</td>
<td>Professional training provided to service provider</td>
</tr>
<tr>
<td>Mimicking Others</td>
<td>Actions of those who work close to the service provider</td>
</tr>
<tr>
<td>Pressure from other Organizations</td>
<td>Pressure from organizations upon which the service provider’s organization depends</td>
</tr>
<tr>
<td>Service Recipients</td>
<td>Learning from the shared perspectives of those who receive a service</td>
</tr>
</tbody>
</table>

Figure 2 below is the same as Figure 1 except that it contains a sixth element, service recipients from underrepresented groups, that can be used as a vehicle to change the system in which assumptions arise through participatory mechanisms, and thus change policy arguments and decisions. Again, each of the six factors act alone, but also interact with one another over time. By using participation by service recipients to inform service providers of their assumptions, service providers may be better equipped to
reconsider or reevaluate the reasons that underlie their various policy claims and, in turn, make decisions that create more equal outcomes.
Figure 2. Amended Sources of Assumptions Used in Service Delivery

- Personal Experience
- Organizational History
- Training
- Service Recipients
- Mimicking Others
- Pressure from Other Organizations

Assumptions

Policy Arguments

Decisions
The Benefits of Student-Centered Learning

Student-centered learning, as used by the MCP, provides more opportunities for “proper participation”, as described by Webler and Tuler (2002), in the classroom in comparison to traditional, teacher-centered learning. While a student is “present” in the classroom for both student-centered and teacher-centered learning, the student is “present” in different ways. In particular, because teachers are encouraged to ask open-ended questions in the student-centered learning approach, the students are given significantly more opportunities to initiate discussion of the questions. Moreover, because teachers using this approach are encouraged to be open to multiple ways of solving problems, students are better able to participate in the discussion and to challenge traditional ideas as they work to solve problems. Throughout this process, students are given more opportunities to guide decisions about the best way to approach problems and the best ways for them to learn.

Conclusion

The goal of this framework is to capture the complex environment in which service providers and service recipients interact. Sources of assumptions are not independent, and the interactions among them are important to our understanding of organizational outputs, especially when they can invisibly reproduce spaces that favor some groups over others.

Policymakers and researchers can benefit from understanding that service providers, including teachers, do not make decisions in a vacuum; various factors influence their decisions and these factors can affect the influence of other factors. For
example, even if teachers’ personal characteristics are similar to their students, the nature and type of training they receive interacts with their personal characteristics to influence their interaction with their students. In particular, policymakers cannot focus on each of these factors separately but must instead understand that they interact.

This framework creates a space where we can classify the kinds of assumptions and therefore policy arguments and decisions that favor some groups and marginalize others. Researchers and policymakers can construct a systems model to explore the consequences of various ways in which these factors interact with one another in a particular context. This type of simulation can provide opportunities to understand how assumptions that lead to inequality may unintentionally arise, but also the consequences of adding participation by service recipients to the system.
Chapter 3: Understanding Representation and Participation: A Multi-Level Assessment of the Math Coaching Program

Introduction

Service provider organizations in a heterogeneous society adopt a host of assumptions about social reality that are not necessarily applicable to all service recipients. For example, educational decision-makers may assume that a teaching approach that is successful for students from the dominant culture will be equally successful for all students. If such an assumption is incorrect, students from the dominant culture are privileged over other students. As discussed previously, implicit bias scholars have focused on these issues, acknowledging the importance of bringing bias assumptions to light (Staats, 2014). Through the exploration of these assumptions we can begin to understand how our biases inform or distort our policy arguments (You, 1990; Toulmin, 1958), behaviors and attitudes towards different groups within society.

The focus of this chapter is on addressing unequal delivery of services through addressing assumptions made by service providers. The assumptions of service providers can be changed in many ways, and I will examine a particular kind of interaction between providers and recipients of a service as one way to do so. Service providers can create
opportunities for service recipients to participate in their decision-making processes and to challenge their assumptions about the best ways to provide services.

This is done within the context of the participatory, student-centered Math Coaching Program (MCP), in which students can be thought of as service recipients and teachers as service providers. K-12 Education in the United States provides an opportunity to explore these issues because teachers do not always have the same cultural backgrounds as their students and therefore have different assumptions regarding student motivations and behaviors, which can lead to unequal treatment of one group by another. In the context of the MCP, students are given opportunities to change teachers’ assumptions through more opportunities to participate in educational decisions.

In this chapter, I focus on the following research question: to what extent is teacher participation in the MCP related to reducing inequality in service provision to minority students? Using the conceptual framework developed in Chapter 2, I hypothesize that minority students in classrooms with teachers who were coached (in MCP techniques) will show better outcomes than those in classrooms with a teacher who was not coached. I also hypothesize that minority students will benefit more from the MCP than white students.

These hypotheses are tested using test scores from a sample of students in Ohio schools during school years 2012, 2013, and 2014. Multi-level modeling techniques are used because of the inherent nested structure of the data. In particular, test scores are nested within students, which are nested within teachers, which are nested within schools;
for example, scores from the same student can be expected to be more similar than scores from different students.

This chapter is organized into five sections. First, I provide background about the Math Coaching Program and how it can serve as a participatory approach to changing assumptions used within the classroom. Next, I briefly summarize the extant literature regarding assumptions, participation and outcomes for students and service recipients, more broadly. Third, I introduce the research design, including the methodological approach, data, and methods. Fourth, I review the results of the analyses, which suggest that the MCP improves the performance of black students but does not have a corresponding effect for white students. Finally, I conclude with a discussion of the results and the limitations of this research and make recommendations for future research.

Background

In this chapter, I explore whether the interaction between teachers and students through the participatory, student-guided Math Coaching Program (MCP) leads to improved outcomes among different groups of students. As described in the introduction, the MCP at The Ohio State University trains teachers in a participatory, student-centered learning approach. Schools that are struggling to meet academic performance measures, designated as schools in “Continuous Improvement” by the Ohio Department of Education, were given state funding to participate in MCP training. The MCP lasted for 10 years, and completed its final year in 2015.
Teachers at MCP schools are given the option to work with a coach at their school, trained by the MCP, who co-teaches with them in their classroom for six weeks and supports them as they implement MCP techniques (see Table 3 for a summary of these terms). Coaches are provided with further support to help them implement MCP techniques by meeting with MCP staff and facilitators throughout the school year.

Table 3. Math Coaching Program Actors

<table>
<thead>
<tr>
<th>Actor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCP Coach</td>
<td>A teacher who coaches other teachers at their school in MCP techniques</td>
</tr>
<tr>
<td>Coached Teacher</td>
<td>A teacher coached in MCP techniques</td>
</tr>
</tbody>
</table>

The MCP encourages teachers to ask open-ended questions and to be open to alternative methods used by students to solve problems. As described in Chapter 1, the MCP creates more opportunities for students to participate in classroom structure and problem-solving, allowing for teachers to improve their understanding of the contexts in which students make decisions. More broadly, this chapter provides a space to test the conceptual framework developed in Chapter 2 by understanding the relationship between the MCP and student outcomes; in particular, this research can inform questions regarding how participation by service recipients relates to achieving service delivery goals and improving service delivery for underrepresented groups.
In Chapter 2, I discussed how assumptions inform policy arguments and therefore decisions about the best ways to deliver services to various groups of service recipients. Moreover, understanding how assumptions arise can inform policymakers about how they may favor some groups of service recipients over others. I suggested participation by service recipients, especially those from underrepresented groups, as a potential mechanism to change assumptions in ways that improve service delivery.

As discussed in the previous chapter, a decision-makers’ assumptions may favor some groups over others due to his or her personal characteristics or experience (see, for example, Meier, et al, 1999; Roch & Edwards, 2015; Bradbury & Kellough, 2008), training (see Bakari, 2003; Glock & Kovacs, 2013; Staats, 2014; Meyer & Rowan, 1977), pressure from other organizations (see Meyer & Rowan, 1977; Chubb & Moe, 1988), mimicking others around him or her (see Meyer & Rowan, 1977; Selden, 1998), or the history of their organization (see Martin, 2011; Raadschelders, 1998; Putnam, 1993). Participation by service recipients allows service providers to better understand the needs and assets of service recipients (Altschuld, 2015), the solutions they believe are best, and how they will react to various policy solutions (Walters, et al., 2002).

In education, Sadler and Sonnert (2016)’s research indicated a need for teachers to gain more insight about the ways that students understand problems. Sadler and Sonnert (2016) noted that teachers in their nationwide study had weak knowledge of common student wrong answers or misconceptions. Moreover, they found that some
groups of students performed better if their teachers had strong knowledge of students’ common misconceptions regarding certain types of problems.

Bystydzienski and Schacht (2001) note the importance of recognizing experiential differences, especially those that result from societal categorizations, among diverse individuals who are working to achieve a common goal. This can mean teachers recognize their diverse experiences that arise from racial and other identities and how privilege based on their identities, including gender and race, influences their relationships with and assumptions about students. This includes recognizing stereotypes and other “essentialist notions” (Bystydzienski and Schacht, 2001).

Consistent with the conceptual framework in the previous chapter, Bystydzienski and Schact (2001) argue that existing structures need to be transformed into those that are more participatory to ensure that inappropriate assumptions are acknowledged and challenged (Bystydzienski and Schacht, 2001). This is because structures or patterns can become taken for granted when all decision-makers are from the same group and thus hold similar assumptions. Opportunities to explore the assumptions of others from different groups encourages decision-makers to question their taken-for-granted assumptions and misconceptions (Bystydzienski and Schacht, 2001).

Race, gender, and other characteristics can intersect (Murphy et al, 2009) to affect the ways that different groups respond to programs that encourage participation. In particular, “intersectional paradigms remind us that oppression cannot be reduced to one fundamental type, and that oppressions work together in producing injustice” (Collins 2000, 18; Murphy, et al, 2009). For example, black women face stereotypes for being
black and a woman, and black men experience stereotypes by being both black and a man (Myhill and Jones, 2006; Rusby et al., 2007; Black, et al., 2011).

Similarly, educators and other service providers may have stereotypes about black women being angry or aggressive, or perceptions of their sexuality that increase the likelihood they will be cited for violating school dress codes (Harris-Perry, 2013; Black, et al., 2010; NAACP & NWLC, 2014). Different assumptions about black male and female students may potentially result in different experiences of programs meant to improve their educational outcomes.

One should also acknowledge that the experience of being a student of color interacts with socioeconomic status (SES). While SES alone cannot explain racial inequities and inequalities, black students are more likely to attend high poverty schools (Orfield, et al., 2012; NAACP & NWLC, 2014). Moreover, the experience of being poor and black can differ significantly from the experience of being poor and white (The Century Foundation, 2015).

In summary, many scholars have focused on how assumptions influence the decisions of those who create policy, and some have suggested participation as a means to challenge assumptions to further understand the needs of service recipients. In the case of education, Sadler and Sonnert (2016)’s research indicates that teachers have weak understanding of students’ assumptions about problems and that this understanding is related to students’ outcomes. Their research highlights a need to obtain and use student’s assumptions about problem-solving as a resource to improving teachers’ understanding of
the best way to educate students. One mechanism to do this is to encourage more participation and opportunities for students to share how they think with teachers.

Also, black students of different genders face unique stereotypes and share diverse experiences. As a result, programs used to understand students’ assumptions may vary in their effectiveness for various groups of students. Groups that benefit most from these types of programs may be those whose assumptions are the least embedded within the educational system and whose needs are least understood, as described in the conceptual framework in Chapter 2.

**Methodological Approach**

In response to Sadler and Sonnert (2016), but with the purpose of understanding racial inequality, I study the MCP as an intervention that uses students’ assumptions about problem-solving as a resource to improving teachers’ understanding of the best ways to educate students. More broadly, understanding the assumptions of service recipients may be particularly important in contexts in which service providers use different assumptions from service recipients.

In this chapter, I use the Math Coaching Program (MCP) as a case to explore the relationship between participation by underrepresented groups and inequality in service delivery. I use students as the unit of analysis and test scores collected by the MCP as the measurement of analysis to estimate a mixed effects, hierarchical cross-classified model to understand the relationship between the MCP and test scores. Student test scores are nested within students, teachers, and schools; therefore, this type of multi-level model is used to account for the similarity between scores that come from the same student or
those that come from the same teacher. For example, student-level characteristics influence scores, while teacher-level characteristics influence students and school-level characteristics influence teachers.

I explained in Chapter 2 that the MCP offers a participatory approach that exposes teachers’ assumptions and allows students to help teachers question their assumptions. In particular, the MCP encourages teachers to ask open-ended questions, providing significantly more opportunities for students to initiate discussion in the classroom and share their ideas. The MCP also provides more opportunities for students to challenge teachers’ traditional ideas about how to solve problems. More broadly, this type of participation allows teachers to better understand students’ needs and assets and how they will react to various approaches to teaching. Therefore, we may expect that the MCP is associated with better outcomes for minority students.

Evaluation research has often focused on “average program effects” rather than on variation in effects across different groups of individuals (Weiss, et al., 2014). We can separately examine, and compare, MCP program outcomes for minority and non-minority students. For example, as mentioned previously, white students’ assumptions and culture may be better represented within educational decision-making processes, thus limiting the advantages of their teachers’ participation and benefits of the MCP program for white students as compared to black students.

The specific research question explored here is as follows:

How is the MCP associated with student outcomes for different groups of students?
Based on the literature examined above, the following four hypotheses are tested:

Hypothesis 1: Minority students in classrooms with teachers who were coached (in MCP techniques) will show better student outcomes than those in classrooms with a teacher that was not coached.

Hypothesis 2: Program benefits will vary across different subgroups of minority students.

Hypothesis 3: There is no significant relationship between having a coached teacher and majority student outcomes.

Hypothesis 4: Minority students in classrooms with teachers who were coached will show greater benefits from the program than majority students in classrooms with a teacher who was coached.

Population and Sample

To test these hypotheses, I use data from a sample of Ohio schools from school years 2012, 2013, and 2014. My population includes all students in grades K-8 in Ohio during those years. My sample of students includes only those with teachers who were willing to provide their test scores during those years.

To compare the sample to the population, Tables 4, 5 and 6 summarize the average enrollment, average performance index, average percent of students with a disability, and average percentage of students who are black at the schools with and without data provided by the MCP for each year. The tables contain four categories: schools with data and with teachers who were coached, schools with data but with
teachers who were not coached, schools without data but teachers who were coached, and schools without data whose teachers were not coached.

Schools receive performance index scores based upon the passing rates of their students on state tests; the average performance index for each of the 3 years fell between 94 and 95 with standard deviations between 13 and 15 points. Because the MCP focused on struggling schools, as expected, schools that were coached tended to have lower performance indexes than schools that were not coached. Schools that provided data to the MCP tended to have slightly lower performance index scores (typically by 1 to 2 points) than those that did not provide data to the MCP.

The average enrollment at all schools tended to fall between 400 and 650 students without any discernable patterns between those that provided data and those that did not. Schools without data tended to have a smaller proportion of students with disabilities. Most noticeable, schools that did not provide data to the MCP tended to have a larger proportion of black students compared to schools with data.

Table 4. Characteristics of Sample Compared to Population for 2012

<table>
<thead>
<tr>
<th>2012</th>
<th>Schools with Data</th>
<th>Schools Without Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>School Coached</td>
<td>School Not Coached</td>
</tr>
<tr>
<td>Average Performance Index</td>
<td>92.3</td>
<td>93.1</td>
</tr>
<tr>
<td>Average Enrollment</td>
<td>729</td>
<td>506</td>
</tr>
<tr>
<td>Average % with Disability</td>
<td>16.8</td>
<td>16.5</td>
</tr>
<tr>
<td>Average % Black</td>
<td>10.7</td>
<td>7.5</td>
</tr>
</tbody>
</table>
Table 5. Characteristics of Sample Compared to Population for 2013

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>2013 Schools with Data</th>
<th>2013 Schools Without Data</th>
<th>2014 Schools with Data</th>
<th>2014 Schools Without Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>School Coached</td>
<td>School Not Coached</td>
<td>School Coached</td>
<td>School Not Coached</td>
</tr>
<tr>
<td>Average Performance Index</td>
<td>90.7</td>
<td>93.2</td>
<td>92.7</td>
<td>95.2</td>
</tr>
<tr>
<td>Average Enrollment</td>
<td>616</td>
<td>454</td>
<td>661</td>
<td>460</td>
</tr>
<tr>
<td>Average % with Disability</td>
<td>18.5</td>
<td>14.9</td>
<td>15.9</td>
<td>10.2</td>
</tr>
<tr>
<td>Average % Black</td>
<td>11.0</td>
<td>6.7</td>
<td>30.6</td>
<td>28.5</td>
</tr>
</tbody>
</table>

Table 6. Characteristics of Sample Compared to Population 2014

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>2014 Schools with Data</th>
<th>2014 Schools Without Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>School Coached</td>
<td>School Not Coached</td>
</tr>
<tr>
<td>Average Performance Index</td>
<td>94.7</td>
<td>86.4</td>
</tr>
<tr>
<td>Average Enrollment</td>
<td>567</td>
<td>427</td>
</tr>
<tr>
<td>Average % with Disability</td>
<td>15.3</td>
<td>18.5</td>
</tr>
<tr>
<td>Average % Black</td>
<td>5.7</td>
<td>8.0</td>
</tr>
</tbody>
</table>

The MCP provided student scores on the Ohio Achievement Assessment for the test administered in May 2012, May 2013, and May 2014. Data came from teachers and schools in Continuous Improvement who volunteered to provide the MCP with student test scores, regardless of whether they were coached. Figure 3 illustrates how the sample
of data was obtained. Test scores came from teachers at both MCP and non-MCP schools, and from coached and non-coached teachers.

Figure 3. Sources of Math Coaching Program Data

Some teachers in the sample were coached and others were not coached. In the sample, there were 210 teachers who instructed 8,189 students. Some teachers had test scores for more students than others (some teachers had scores for close to 200 students) because they were able to provide test scores for multiple years or had multiple classrooms. Moreover, some teachers included in the sample had only one or two students.
In this chapter, a “coached teacher” means a teacher who was coached in a particular school year. Coached teachers continued to be coached throughout their time in the sample; in particular, there were no teachers who were previously coached but no longer coached. Of the 210 teachers in the sample, 43 were coached at least one year. In 2012, 9 teachers were coached out of 94 teachers. In 2013, 13 teachers were coached out of 134 teachers. In 2014, 32 teachers were coached out of 50 teachers.

The data include 229 black students with teachers who were coached out of a total of 604 black students total in the sample. Only about 7 percent of the students in the sample were black, and 37 percent of those black students had a teacher who was coached. The data include 6,727 white students, comprising about 82 percent of the sample. Of the white students in the sample, 2,980 had a teacher who was coached, meaning 43 percent of white students had a teacher who was coached.

The data set includes 156 teachers who had black students in their classrooms, and 36 of the 156 teachers with black students in their classrooms were coached (23 percent). Two-hundred seven teachers had white students in their classrooms and 43 of them were coached (21 percent).

Table 7 provides a summary of these numbers. It lists the number of teachers and students in the sample, along with the number of coached teachers. It also provides the information mentioned above corresponding to black and white students separately.
Table 7. Description of Sample of Teachers and Students

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Teachers</td>
<td>210</td>
</tr>
<tr>
<td>Number of Coached Teachers</td>
<td>43</td>
</tr>
<tr>
<td>Number of Students</td>
<td>8,189</td>
</tr>
<tr>
<td>Number of Students with a Coached Teacher</td>
<td>3,452</td>
</tr>
<tr>
<td>Number of White Students</td>
<td>6,727</td>
</tr>
<tr>
<td>Number of White Students with a Coached Teacher</td>
<td>2,898</td>
</tr>
<tr>
<td>Number of Black Students</td>
<td>604</td>
</tr>
<tr>
<td>Number of Black Students with a Coached Teacher</td>
<td>229</td>
</tr>
<tr>
<td>Number of Teachers with Black Students</td>
<td>156</td>
</tr>
<tr>
<td>Number of Coached Teachers with Black Students</td>
<td>36</td>
</tr>
<tr>
<td>Number of Teachers with White Students</td>
<td>207</td>
</tr>
<tr>
<td>Number of Coached Teachers with White Students</td>
<td>43</td>
</tr>
</tbody>
</table>

Table 8 below includes the number of black and white students with test scores for each of the three years, and the number of those who had scores for all three years. It also provides the number of black and white students who had a coached teacher in each of the three years. The table shows that significantly fewer students had scores for all three years, and that the number of students with a coached teacher in the sample increased over the three years.
Table 8. Description of Sample of Students for 2012, 2013, and 2014

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Total students with scores 2012</th>
<th>Total students with scores 2013</th>
<th>Total students with scores 2014</th>
<th>Total students with scores all 3 years</th>
<th>Total students with coached teacher 2012</th>
<th>Total students with coached teacher 2013</th>
<th>Total students with coached teacher 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>377</td>
<td>408</td>
<td>265</td>
<td>97</td>
<td>75</td>
<td>83</td>
<td>121</td>
</tr>
<tr>
<td>White</td>
<td>3092</td>
<td>4771</td>
<td>3929</td>
<td>1115</td>
<td>623</td>
<td>650</td>
<td>2124</td>
</tr>
</tbody>
</table>

Data

Data Structure

The student test scores are nested within a hierarchical structure. In particular, test scores are nested within students, which are nested within teachers, which are nested within schools. Scores are nested within students, meaning that student-level characteristics, including whether the student has a math disability or a student’s gender, may influence the nature of the test scores coming from that particular student and potentially differentiate those test scores from other students with different characteristics. Similarly, students are nested within teachers; teacher-level characteristics, including their amount of experience or education, may influence the experience of the student in a particular teacher’s classroom. Teachers are nested within schools, and are influenced by school-level characteristics, including school policies and administration.

The data are cross-classified (Raudenbush & Bryk, 2002), meaning that students do not remain with the same teacher over time, as illustrated in Figure 3. In particular, the data are not perfectly nested but instead can be understood as cells created by teacher-
student pairings. For example, if a student has the same teacher for two years, then two scores will correspond to that specific teacher-student cell.

Figure 4 illustrates what nested data often look like. However, Figure 5 illustrates the cross-classified nature of the data. Students do not necessarily remain perfectly nested within the same teacher every year but instead can switch teachers. The arrows in this picture show that a student can switch teachers and is not always nested within a particular teacher every year.

Figure 4. Perfectly Nested Data
Figure 5. Cross-Classified Data

Table 9 illustrates an example of cross-classified data by showing how scores are nested within student-teacher cells. In this data structure, Student1 had Teacher1 for two years but did not have Teacher1 across all 3 years. Student2 had Teacher2 and TeacherJ for one year. As a result, we can expect scores from the same teacher-student cells to be similar because they correspond to both the same teacher and the same student.

Table 9. Example of Cross-Classified Data Structure

<table>
<thead>
<tr>
<th></th>
<th>Teacher1</th>
<th>Teacher2</th>
<th>….</th>
<th>….</th>
<th>TeacherJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student1</td>
<td>xx</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student2</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>StudentK</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>
**Dependent and Control Variables**

In order to examine the relationship of the MCP to student outcomes, the dependent variable for this study is student math scores on the Ohio Achievement Assessment (OAA). The Ohio Achievement Assessment is given to students in grades K-8 to measure their knowledge of various subjects, including mathematics. Students receive scores based solely on their performance on the OAA each year (the scores are not based upon any other tests, including OAA tests from the previous year). Math scores are examined because the program was primarily focused on mathematics education.

I use students’ OAA reading scores, gender, race, and whether they received special education services due to a disability and thus has an individualized education program (IEP) as covariates (or control variables) in my analyses. Other variables, including a student’s SES, may be related to student math scores (Reardon, et al, 2013; Downey, et al, 2008; Rech & Stevens, 1996). However, students’ reading scores, which also have been suggested to be related to students’ SES, may serve as a proxy for some of these missing variables, including children’s home environments (Downey, et al, 2008). In addition, research suggests that the relationship between gender and math performance is related to context, including the type of questions asked of students and the performance level of the students (Ganley & Lubienski, 2016; Lindberg, et al., 2010).

The data contain 14310 OAA test scores (including math and reading) across all 3 years. The mean math score is 418 with a standard deviation of 32. The minimum score is
277 and the maximum score is 575. The mean reading score is 421, with a minimum reading score of 271 and a maximum of 561. See Table 5 for a list of these values.

The data also contain information regarding whether the student has a registered disability in mathematics, as well as the student’s gender. The math disability indicator variable is 0 if the student does not have a math disability and 1 if a student does have a math disability; approximately 13 percent of students in the sample have a math disability. The gender variable is 0 if a student is male and 1 if a student is female; the sample is divided very evenly among female and male students (see Table 5). Similarly, the data include an indicator variable that is 0 if the student’s teacher is not coached (not a participant in the MCP program) and 1 if the student’s teacher is coached. Twenty-one percent of all teachers with student scores in the sample were coached; of the scores in the sample, twenty-eight percent correspond to a coached teacher (see Table 10 for a description of these variables).

The data also include information about the date the student took the OAA test; a 0 denotes the student took the exam in May of 2012, a 1 denotes that the student took the exam in May of 2013, and a 2 denotes that the student took the exam in May of 2014.
Table 10. Description of Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Median</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math Score</td>
<td>277</td>
<td>575</td>
<td>419</td>
<td>418 (32)</td>
</tr>
<tr>
<td>Reading Score</td>
<td>271</td>
<td>561</td>
<td>422</td>
<td>421 (27)</td>
</tr>
<tr>
<td>Math Disability Status</td>
<td>0</td>
<td>1</td>
<td>NA</td>
<td>.13</td>
</tr>
<tr>
<td>Gender</td>
<td>0 (male)</td>
<td>1 (female)</td>
<td>NA</td>
<td>.49</td>
</tr>
<tr>
<td>Teacher Coached</td>
<td>0</td>
<td>1</td>
<td>NA</td>
<td>.28</td>
</tr>
<tr>
<td>Date</td>
<td>0</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Methods

In order to understand how the MCP is related to test scores across various groups of students, I used a mixed effects, multi-level model to examine student math scores, adjusting for students’ teacher and school characteristics.

Subgroups

I divided my data into two subgroups: a dataset for black students, and a dataset for white students. I chose to focus on black student scores because they were the largest minority population within my sample. Moreover, as explained in Chapter 2, black students encounter discrimination and other barriers due to their race. Models were estimated separately for black students and for white students to determine whether the program was significantly related to student scores for each group.

Researchers’ choices of methods are inherently subjective and influence their results. It is therefore important to recognize the implications of choosing particular methods for particular groups. Traditionally, education researchers have used samples that were wholly or predominantly white to draw conclusions applied to all students (Martin, 2011). There is often value in modeling black students as a population by
themselves, without including white students in the analysis, when evaluating educational interventions (Martin, 2011); this is especially true with MCP student data because it consists mostly of white students. Research suggests that black students have unique educational needs that may not be reflected by models developed for white students (e.g., Steele and Aronson (1995)).

Modeling a sample’s subsets of black and white students separately allows a researcher to acknowledge that black students may differ from white students in terms of how covariates or interventions relate to outcomes. As explained later, in this case, school characteristics were not significantly related to the outcomes of black students, even though school characteristics were significantly related to the outcomes of white students. In particular, black students can require their own model structures in order to observe the effects of interventions meant to improve their education, and this is especially true in samples that consist primarily of white students. Therefore, the analyses will focus on two separate samples: one of black students and one of white students.

Models

In order to test hypotheses 1, 2, and 3 regarding the relationship between the MCP and scores from different groups of students, I used the model outlined in Equation 1 to analyze the data for each subgroup corresponding to black students and white students.
\[ \text{mathscore}_{ijk} = \beta_{oijk} + a_{0j} + b_{0k} + c_{0l} + \beta_{1j} \ast \text{studentgender} + \beta_{2j} \ast \text{mathIEP} \\
+ \beta_{3k} \ast \text{teachercoached} + \beta_{4j} \ast \text{readingscore} + (\beta_{5k} + b_{5k}) \ast \text{date} \\
+ r_{ijk} \]

where \( a_{0j} \) denotes random effects associated with student-specific predictors;

\( b_{0k} \) and \( b_{5k} \) denote random effects associated with teacher-specific predictors,

and

\( c_{0l} \) denotes random effects associated with school-specific predictors.

Equation 1.

I used student gender and disability status (see math IEP) as control variables, and estimated models with and without the student reading scores as an additional control variable. The reading score was removed from one model because MCP staff reported evidence that the MCP appeared to also influence the reading scores of students with coached teachers. I considered using the influence of year on the effect of other variables in the model but this created multicollinearity.

The mixed effects, multi-level model addresses correlations among scores from the same student or teacher. In particular, error terms may be correlated among scores belonging to the same student (or teacher). In order to address this correlation, I added student-level random effects to my model (see Equation 1). This gives each student unique intercept and slope coefficients\(^2\), allowing for effects of the program to vary for

\(^2\) I ultimately was unable to include random slope coefficients for students because of my sample size (I am limited in the number of coefficients allowed to randomly vary because
each student depending on that student’s characteristics. This dividing up of the error term helps to address these correlations and reduces the likelihood of overestimating significance.

In order to account for students with the same teacher having similar scores that result from teacher-level effects, I included teacher-level random effects. This is because math scores from students who are in the same classroom may be more similar than scores from students who are in different classrooms. Finally, I also initially included school-level random effects, which were not significantly related to math scores for black students.

Models that include random effects permit the estimation of coefficients by weighting the coefficients estimated in a typical regression model and a new coefficient that accounts for student and classroom trends. For example, each classroom is associated with a coefficient that is calculated using the characteristics of all students in the sample but also the characteristics of students from just that classroom.³

In order to test the fourth hypothesis - whether the MCP is associated with student scores significantly more for black students than white students – I use a model of black and white students combined. However, unless interaction terms are carefully included, estimates of covariates for this model may be more reflective of white students who make up the largest part of the sample (in this case, adding a race interaction term is necessary for all covariates in the model). Additionally, predictor estimations used to denote racial

³ See footnote above
differences may reproduce racial stereotypes (Martin, 2009). For the purpose of transparency and further understanding of my results, I include a combined model to address my fourth hypothesis. This combined model, in Equation 2 below, includes a dummy variable for race that interacts with other covariates in the model. It also includes student, teacher, and school random-effects, as shown below.

$$mathscore_{ijk} = \beta_{0ijk} + a_{0j} + b_{0k} + c_{0l} + \beta_{1j} \times studentgender + \beta_{2j} \times mathIEP$$
$$+ \beta_{3k} \times teachercoached + \beta_{4j} \times readingscore + (\beta_{5k} + b_{5k}) \times date$$
$$+ \beta_{6j} \times studentgender \times white + \beta_{7j} \times mathIEP \times white + \beta_{9k} \times teachercoached \times white + \beta_{10j} \times readingscore \times white$$
$$+ (\beta_{11k} + b_{11k}) \times date \times white + \beta_{12j} \times white + r_{ijk}$$

where $a_{0j}$ denotes random effects associated with student-specific predictors; $b_{0k}$, $b_{5k}$, and $b_{11k}$ denote random effects associated with teacher-specific predictors, and $c_{0l}$ denotes random effects associated with school-specific predictors.

**Equation 2.**

**Analysis**

I used the software lme4 package in R (Bates, et al., 2012) along with the mixed effects model options to estimate the models. I also confirmed comparability in estimates between both R and Stata software. I used reduced maximum likelihood estimates to allow for a loss of degrees of freedom and for uncertainty regarding the fixed parameters, unlike when one uses full maximum likelihood in which the fixed effects are assumed to be known before estimating the random effects (Snijders & Bosker, 1999, p.56). For
reduced maximum likelihood estimation, the residuals from estimating a fixed effects model are modeled and estimated using full maximum likelihood; because the fixed effects have been accounted for, the degrees of freedom in this model no longer account for the degrees of freedom associated with the fixed effects coefficients\(^4\).

In order to test hypotheses 1, 2, and 3 to understand the relationship between coached teachers and student math scores, I estimated a model that includes an indicator variable for whether a teacher was coached, and a model without the indicator variable. I compared deviances (log of likelihood ratio test), AIC, and BIC to calculate the probability of obtaining my data given the model with the coach indicator variable against the probability of obtaining my data without the coached variable. I used full maximum likelihood estimation to compare the nested models, and reduced maximum likelihood estimation to estimate the final model. I plotted the error terms (including those associated with student and teacher random effects) for both models, which appeared to be homoscedastic and normally distributed. I also examined the error terms for homogeneity of variance (see Figures 14 and 15 in Appendix B). Finally, the level 1 and level 2 residuals appear normal (see Figures 16 through 22 in Appendix B).

Some authors argue that comparison of mixed effects models should be verified using the Akaike Information Criterion\(^5\) (AIC), which corrects for the number of covariates in the model (or complexity of the model), and the Bayesian Information

\(^4\)The loss of degrees of freedom means that the variance estimators are larger for reduced maximum likelihood (due to having a smaller denominator reflecting the smaller number of degrees of freedom)

\(^5\)The AIC is equal to \(2k-2\log(L)\) where \(k\) is the number of covariates in the model and \(L\) is the maximized value of the likelihood function
Criterion\textsuperscript{6} (BIC), which corrects for both model complexity and the size of the sample. The AIC tends to prefer the more complex model until the number of parameters reaches 7, but then prefers the more parsimonious model. A model corresponding to a smaller value is preferred for both tests.

The difference in choice between the AIC and BIC depends on the approach to and goals of the model. If a finite number of factors are expected to explain the dependent variable, or if a “true” model exists among a finite number of models being considered, then the BIC may be preferable. On the other hand, the AIC can be used to determine the “best” model if no such “true” model exists (e.g. if no finite set of covariates can explain the dependent variable)\textsuperscript{7} (Burnham & Anderson, 2004).

In order to understand whether student gender influences the effect of the program on black students, I estimated models in Equation 1 with and without interaction terms between the teacher coached and gender variables and again compared deviances, AIC, and BIC.

In order to test the fourth hypothesis and determine if the difference in program effects between white and black students is statistically significant, I focused on the interaction term between the teacher coached and the race variable. I compared models with and without an interaction term between the teacher coached variable and a variable denoting the student’s race.

\textsuperscript{6} The BIC is equal to $\log(n)k - 2\log(L)$ where $n$ is the sample size, $k$ is the number of covariates, and $L$ is the value of the likelihood function

\textsuperscript{7} This is because as the sample size increases, the amount of “influence” or “effect size” for each added variable must be bigger for the BIC to favor or argue for the model
Results

For black students, the results suggest that the model with the coached variable fits the data better than the model without the coached variable. The results do not indicate that the program effects varied by gender for black students. For white students, unlike black students, the results do not indicate a need to include the teacher coached variable in the model. However, there was no statistically significant difference in program effects between black and white students.

Hypothesis 1

In order to test the first hypothesis – that black students with a coached teacher were associated with better outcomes than with a teacher that was not coached – I first estimated a random intercept empty model with no predictors to understand the difference in black student math scores explained by both teachers and students. The correlation between two randomly selected scores from the same student is 0.67 and the correlation between two randomly selected scores from the same teacher is 0.1. In particular, differences between students, as compared to between teachers, explain more (67 percent) of the variance among scores across all 3 years.\(^8\)

I estimated coefficients for Equation 1 using a model that controlled for student reading scores and a model that did not control for student reading scores (see Table 11). Whether a teacher was coached is significantly and positively associated with student

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\(^8\) I also estimated a model using school random effects, and differences between schools explained 3 percent of the variance.
math scores ($p<.01$) for the model without reading scores. In particular, holding all other variables constant, having a coached teacher is associated with a seven point increase in math score. For the model with the reading score, whether a teacher is coached is still significantly and positively related, albeit less so, to math scores ($p<.05$), corresponding to an increase of about 4 points)\(^9\).

Table 11. Model for Black Students Relating Math Scores and MCP with and without Reading Score

<table>
<thead>
<tr>
<th>Black student math scores</th>
<th>Model without Reading Score Coefficient (Standard Error)</th>
<th>Model with Reading Score Coefficient (Standard Error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>409.2*** (2.1)</td>
<td>409.5*** (1.6)</td>
</tr>
<tr>
<td>Math disability (1 denotes students with a disability)</td>
<td>-25.5*** (3.0)</td>
<td>-12.8*** (2.3)</td>
</tr>
<tr>
<td>Student gender (female=1)</td>
<td>-2.2* (2.0)</td>
<td>-4.6** (1.4)</td>
</tr>
<tr>
<td>Teacher coached (1 denotes teacher was coached)</td>
<td>6.8*** (2.2)</td>
<td>4.2* (2.0)</td>
</tr>
<tr>
<td>Year</td>
<td>-2.8** (1.2)</td>
<td>-2.9*** (1.0)</td>
</tr>
<tr>
<td>Reading Score (centered)</td>
<td>.6*** (0.0)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual</td>
<td>155.4</td>
</tr>
<tr>
<td>Student</td>
<td>413.0</td>
</tr>
<tr>
<td>Teacher (Intercept)</td>
<td>130.9</td>
</tr>
<tr>
<td>Teacher (Slope)</td>
<td>42.2</td>
</tr>
</tbody>
</table>

\(*p<.1, \ **p<.05, \ ***p<.01; N=968 (569 students with 96 teachers)\(^10\)

\(^9\) I also compared my final model with another using school-specific random effects but there was no significant difference between the two models

\(^10\) The p-values should be interpreted with caution due to differing opinions regarding how to interpret p-values in these models (Winter, O’Connell).
The deviance, AIC, and BIC (see Table 24 in the Appendix for their values) agree that for the two models without the reading score, they prefer the model with the teacher coached variable. For the models with the reading score, the deviance and AIC prefer the model with the teacher coached variable, while the BIC shows a slight preference toward the model without the teacher coached variable.

The model suggests that math disability is statistically significant and negatively associated with black student math scores. According to the model without the reading score, holding all other variables constant, having a math disability is associated with a 25 point decrease in a student’s math score. Student gender is also negatively associated with student math scores at a statistically significant level; in particular, female students are associated with slightly lower math scores than male students (by about 2 points, holding other variables constant). The year variable is also statistically significant and negatively associated with math scores. In particular, as time passes, black student math scores decrease. This is likely because the Ohio Department of Education made changes to the OAA between each of the years.

**Hypothesis 2**

I estimated a model with and without an interaction term to test the second hypothesis – that program benefits vary among different groups of students – to explore whether gender mediated or moderated the association between the program and black student scores. However, after comparing deviances with a chi-square test, this
interaction term was not significantly associated with student math scores (see Appendix Tables 25 and 26 for model and comparisons). Therefore, there is no evidence to support this hypothesis.

**Hypothesis 3**

In order to test the third hypothesis – that no significant relationship exists between the MCP and white student scores - I again first estimated a random intercept empty model with no predictors in order to understand the difference in white student math scores explained by teachers, students, and schools. The correlation between two randomly selected scores from the same student is .54 and the correlation between two randomly selected scores from the same teacher is 0.02. The correlation between two randomly selected scores from the same school is 0.09. In particular, differences between students explain more (54 percent) of the variance among scores. In addition, differences between schools explain nine percent of the variance among scores, which is six percent higher than that for black students.

I again estimated coefficients for Equation 1 using a model that controlled for student reading scores and a model that did not control for student reading scores. In addition, I included models with school random effects. See Tables 12 and 13. In the case of white students, the difference in deviances between the two models is not significant. Moreover, the AIC and BIC both prefer the simpler model without the teacher coached variable (see Tables 25 and 26 in the Appendix for their values).

Similar to black students, math disability is negatively associated with white student scores at a statistically significant level. In particular, holding all other variables
constant, having a math disability is associated with a 29 point decrease in white student scores. Gender is also negatively and statistically significantly associated with math scores. In particular, female students are associated with lower white student scores by about four points (holding all other variables constant). The year variable is negatively associated with student scores and this is statistically significant. As mentioned previously, this is likely due to changes in the OAA made by the Ohio Department of Education.

Table 12. Models for White Students Relating Math Scores and the MCP with and without Reading Score

<table>
<thead>
<tr>
<th>White student math scores</th>
<th>Model without Reading Score (Coefficient (Standard Error))</th>
<th>Model with Reading Score (Coefficient (Standard Error))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>424.5*** (1.5)</td>
<td>426.9*** (1.2)</td>
</tr>
<tr>
<td>Math disability (1 denotes students with a disability)</td>
<td>-28.8*** (1.0)</td>
<td>-14.2*** (0.7)</td>
</tr>
<tr>
<td>Student gender (female=1)</td>
<td>-3.5*** (0.6)</td>
<td>-5.6*** (0.5)</td>
</tr>
<tr>
<td>Teacher coached (1 denotes coached teacher)</td>
<td>2.0 (1.8)</td>
<td>0.9 (1.5)</td>
</tr>
<tr>
<td>Year</td>
<td>-1.9** (1.0)</td>
<td>(-3.0)***(0.8)</td>
</tr>
<tr>
<td>Reading Score (centered)</td>
<td></td>
<td>(0.6)***(0.0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual</td>
<td>208.0</td>
</tr>
<tr>
<td>Student</td>
<td>522.2</td>
</tr>
<tr>
<td>Teacher (Intercept)</td>
<td>260.4</td>
</tr>
<tr>
<td>Teacher (Slope)</td>
<td>60.3</td>
</tr>
</tbody>
</table>

*p<.1, **p<.05; N=11,763 (with 6,727 students and 203 teachers) for model without reading score
*p<.1, **p<.05; N=11,677 (with 6,680 students and 202 teachers) for model with reading score
Table 13. Models for White Students Relating Math Scores and the MCP with and without Reading Scores with Random School Effects

<table>
<thead>
<tr>
<th>White student math scores</th>
<th>Model without Reading Score Coefficient (Standard Error)</th>
<th>Model with Reading Score Coefficient (Standard Error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>424.8*** (2.2)</td>
<td>427.0*** (1.7)</td>
</tr>
<tr>
<td>Math disability (1 denotes students with a disability)</td>
<td>-28.9*** (1.0)</td>
<td>-14.2*** (0.8)</td>
</tr>
<tr>
<td>Student gender (female=1)</td>
<td>-3.5*** (0.6)</td>
<td>-5.6*** (0.5)</td>
</tr>
<tr>
<td>Teacher coached (1 denotes teacher was coached)</td>
<td>1.0 (1.7)</td>
<td>0.7 (1.4)</td>
</tr>
<tr>
<td>Year</td>
<td>-2.1** (0.9)</td>
<td>(-3.0)** (0.8)</td>
</tr>
<tr>
<td>Reading Score (centered)</td>
<td></td>
<td>(0.6)** (0.0)</td>
</tr>
</tbody>
</table>

Variance

<table>
<thead>
<tr>
<th>Residual</th>
<th>207.7</th>
<th>227.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>523.8</td>
<td>210.8</td>
</tr>
<tr>
<td>Teacher (Intercept)</td>
<td>203.4</td>
<td>144.5</td>
</tr>
<tr>
<td>Teacher (Slope)</td>
<td>53.4</td>
<td>36.6</td>
</tr>
<tr>
<td>School (Intercept)</td>
<td>58.3</td>
<td>29.3</td>
</tr>
</tbody>
</table>

See notes from table above

**Hypothesis 4.**

A final model was estimated from Equation 2 above to test the fourth hypothesis and determine whether the program related to student scores differently for black and white students (see Table 14). While the estimations indicate that white students benefitted less (1.1 points) from the program than black students, this coefficient was not statistically significant when this model was compared to a model without that coefficient.
using a Chi-Square Test comparison of deviances; the AIC and BIC also preferred the simpler model (see Tables 27 and 28 in the Appendix for their values).

The math disability variable is statistically significant and negatively associated with student math scores. As before, the gender variable denoting female students is also statistically significant and negatively associated with math scores; this relationship does not vary statistically significantly for black and white students. The year variable is also negative and statistically significantly associated with math scores, and this association does not vary significantly for black and white students. While the white variable is also statistically significant and positive, indicating that white students are associated with higher math scores than black students, this variable should be interpreted while understanding that black students face many social and institutional barriers that are not encountered by white students.
Table 14. Model to Estimate Differences in Program Benefits for Black and White Students

<table>
<thead>
<tr>
<th>Black and White Student Math Scores</th>
<th>Model with School Random Effects</th>
<th>Model without School Random Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient (Standard Error)</td>
<td>Coefficient (Standard Error)</td>
</tr>
<tr>
<td>Intercept</td>
<td>408.1*** (2.14)</td>
<td>408.0** (1.8)</td>
</tr>
<tr>
<td>Math IEP (1 denotes students with disability)</td>
<td>-12.1*** (2.5)</td>
<td>-11.9** (2.5)</td>
</tr>
<tr>
<td>Math IEP * White</td>
<td>-2.0 (2.6)</td>
<td>-2.3 (2.6)</td>
</tr>
<tr>
<td>Reading score (centered)</td>
<td>0.6** (0.0)</td>
<td>0.6** (0.0)</td>
</tr>
<tr>
<td>Reading score*White</td>
<td>0.0* (0.0)</td>
<td>0.1* (0.0)</td>
</tr>
<tr>
<td>Gender (1=female)</td>
<td>-4.5** (1.6)</td>
<td>-4.5** (1.6)</td>
</tr>
<tr>
<td>Gender*White</td>
<td>-1.2 (1.7)</td>
<td>-1.2 (1.7)</td>
</tr>
<tr>
<td>Teacher coached (1 denotes teacher was coached)</td>
<td>2.2 (2.0)</td>
<td>2.5 (2.0)</td>
</tr>
<tr>
<td>Teacher coached*White</td>
<td>-1.1 (1.5)</td>
<td>-1.1 (1.5)</td>
</tr>
<tr>
<td>Year</td>
<td>-1.9* (1.0)</td>
<td>-1.9* (1.1)</td>
</tr>
<tr>
<td>Year*White</td>
<td>-1.3 (0.8)</td>
<td>-1.3 (0.8)</td>
</tr>
<tr>
<td>White (1=white)</td>
<td>19.0*** (1.5)</td>
<td>19.0** (1.5)</td>
</tr>
<tr>
<td>Variance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>225.6</td>
<td>225.9</td>
</tr>
<tr>
<td>Student</td>
<td>206.0</td>
<td>205.2</td>
</tr>
<tr>
<td>Teacher (Intercept)</td>
<td>141.0</td>
<td>162.3</td>
</tr>
<tr>
<td>Teacher (Slope)</td>
<td>36.7</td>
<td>50.0</td>
</tr>
<tr>
<td>School (Intercept)</td>
<td>27.6</td>
<td></td>
</tr>
</tbody>
</table>

*p<.1, **p<.05; N=12,645 (with 7,249 students and 202 teachers)
Comparison of Black and White Student Multi-Level Models

The model estimations corresponding to black students indicate a statistically significant association between the teacher coached indicator variable and black student scores, while the model estimations corresponding to white students did not suggest a statistically significant association between the teacher coached indicator variable and white student scores. However, this does not mean that the relationship between the MCP and student outcomes differed significantly between black and white students; in particular, the data do not support Hypothesis 4. Additionally, a model including school-level random effects estimated white student math scores significantly better than a model without these random effects, but this was not true for black students.

Discussion

The results provide evidence for hypotheses 1: the MCP is positively associated with black student scores and hypothesis 3: the MCP is not significantly associated with white student scores. However, the results do not provide evidence for hypothesis 2, that program effects differed statistically significantly between black female and black male students, or hypothesis 4, that program effects differed statistically significantly between black and white students.

The results provide evidence for the first hypothesis and suggest that the Math Coaching Program is associated positively with black student scores. More broadly, the
analyses suggest that service providers and policymakers may wish to create more opportunities for participation in organizational decision-making by those from underrepresented groups. In particular, service providers and policymakers should examine how the backgrounds of those who participate in decision-making affect assumptions used, sometimes in a taken-for-granted fashion, within an organization.

The MCP is statistically significantly associated with black student scores but the program is not statistically significantly associated with white student scores. This result is consistent with the notion that white students’ needs may already be represented in educational decision-making processes; however, because the difference in program benefits between black and white students is not statistically significant, more evidence is needed to conclude that the program differs in its impact among both groups (Gelman & Stern, 2006).

In addition, these results support the observation by Weiss, et al, (2014) that programs may vary in their effectiveness across different groups (in this case, groups of black and white students) and that “average program effects may not tell the whole story about program effectiveness” (Weiss, et al., 2014, 779). Finally, these results add to the already strong evidence that other factors than simply ability level may underlie the “achievement gap” between black and white students.

The second hypothesis was not supported, at least in regard to student gender. This may suggest that, in this case, race is more salient than gender in terms of representation of assumptions in mathematics teaching.
The MCP was unable to obtain student test scores from all schools that participated in the program in those school years because it required the participation of school administration, which was not always possible. Moreover, not all teachers from a particular school provided test scores. While there may be general interest in other outcome variables (including students’ attendance, discipline records, and classroom motivation, for example), I was only able to obtain information on student math scores.

We can further increase our knowledge by examining a larger sample of students and schools, and by better controlling for student characteristics and teachers’ scores before the implementation of the MCP and after. On the other hand, white students’ scores do not indicate selection bias, i.e. that only good teachers selected to participate in the MCP, because white students’ scores remained similar regardless of whether their teachers were coached.

In the future, researchers can explore the relationship between implementation scores, including how well the program elicited student participation, and students’ outcomes, illuminating variations in MCP implementation experienced by students, or what Weiss, et al (2014) refer to as “treatment contrasts” (Weiss, et al, 2014, 787). In particular, some teachers may have implemented the program better than others, creating difficulty in discerning the relationship between the program and outcomes.

To further understanding about how student-centered learning is related to classroom interactions and outcomes, researchers could qualitatively examine the experiences of both the students and teachers. While student test scores are important, students’ perceptions of the MCP and other programs may provide further information to
decision-makers about whether to implement similar programs or how they can be improved.

Additionally, scholars could explore how the MCP is related to changes in teachers’ assumptions through interviews with and observations of teachers who implement the program. Finally, student-centered learning and participatory programs other than the MCP can be evaluated in order to understand their relationship with outcomes for minority groups. The results in this chapter provide some evidence that participation by those from underrepresented groups may improve service delivery outcomes and result in more equal service delivery.

While the MCP was related to black student outcomes in Ohio, more research is needed to generalize these conclusions to schools, teachers, and students in other states. For example, the data came from schools that tended to have a larger proportion of white students than other schools in Ohio. In particular, researchers and practitioners should be careful when applying these results to schools or states with larger proportions of black students. Schools that contain a larger proportion of black students may be more attune to black students’ needs because they have more experience with black students and may thus have more knowledge of the assumptions they use to solve problems (perhaps varying depending on how teacher or student-centered the classroom is); they may also be in areas with more black teachers who identify more with black students. Researchers can add to this study by implementing student-centered or other programs that elicit more participation at these schools to see if a similar association exists.
Chapter 4: Implementation of the MCP and Perceived School Culture

Introduction

The results in Chapter 3 indicate that the Math Coaching Program (MCP) is associated with better test scores for black students in Ohio. These results suggest that policymakers may wish to explore participation by underrepresented groups as a possible mechanism to improve service delivery to those groups. However, to improve the evaluation and implementation of programs similar to the MCP, researchers and policymakers need knowledge about whether these programs are implemented properly and about the contexts in which they are implemented as desired.

If a program is not implemented properly or as intended, policymakers and researchers may struggle to evaluate its effects on a population. Moreover, policymakers could have strong evidence that a program may lead to desired outcomes, but this matters very little if they cannot achieve the desired mechanisms that they believe will create change. Therefore, policymakers and researchers often need information regarding the contexts in which programs can be enacted as desired; this information provides decision-makers with knowledge of the various factors that need attention to achieve their goals. For example, in the case of a program that encourages participation from
underrepresented groups, implementers who work in environments that are rigid or less open to collaboration may struggle to enact the program as desired.

The Math Coaching Program (MCP) serves as a case study to enhance our understanding of the relationship between various contexts and the implementation of programs that encourage participation by underrepresented groups. School culture is one example of a factor that may influence the implementation of the MCP and other participatory programs. For example, schools with more rigid cultures may struggle to implement a less traditional student-centered program. Moreover, schools with more participatory cultures may be better able to implement programs that encourage participation.

In this chapter, I explore the relationship between coaches’ perceptions of their school’s culture and their ability to successfully implement the MCP. I hypothesize that coaches who perceive their school culture to be more collaborative and flexible are more successful at implementing the MCP.

I begin with a review of the literature and introduction of the Competing Values Framework, used to understand school culture and guide this research. I also introduce specific research questions and describe the methods used to collect and analyze quantitative data about teachers’ perceptions of their school culture and qualitative data involving teachers’ responses to open-ended questions about what helped or hindered them as they implemented the MCP. I then present results, which suggest that teachers who perceived their school culture to be more flexible and collaborative were better able
to implement the program. I conclude by discussing limitations and explaining how the findings support and add to current knowledge on implementation.

Background

As described in the previous chapters, the Math Coaching Program (MCP) trains teachers in student-centered learning approaches at schools in Ohio. Any school determined to be in “Continuous Improvement” status by the Ohio Department of Education is given funding to choose the MCP among other interventions. Teachers at participating schools volunteer to have coaches in their classroom who encourage them to remain open to multiple ways of problem-solving and ask more open-ended questions. The MCP was implemented for ten years and completed its final year in 2015. The MCP collected information about teachers’ abilities to implement the program, providing information to explore how various contexts are related to the successful implementation of the program.

Literature Review

There is a difference between an organization with diverse members and an organization that is open to diverse perspectives. The perceived culture of an organization by its members contributes to their openness to diverse perspectives. In particular, some service providers are less equipped to receive, or less open to receiving, information from service recipients or different groups because of their perceptions of their organization’s culture. For example, some organizations have cultures that encourage members to defer to “experts” or to what is considered “scientific knowledge,” making members less open
to participatory processes involving those who are not considered experts or those whose opinions are not traditionally valued (Fisher, 2009). Other organizations have more flexible cultures and are more adaptable to changes in organizational technology (the means by which an organization turns inputs into outputs) (Selznick, 1948), including new participatory structures.

Scholars have used the Competing Values Framework (CVF), created by Quinn and Rohrbaugh (1983), to understand how collaborative and flexible organizational cultures are related to organizational outcomes. The CVF organizes culture within an organization into four quadrants based upon how open an organization is to changes in technology, and whether an organization is focused on its internal operations or externally focused on other organizations around it. Researchers have focused on how these quadrants, including one that describes organizations that encourage collaboration among their members, relate to organizational outcomes (Lincoln, 2010).

*Competing Values Framework*

The CVF uses two dimensions at two levels to distinguish among four quadrants representing types of culture within organizations. Quinn and Rohrbaugh (1983) devised these four CVF quadrants after examining how previous researchers conceptualized the construct of “organizational effectiveness”. They took Campbell’s (1977) list of thirty criteria commonly found in the literature associated with organizational effectiveness and, using multidimensional scaling, organized the criteria according to two dimensions: organizational focus and level of control. Organizational focus refers to whether there is emphasis on an internal focus on the operations within an organization versus an external
focus on what is being done by other organizations, while level of control refers to whether the organization has a flexible versus a more controlling structure. An organization with a more flexible structure is better able to adapt to changes, including those in technology or human resources.

Quinn and Rohrbaugh (1983) recognized that the four quadrants determined by the two dimensions (see Figure 6) were similar to conceptualizations of organizations discussed by previous scholars. They described the quadrants by referencing the human relations model, the open system model, the rational goal model, and the internal process model.

Cameron and Quinn (2006) refer to the four quadrants as clan, hierarchy, adhocracy, and market cultures. Their labeling is informed by Ouchi’s work (1980), in which he described the use of shared values and beliefs to encourage cooperation, as distinct from coordinating through prices in a market or rules in a bureaucracy. In addition, Cameron, et al (2006) have used the terms collaborate, create, compete, and control to describe the quadrants (Lincoln, 2010).

The Collaborative culture is used to describe the clustering of characteristics including teamwork, employee involvement, empowerment, cohesion, and participation. In this quadrant, leaders operate as mentors. The Adhocracy or Creative culture is entrepreneurial, creative, and innovative. Leaders are visionary and innovative. The Control or Hierarchy culture is formalized and structured, and reliability and efficiency are valued. Employees have little discretion and leaders are expected to organize. The
Compete or Market culture is competitive and goal oriented. The focus is on productivity and winning, with leaders being tough and competitive (Lincoln, 2010).

Figure 6. Quadrants of the Competing Values Framework (Cameron & Quinn, 2006)\textsuperscript{11}

Some researchers suggest that organizational leaders should effectively balance or integrate the competing values by exhibiting skilled behavior in all quadrants of the model, depending on the situation, instead of attending more to some quadrants and

\textsuperscript{11} For the purpose of this paper, we will refer to the “Clan Culture” as the “Collaborative Culture”
neglecting others (Lincoln, 2010; Lawrence, et al, 1992; Denison, et al, 1995). For example, we want organizations to be adaptable and flexible, but we also want them to be stable and controlled (Cameron, n.d.).

Few scholars have studied the effects of K-12 schools positioning themselves in various quadrants of the CVF. However, at the university-level, some research has indicated that students were more satisfied in schools with cultures that were higher on the flexibility and internal focus ends of the dimensions (Cameron & Freeman, 1991; Lincoln 2010). Cameron (1986) found evidence that universities with more flexible cultures showed more effectiveness (Cameron, 1986; Lincoln, 2010).

To summarize, scholars have focused on how tension between experts and non-experts can inhibit participation in government decision-making processes. Some organizational cultures are more open to participatory mechanisms and non-traditional practices; moreover, researchers have suggested that these types of cultures are positively related to educational outcomes. This research highlights a need for those implementing participatory programs to explore the types of organizational culture that allow for more participatory and less traditional structures.

Methodological Approach

The purpose of this chapter is to use the CVF to understand how teachers’ experiences of school culture (including flexibility and focus) may influence their ability to implement the MCP. More broadly, this serves as a case study in which I use the CVF to understand some but not all aspects of an organization’s culture that influence the ability of an organization to be open to participation by service recipients.
I chose the CVF to represent aspects of a service delivery organization’s culture in this chapter for three reasons. First, the CVF framework allows measurement of perceived organizational flexibility and collaboration. I focus on organizational flexibility because student-centered methods are not traditionally used in schools and, to successfully implement the MCP, teachers and school environments must be open and capable of adapting to new techniques that may contradict previous practices or instruction. Teachers are often trained in teacher-centered methods, and they often see other teachers using these methods, as well. Implementing the MCP may mean acting against professional norms, especially if their school environment is rigid and does not encourage teachers to innovate or adopt new practices.

Moreover, collaboration among teachers and students is necessary to implement a participatory program like the MCP. In particular, teachers who are comfortable incorporating the perspectives of others in their decisions will likely find it easier to learn from students, as well. On the other hand, teachers who are accustomed to making decisions about their classrooms unilaterally may struggle to incorporate new perspectives into their instruction decisions, especially those from students. Therefore, teachers who perceive their schools as having organizational flexibility or a collaborative culture may be better able to implement the MCP.

Second, the CVF framework is well-established and has been used in many organizations over the past 20 years to understand productive and unproductive organizational cultures and cultural change. For example, Kalliath, et al., (1999) assessed and found support for the CVF using a confirmatory factor analysis in health care.
settings. Moreover, the results of this research can add to previous studies exploring the association between CVF quadrants and organizational outcomes, especially in education.

Third, the rational quadrant of the CVF describes a market-like, competitive, and results-oriented organization that encompasses many of the more salient and controversial changes in public education in the United States. For example, arguments for charter schools are often based upon concepts like markets and competition. In addition, some federal administrations have supported results-oriented policies, including results-oriented teacher-evaluations or No Child Left Behind. These policies have held schools and teachers more responsible for student outputs on tests. As decision-makers consider these types of policies, they may account for how they relate to the implementation of programs, including the MCP, that are designed to improve student outcomes.

*Research Questions and Hypotheses*

As described above, some classrooms, schools, and districts may be more receptive to student participation through the MCP. I use the CVF to understand teachers’ perceptions of schools that are more open to student-centered learning approaches. This understanding will increase researchers’ and practitioners’ abilities to properly implement and evaluate consequences of student-centered learning programs like the MCP.

In this chapter, my goal is to understand the factors that contributed to the implementation of the MCP and also, more specifically, how school culture is related to the implementation of the MCP.
Research Question 1: What are the individual, organizational, and environmental contexts in which participation by underrepresented groups is more successful?

In addition to this broad research question, I also explore a specific question: How is perceived school culture associated with successful implementation of the MCP?

This study applies the CVF framework to test the following two hypotheses:

Hypothesis 1: Schools with more flexible cultures will be associated with better implementation of MCP ideas

Hypothesis 2: Schools with more participatory cultures will be associated with better implementation of MCP ideas.

Sources of Data

I examined the relationship between teachers’ perceived school culture and successful implementation of the MCP using survey responses from teachers who served as MCP coaches, hereinafter referred to as coaches. My population includes the teachers who implemented the MCP in either the 2013-2014 or the 2014-2015 school years. My sample includes only coaches who took the culture survey and who had scores evaluating how well they implemented the program. Each of these two data sources, as well as the sample size for both, are discussed below.

Organizational Culture Assessment Scores and Culture Assessment Survey

I constructed an online survey using Qualtrics in order to measure coaches’ perceptions of the distribution of CVF quadrants at their school; I also used this survey to more broadly understand what factors aided or hindered the coaches as they implemented the MCP (see Figure 24 in Appendix C). The beginning of the survey requested coaches’
basic demographic information, including their age, race, the number of years they have been teaching, and the number of years their school has had its current principal.

The second part of the survey included the *Organizational Culture Assessment Inventory* created by Cameron and Quinn. This survey has been administered frequently for over 20 years in order to understand the distribution of CVF cultures in private businesses as well as in university and healthcare settings (Cameron & Freeman, 1991; Lincoln 2010). Furthermore, Kalliath, et al. (1999) found support for the reliability and validity of the OCAI in healthcare settings.

The survey measures six components of organizational culture: the organization’s dominant or primary characteristics, organizational leadership, management of employees, organizational glue, strategic emphasis, and criteria of success (see Figure 7 below for a list of these components). The overall culture of an organization may be characterized by CVF characteristics that might differ from its leadership or criteria it uses to determine success. For example, an organization may reflect the “market” culture in the way it manages its employees by emphasizing outcomes-based evaluations and comparing employees’ performance. However, the leadership in the organization may correspond more closely to the “collaborate” quadrant if those in leadership positions are very nurturing. As a result, the survey captures the distribution of CVF cultures associated with each of these six components.
Figure 7. Aspects of Culture Assessed by OCAI Survey

<table>
<thead>
<tr>
<th>Dominant Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational Leadership</td>
</tr>
<tr>
<td>Management of Employees</td>
</tr>
<tr>
<td>Organizational Glue</td>
</tr>
<tr>
<td>Strategic Emphasis</td>
</tr>
<tr>
<td>Criteria of Success</td>
</tr>
</tbody>
</table>

The survey was adapted to be used in the context of schools. For each of the six components listed above, coaches were given 100 points to allocate among four alternatives (corresponding to the 4 CVF quadrants) depending on how much each alternative described their school (for more detailed information, please see the survey in Appendix Figure 24). For example, for a particular component, if a coach thought that each quadrant described their school equally, they would allocate 25 points to each quadrant or option; if a coach thought that a quadrant did not describe their school at all, they would allocate 0 points to the option corresponding to that quadrant.

The OCAI survey was appended to include two open ended questions. The third part of the survey asked coaches what had helped or hindered them in implementing the program, and what would continue to help or hinder them in the future.

I obtained a list of 69 current coaches (2014-2015 school year) from MCP staff. Coaches were given a link to the survey via email, and a reminder email was sent one week later encouraging them to take the survey. Coaches were also notified of the survey in a facilitator session held the day that the survey was distributed. Thirty-two coaches responded to the survey (a response rate of 46 percent).
I also obtained a list of 38 former coaches from the 2012-2013 school year, but only 6 responded to the survey. Of the total of 38 respondents to the survey, 31 responded to the OCAI and all 38 provided at least some demographic information.

Five of the respondents were men and 33 were women. All respondents reported being white except one who chose not to disclose his or her race. The minimum number of years taught was 3 years, the maximum was 36 years, the average was 17 years, and the median was 15 years. See Table 15 for a summary of the description of survey respondents.

Table 15. Description of Survey Respondents

<table>
<thead>
<tr>
<th>Number of Respondents</th>
<th>38</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of 2014-2015 Coaches</td>
<td>46 percent</td>
</tr>
<tr>
<td>Percent of 2013-2014 Coaches</td>
<td>16 percent</td>
</tr>
<tr>
<td>Gender of Women</td>
<td>33</td>
</tr>
<tr>
<td>Number of Men</td>
<td>5</td>
</tr>
<tr>
<td>Average (Median) Number of Years Taught</td>
<td>17 (15)</td>
</tr>
<tr>
<td>Mean (Median) Age</td>
<td>44 (43.5)</td>
</tr>
</tbody>
</table>

It is important to note that the data corresponding to school culture as obtained by the OCAI are not meant to represent overall school culture. Instead, these data represent school culture as perceived by the coach taking the survey. In particular, I am interested not in the overall culture of a school, but in how a coach’s experience of a school’s culture relates to his or her implementation of the program.

*Teacher Implementation Scores*
In the 2013-2014 school year, MCP staff visited coaches’ classrooms with the teachers they coached to assign implementation scores to each coach-teacher pair. The implementation score was used to evaluate coaches in several different categories, including whether “The mathematics being discussed [was] (procedural vs. conceptual)” (Math Coaching Program), whether all children were challenged by the task, and questions about who was participating in activities. The participation question specifically asked the evaluator: “Who is participating? What is the nature of participation? Who initiates activities?” The evaluators ranked these values between 1 and 4, with 4 signifying evident student-centered learning, and 1 signifying little evidence of student-centered learning (See Appendix Figure 25).

The MCP had implementation scores for 89 classroom sessions involving a coach and teacher. Of those sessions, 31 included 16 coaches who completed the culture survey (described below).

Culture Survey Responses and Teacher Implementation Scores

Sixteen coaches who completed the school culture survey also had an implementation score. Four of these 16 coaches were no longer coaches in the 2014-2015 school year; fifteen were evaluated with two teachers. This resulted in 31 implementation observations that were also associated with culture survey scores, with some of these observations associated with the same culture survey score because they represented evaluation of the same coach. See Figure 8, which shows how the teachers corresponded to implementation scores or classroom observations.
To answer the research question, how perceived school culture is associated with successful implementation of the MCP, I used a mixed-methods approach. First, I analyzed the data using Fischer’s Exact Test to understand coaches’ quantitative responses to the OCAI. Then, inductive coding of coaches’ qualitative responses was used to search for themes relating to the CVF in the coaches’ responses to the open-ended questions. This is an approach similar to that referenced by Cresswell & Clark (2007) in their description of the Triangulation Design: Convergence Model, in which one compares qualitative and quantitative results to answer a single research question.

For the quantitative component, a coach’s scores assigned to each quadrant corresponding to their school’s dominant characteristics (described above) were placed into two categories. Scores assigned to the Collaborative quadrant corresponding to a
school’s dominant characteristics were placed into one category if they were in the top 50th percentile of those scores and another category if they were in the bottom 50th percentile. The 50th percentile was calculated using scores that came from all coaches, regardless of whether they had implementation scores. This was also done for adhocracy, market, and hierarchical cultures corresponding to a school’s dominant characteristics.

From the Teacher Implementation Scores, the participation score was divided into those who earned a score of 3 or above and those who earned a score of 2 or below. Participation scores of 3 or greater were considered “adequate” participation by the MCP, while a 2 or below was considered “inadequate”. None of the teachers in the sample had a participation score of 0.

I used Fisher’s Exact Test12 to understand the relationship between perceived school culture and successful implementation of the MCP by exploring the relationship between those with adequate and inadequate participation score groups and the two percentile groups corresponding to perceived culture. Fisher’s Exact Test was used to calculate the probability that teachers belonging to each percentile group (corresponding to a particular culture) would be divided into the successful and unsuccessful participation groups, assuming that those in the bottom 50th percentile group are equally likely as those in the top 50th percentile group to obtain successful participation scores.

I also used a t-Test to compare the mean culture scores for teachers who successfully implemented the MCP and those who struggled to implement the program.

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12 For the equation and more information, please see Bernard, H.R. (2011). Research Methods in Anthropology: Qualitative and Quantitative Approaches. Lanham, MD: AltaMira Press.
However, observations for many of the cultural characteristics did not follow a normal distribution. On the other hand, the dominant Collaborative culture and criteria for success Collaborative culture were normally distributed. Therefore, I used a t-Test for comparisons for Collaborative culture scores only.

For the t-Tests, the data for each of these two characteristics were placed into two groups based upon whether the participation implementation score for each observation was in the top two categories (3 or 4) or the bottom two categories (1 or 2), as described above. More specifically, I still keep the implementation scores split the same way but this time I no longer split up the scores corresponding to the Collaborative quadrant. The variances in both cases for the two samples were tested to ensure that the appropriate t-Test was used.

*Coach Responses to Open-Ended Questions*

I also investigated coaches’ responses to the open-ended questions by asking who or what helped or hindered them when they implemented the program; any coach who responded to these questions (and not just those who had implementation scores) were included in the analysis. I assumed that there is no one correct way to interpret coaches’ responses and that the interpretations are dependent on both the coach and the person analyzing the data (Madill, et al, 2000). In other words, “it is no longer assumed that there is one reality that can be revealed through the utilization of correct methodology” and, instead of being discovered within the data, interpretations arise as a result of inter-subjective meaning (Madill, et al, 2000, p.9). I approached my analysis assuming that themes that arise from the data may vary depending on the analyst, the point in time that
the data are analyzed, and other contextual factors. A second researcher also inductively analyzed the responses and identified themes from her perspective (Wallat and Piazza, 1988; Madill, et al, 2000).

Coaches’ responses to the survey questions were analyzed inductively by first listing their responses to each question in specific, low-level categories. Responses were then grouped into broader categories that were determined due to their frequency based upon the lower-level categories. A second researcher also inductively analyzed the responses and identified themes that were considered along with and in addition to the themes determined from the initial coding. Because I am taking a constructivist approach and no theme is assumed to exist outside of one’s perceptions, this second coder adds diversity to the themes through providing her perspective. Coaches’ responses to the survey questions were also analyzed deductively by looking for themes related to the CVF.

Results

The results of Fischer’s Exact Test and the t-Test suggest a positive relationship between coaches who perceived their schools as being more collaborative and their implementation scores. The analysis of the responses to open-ended questions suggests that teachers’ discomfort with the program was a common hindrance to implementing the program. In addition, interaction with MCP staff and other coaches aided teachers as they implemented the program.
Relationship Between Culture Assessment and Implementation

Results should be interpreted while understanding that the observations may not be independent. However, Fisher’s Exact Test suggests that a borderline significant ($\alpha=.1$) positive relationship exists between the dominant Collaborative culture and the implementation of participation in the classroom. Table 16 and Figure 9 describe the number of respondents in each category (for example, 7 respondents were in the bottom 50th percentile corresponding to the collaborative culture and also received a low classroom participation score) and the corresponding probability from Fisher’s Exact Test.

Table 16. Relationship between Dominant Collaborative Culture and Participation Implementation Score

<table>
<thead>
<tr>
<th>Dominant – Collaborative Culture</th>
<th>Bottom Participation</th>
<th>Top Participation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom 50th</td>
<td>7</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Top 50th</td>
<td>6</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>17</td>
<td>30</td>
</tr>
</tbody>
</table>

Fisher’s exact: .056
I again used Fisher’s Exact Test to understand the relationship between participation and dominant Adhocracy, Market, and Hierarchical cultures. The results of the test did not indicate a significant relationship for $\alpha=.05$ but the dominant Hierarchical culture was positively associated with participation for $\alpha=.1$.

This analysis was repeated using the scores given to the quadrants corresponding to criteria used for success within a school. No significant relationship was evident between Collaborative culture, Adhocracy culture, or Hierarchical culture and participation scores. However, for $\alpha=0.1$, there is a negative relationship between market culture and participation scores. No relationship was evident between leadership style culture variables and participation scores. However, a significant negative relationship
was found for $\alpha=.1$ between management Market culture and participation scores (see Appendix Table 29 for more information on these tests).

*Results of t-Test*

The mean score given to dominant Collaborative culture for observations in the bottom two participation categories is 21.5, while it is 43.1 for those in the top-two participation categories. The associated p-value is .010. The mean score given to the Collaborative culture corresponding to criteria of success scores in the bottom two participation categories is 20.5, while it is 45.8 for those in the top two participation categories. The associated p-value is .032.

Table 17 summarizes the significant results obtained from both Fisher’s Exact Test and the t-tests above to explore the relationship between the various types of perceived school cultures and MCP participation scores. The table shows that the Collaborative school culture appears to be positively related to the participation implementation scores, while the Market culture shows a possible negative relationship with the implementation scores. No t-Test scores were significant for $\alpha=0.1$
Table 17. Summary of Relationships Between Culture Scores and Participation Scores

<table>
<thead>
<tr>
<th>Association with Participation Score</th>
<th>Fisher - $\alpha=.05$</th>
<th>Fisher - $\alpha=.1$</th>
<th>t-Test $\alpha=.05$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant - Collaborative</td>
<td>+</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Dominant - Hierarchy</td>
<td>+</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Criteria for Success - Collaborative</td>
<td>+</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Criteria for Success - Market</td>
<td>-</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Management - Market</td>
<td>-</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Coaches' Explanations of Hindrances to Implementation of the MCP

The most frequent response from coaches is that implementation was hindered by teachers’ discomfort with the MCP. In particular, thirteen coaches listed unwilling teachers or a lack of teacher buy-in to the program as a hindrance to implementing the MCP. Nine coaches specifically indicated that they struggled with teacher buy-in to the program. Coaches said that they did not want to “step on teachers’ toes” (1 coach), that teachers were uninterested or lacked time to implement the program (2 coaches), that teachers were concerned about testing (1 coach), or were uncomfortable with the program (1 coach). The second most frequent response to questions about difficulty implementing the MCP is that coaches needed more time to prepare the new lessons needed to implement the MCP ideas (11 coaches).
Only four coaches mentioned a competitive school environment as a hindrance to the program. One coach wrote that a competitive environment led to teachers feeling less creative and uncomfortable innovating, while another mentioned that teachers would not buy into the program due to high stakes testing. In addition, three coaches mentioned that some teachers were unwilling to change their approaches to teaching. For example, one coach wrote, “Some of the staff were not open-minded.”

I identified a final category of regulatory constraints arising from the school, district, or state level (mentioned by 5 coaches). The other analyst noted an additional category of hindrance emerging from the data: students behavior in the coaches’ classrooms (2 responses); for example, one coach mentioned that student attendance was a problem because not all students benefitted from the program. The other analyst and I both identified themes involving teacher discomfort and top-down regulations. However, she also noted the student theme and only I identified the time-related constraints mentioned by teachers as a theme that hindered MCP implementation. See Table 18 below for the list of themes identified by both coders.
Table 18. List of Themes Regarding What Hindered MCP Implementation

<table>
<thead>
<tr>
<th>Themes from Inductive Analysis</th>
<th>Themes from Deductive Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theme</td>
<td>Frequency</td>
</tr>
<tr>
<td>Unwilling or Uncomfortable Teachers</td>
<td>13</td>
</tr>
<tr>
<td>Lack of Time to Implement Program</td>
<td>11</td>
</tr>
<tr>
<td>Regulatory Constraints</td>
<td>5</td>
</tr>
<tr>
<td>Student Behavior</td>
<td>2</td>
</tr>
</tbody>
</table>

Coaches’ Explanations of What Helped Them Implement the MCP

Coaches’ answers to what helped them implement the program were very diverse; the other analyst and I were unable to clearly identify specific themes, in contrast to coaches’ responses to what hindered them in implementing the program; however, we were able to identify broader themes. For example, seventeen coaches wrote that their interaction with MCP staff, through various means (professional development or informally), helped them implement the program. Five coaches specifically mentioned that MCP staff gave them new knowledge of teaching and learning. For example, one coach wrote “I really enjoyed having the opportunity to learn about mathematics again.” Another wrote that the MCP staff and graduate assistants “taught me how to adjust/adapt problems from mundane one-solution tasks to rich, multi-dimensional tasks.”

Moreover, nine coaches wrote that their interactions with other coaches helped them implement the program. A coach described that “the interactions with other math
coaches were extremely helpful in implementing the ideas of the MCP.” Another teacher wrote that meeting with other coaches allowed him or her to “stay consistent.”

Seven coaches also mentioned the importance of administrative support in successfully implementing the program. They mentioned support from superintendents, principals, and curriculum directors, specifically. One coach wrote “I learned a lot from our meetings but it came down to the support I had from my middle school principal.” Another acknowledged that support came from “Willingness of my principal and some teachers.” See Table 19 for a list of themes that were identified to improve MCP implementation. None of the themes identified directly corresponded to the quadrants of the CVF, and thus none were derived from the deductive analysis.

Table 19. List of Themes Regarding What Improved MCP Implementation

<table>
<thead>
<tr>
<th>Themes from Inductive Analysis</th>
<th>Frequency of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction with MCP Staff</td>
<td>17</td>
</tr>
<tr>
<td>Interaction with Other Coaches</td>
<td>9</td>
</tr>
<tr>
<td>Support from School and District Administration</td>
<td>7</td>
</tr>
</tbody>
</table>

Discussion

Perceived Culture and Implementation

The results provide support for both hypotheses 1 and 2: schools with more flexible and internally focused cultures were better able to implement the MCP. These results support the research done by Cameron & Freeman (1991) and Cameron (1986) suggesting that the collaborative culture is associated with better outcomes in an
academic setting. Moreover, this research may signify that the ability to implement the MCP and other participatory programs may moderate these relationships. In particular, a Collaborative culture may be associated with better educational outcomes because teachers are better able to implement programs that help students if they are at schools with this culture. The results also indicate that the types of perceived culture (dominant, managerial, or those used for criteria of success) are related to implementation in sometimes stronger or weaker ways.

The results could be interpreted in the opposite direction: successful implementation of the MCP may have incentivized schools to develop more flexible and participatory cultures (or a feedback loop may exist in which they both reinforce one another). Assessing a teacher’s perceived school culture before and after the implementation of the MCP (or another similar program) may illuminate whether a causal loop exists between perceived culture and successful implementation.

Relevance to Implementation Research

The themes that we identified in the coaches’ qualitative responses are similar to issues described by implementation scholars regarding the influence of different governing levels on policy implementation (Pressman & Wildavsky 1973; Moulton & Sandfort, 2016). Coaches claimed that rules at the state level (such as those regarding testing and funding) prevented them from successfully implementing the MCP. In particular, teachers reported being hindered in implementing the MCP by the requirement that their schools achieve a certain level of performance based upon student testing to receive significant state or federal funding. On the other hand, some teachers mentioned
that administrative support from higher level positions, including superintendents and principals, was essential to helping them successfully implement the program.

In addition, coaches mentioned that teachers’ resistance to and discomfort with the program became an obstacle to successfully implementing the program. In response, service providers and policymakers may consider the circumstances in which organizations are more open and responsive to participation by underrepresented groups. For example, Schneider and Ingram (1993) argue that policy decision-makers are more open to participation from groups that have political power and are also more willing to direct resources toward these groups. Further analyses can examine Schneider & Ingram’s (1993) framework and how this relates to the effectiveness of participatory interventions by service recipients.

Current policy or professional norms that were created before the program could also have inhibited the behavioral change required for teachers to successfully implement the MCP (Hill and Hupe, 2002; Skocpol 1995). For example, coaches mentioned that policies and requirements placed upon teachers (by those at the federal, state, district, or school levels) restricted teachers’ ability to implement the program.

As mentioned by Moulton & Sandfort (2016), professional norms could prevent teachers from successfully implementing the MCP. More specifically, successful implementation of the program may have potentially required teachers to act against their professional experience, or even their own personal experience in more traditionally teacher-centered classrooms. Hill and Hupe mention that “professionalization can undermine top-down control of the process” (2002, p.27).
Similarly, Sabatier and Mazmanian (1980) argue that successful program implementation can depend on the amount of behavioral change required of important actors in adapting to the MCP. The MCP may have been harder to implement because it required a large change in teaching practices. Sabatier and Mazmanian (1980) also mention that incentives can be used to change behavior, but in the case of the MCP, teachers volunteered to be coached and reported the disincentive to implement the program due to the increased time required to prepare for the program.

Conclusion

Different groups’ assumptions may make members more or less amenable to changing assumptions in a manner like the MCP and learning from particular groups of people. More specifically, the culture of or assumptions held by a particular group of teachers may make its members more or less open to learning from students. The goal of this chapter was to explore the contexts in which participation by underrepresented groups is successful by using the MCP as a case study. As explained above, my results suggest that schools with more collaborative cultures are more successful in implementing the MCP. Moreover, implementation of the program was hindered by teachers feeling uncomfortable, coaches needing more time to prepare lessons that incorporate MCP ideas, and regulatory constraints.

The results should be interpreted while noting that the sample size is limited; in particular, I only received culture scores from 16 coaches who also had implementation scores. Moreover, these results are based upon perceptions of both school culture and implementation scores. Two teachers with the same types of interactions with others at
their school still may have different perceptions of their school’s culture. In addition, classroom evaluators may judge the amount of student participation differently and thus assign different implementation scores.

The results suggest that scholars and practitioners should consider organizational culture as they implement programs, especially those incorporating perspectives from diverse groups into decision-making structures. An ethnographic study allowing a researcher to embed him or herself within each school as the MCP is implemented could provide additional insights and context to these results. Additionally, one can explore how cultural context is associated with implementation of participatory programs other than the MCP. Researchers and practitioners may also account for how participant characteristics, regulations, and professional norms relate to the implementation of participatory programs.
Chapter 5: Understanding the Mechanisms Behind Implementation of the MCP Using a Systems Perspective

*Introduction*

Policy and decision makers often devise programs or interventions to resolve a problem or to achieve a desired outcome. Achieving desired outcomes depends upon successful implementation of the intervention, assuming that the nature of the intervention, itself, is not flawed. A program may work in some contexts but not others, because the nature of the problem varies among various contexts, or due to variations in the ability to implement the program in those contexts. For example, Pressman and Wildavsky (1973) devoted a book to describing the various hurdles and unintended consequences government officials encountered as they tried to implement various policy decisions.

The Math Coaching Program (MCP) is another example of a program that, when enacted properly, may result in desirable outcomes, as illustrated in Chapter 3, but successful enactment of the program becomes its own hurdle. As described previously, the MCP trains teachers in student-centered learning in Ohio schools that are struggling academically. It trains teachers to ask more open-ended questions, to remain more
receptive to multiple ways of solving problems, and to create a structure in which learning is student-guided (as opposed to the traditional teacher-guided).

As illustrated in Chapter 4, many teachers struggled to implement the MCP properly. Teachers were given “implementation scores” to evaluate how well they implemented the MCP principles described above. While teachers were trained to implement the MCP, results from the analyses suggest that their perceptions of their school cultures were related to successful implementation. More specifically, teachers who reported that their schools were more collaborative were associated with better implementation scores.

The goal of this chapter is to create a space to understand MCP implementation, using the results obtained in Chapter 4. For example, both training and culture influenced the implementation of the MCP, but the manner in which they interacted is not yet understood; a simulation model can be used to explore behavior that arises from assumptions about their interactions to see if the consequences reflect observed behavior.

First, I describe research questions regarding how a systems model can yield insights into MCP policies that lead to more effective implementation. Second, I introduce concepts that I use to construct a model, including how I define successful implementation and culture for the purposes of the model. Third, I describe how using a systems model furthers our understanding of implementation of the MCP by capturing the complexity of interactions and emergence.

Fourth, I introduce a systems model that can be used to understand implementation of the MCP by focusing on the interactions between teacher training and
school culture. Fifth, I describe how policymakers can use the model to simulate various scenarios of resource allocation and to analyze their relationship to the successful implementation the program. I conclude by suggesting further expansion of the model using the concepts from the framework described in Chapter 2.

Research Questions

The results from the previous chapter raise further questions about the implementation of the MCP and similar programs. The MCP program focused primarily on training to improve teachers’ abilities to implement the program. Teachers at schools were coached by coaches who were trained by MCP program staff on ways to implement the MCP. Results indicate that perceived school culture also influenced teachers’ abilities to implement the MCP.

In particular, the results in Chapter 4 suggest that teachers who reported that their schools had a more collaborative culture were associated with better MCP implementation scores. These teachers also mentioned in response to open-ended questions that frequent contact with other teachers who participated in the MCP improved their ability to successfully implement the program.

These results raise questions about the connection between perceptions of school culture and MCP implementation. In particular, researchers and practitioners need a space to explore the consequences of various assumptions regarding how these two factors interact and influence MCP implementation.

In line with the research in the previous chapter, scholars (e.g., Sabatier & Mazmanian, 1980; Hill & Hupe, 2002; Moulton & Sandfort, 2016) have asked why some
programs are successfully implemented while others fail. Often, more information is needed regarding the underlying mechanisms by which a system of implementation operates that policy and decision makers can use to improve program implementation.

The implementation of the MCP occurs within a system that cannot be divided into independent parts or subparts (Ackoff, 1994). For example, the nature of teacher training alone cannot explain successful MCP implementation because school culture is also a factor, and we do not yet know whether these factors have an independent or interdependent effect on the implementation of the MCP. A systems model can be used to understand the mechanisms behind why a particular factor, which in this case is school culture, is associated with improved outcomes or implementation (Ghaffarzadegan, et al., forthcoming). For these reasons, Butler & Allen (2008) argued for understanding policy implementation processes as self-organizing systems. More broadly, we can study implementation of the MCP holistically, as opposed to focusing only on specific factors, and examine:

Research Question 1: What does the system of MCP implementation look like?

More specifically, this means asking:

Research Question 2: How does a simulation of the MCP implementation yield insights regarding how MCP implementation occurs and the interaction between MCP training effectiveness and school culture?

In addition, we can explore:
Research Question 3: How does a systems model of the MCP yield insights into MCP policies that lead to more effective implementation?

Research Question 4: What are the consequences of decisions made by those who implement the MCP regarding school culture and training?

Concepts Related to MCP Implementation

Important concepts must be defined and understood before building a model of how they interact over time. In this case, important concepts include successful implementation of the MCP, training effectiveness, school culture, contact rate, and adoption fraction.

Successful Implementation of the MCP

In order to model the implementation of the MCP, decision-makers must have a clear idea of what effective implementation of the MCP means. For the purposes of this model, implementation is more successful if more teachers receive successful implementation scores; MCP implementation is less successful if fewer trained teachers successfully applied MCP techniques.

Training Effectiveness

Teachers are traditionally trained to implement teacher-centered, as opposed to student-centered, techniques within their classrooms. As a result, most teachers do not apply MCP principles without some form of training; accordingly, coaches were placed in teachers’ classrooms to guide them and help them implement the program. The effectiveness of this training relates to how well a teacher in a classroom can create a student-centered environment that encompasses MCP principles due to training.
School Culture

Teachers who perceived that their schools were more collaborative were associated with better MCP implementation scores. Schools with more collaborative cultures were associated with more employee involvement, empowerment, cohesion, and participation, as reported by teachers (Lincoln, 2010). I therefore assume that teachers in schools with more collaborative cultures interact more with one another and that these interactions are more meaningful. In particular, I assume that collaborative school culture is positively related to two factors:

1. Contact rate – the number of other teachers that a teacher encounters within a particular time frame to exchange ideas and best practices; and

2. Adoption fraction – the rate at which teachers who encounter another teacher who successfully uses a particular teaching method will also begin using the practice.

As discussed in the previous chapter, teachers mentioned that interactions with other MCP teachers were particularly helpful. However, the contact rate matters very little to the successful implementation of the MCP if teachers who use the practice are unable to convince or help other teachers to do so. Moreover, even a high adoption fraction will matter very little if teachers who do not use the MCP never encounter teachers who do use it.

Table 20 includes a summary of these concepts included in the model, including the definition of successful MCP implementation, training effectiveness, a collaborative school culture, the contact rate, and adoption fraction.
Table 20. Basic Definitions and Concepts used in this Chapter

**Successful Implementation of MCP:** MCP implementation is more successful if more teachers successfully implement the program after receiving training.

**Training Effectiveness:** percent of trained teachers who create a student-centered classroom environment.

**Collaborative School Culture:** culture within a school associated with employee cohesion and participation; it is positively related to the Contact Rate and Adoption Fraction.

- **Contact Rate:** the number of other teachers that a teacher encounters within a particular time frame to exchange best ideas and practices.
- **Adoption Fraction:** the rate at which teachers who encounter another teacher who successfully uses a teaching method will also begin using the practice

The Advantages of Adopting Systems Thinking to Understand Program Implementation

Training and perceived school culture were associated with successful implementation of the MCP, but the nature of the interaction of these two factors over time remains unknown. In other words, we do not know how school culture mediates or moderates the effect of teacher training on MCP techniques over time. For example, while MCP administrators focused largely on training during the implementation of the MCP, they may also have benefited from resources devoted toward school culture. Moreover, MCP administrators may benefit from information that helps them determine how to divide up resources between the two factors.

The need for this information arises because implementation of the MCP occurs within a complex environment in which outputs may unexpectedly arise due to an
interaction among components over time. Systems models provide a space to explicitly model feedback or components that influence the model but are also affected by the model. A model of MCP implementation must capture this complex environment.

Systems models focus on how changes in assumptions (such as, in this case, assumptions about how programs are implemented) lead to different outcomes. They make the assumptions and the structure of interactions among components explicit, open for all to review (Sterman, 1985), and thus more easily manipulated to reflect various environments. Sterman (1985) writes, “[t]hey infallibly compute the logical consequences of the modeler’s assumptions” (p.854). Systems models thus allow decision-makers to examine potential outcomes of various changes in policy decisions under various assumptions, without losing resources or waiting for the decisions to occur (Kim, et al., 2013; Ghaffarzadegan, et al., forthcoming; Misuraca, et al, forthcoming).

Systems models also allow decision-makers to consider outcomes resulting from the interaction of variables over time by allowing for emergent properties that may reveal counterintuitive results. In particular, interactions between components of a system may produce spontaneous and sometimes unexpected patterns (Desai, 2012; Bedau and Humphres, 2008). Moreover, these models can be used to understand how the system moves from one state to another (Sterman, 1985). This understanding is attainable because “[t]he purpose of a simulation model is to mimic the real system so that its behavior can be anticipated and studied” (Sterman, 1985, p. 860).

System Dynamics Model of MCP Program Implementation
I constructed a system dynamics model to partially capture the complex environment in which MCP implementation occurs. This model posits a relationship between training effectiveness and school culture to explore how that relationship affects successful implementation of the MCP over time. The unit of analysis in the model is teachers who receive training to implement the MCP.

The model is based on the Bass Diffusion Model (first presented in Bass (1963)), which has been used to describe the diffusion of innovations or products among potential users. The Bass Diffusion Model is based upon the following principle: “[t]he portion of the potential market that adopts at time t given that they have not yet adopted is equal to a linear function of previous adopters” (see Bass’s Basement Research Institute (2010), http://www.bassbasement.org/BassModel/Default.aspx). In other words, the number of users at time t is proportional to the number of users in the previous time period, t-1. In this case, adoption of the product can be replaced by adoption of MCP principles by teachers to illustrate the number of teachers who successfully implement the program over time.

I use a version of the Bass Diffusion Model because it can be adapted to focus on interactions among successful and unsuccessful implementers of the MCP. As described in the previous chapter, teachers reported in response to a survey and open-ended questions that interactions with other teachers who used the MCP and a collaborative school culture aided them in implementing the program. Using an adaptation of the Bass Diffusion Model captures both the factors of collaboration or cohesion and teacher contact or interaction. The Bass Diffusion Model assumes that if someone comes into
contact with a successful adopter, that person’s likelihood of also becoming an adopter increases. Similarly, this MCP model is based upon the assumption that if teachers who are not successful implementers come into contact with other teachers who are successful implementers, their likelihood of successfully implementing the program increases.

The model contains four primary assumptions: (1) the main drivers of MCP implementation by teachers are training and word of mouth (or contact between teachers and the adoption fraction); (2) the rate at which teachers who are trained and successfully adopt the program is unrelated to the adoption fraction or contact rate among teachers; (3) time steps occur in one year intervals, meaning that interactions that occur on smaller intervals are not modeled; and (4) the contact rate among teachers is static and does not change over time. The model consists of stocks, flows, dynamic variables, and parameters that are organized to reflect their interactions and the behavior of the system.

**Stocks**

Stocks are entities that accumulate over time based upon inflows or outflows that increase or subtract from the stock. Stocks typically have a value at a particular time and are changed by flows. This model of MCP implementation consists of two stocks: the number of teachers who are trained who are successfully using MCP techniques (*UsingTeachers*), and the number of teachers who are trained who are not successfully using MCP techniques (*NonUsing Teachers*). In this model, all trained teachers are assumed to begin in the stock of non-using teachers. The number of these teachers is informed by the parameter *AcEmerTeachers*, described later, that denotes the number of teachers at schools in academic emergency according to the Ohio Department of
Education. Teachers are either in the non-using teacher stock or the using-teacher stock at any point in time.

*Flows*

Flows are rates that change stocks over time. They are either inflows that add to a stock or outflows that deplete or subtract from a stock. In this case, becoming a successful user (*becomingUser*) of the MCP is a flow that adds to the stock of teachers who are successfully using it by transferring teachers from the stock of teachers who are not successfully implementing it. In this model, the flow of becoming a user is equal to the sum of the effects from word of mouth and adoption from training on non-using teachers. Once teachers becoming successful users, they cannot move back to the stock of non-using teachers.

*Parameters*

Parameters are static entities used as inputs into the model. They often are derived from theoretical hypotheses, results of research studies, or interactions with people who are familiar with the situation being modeled. In this case, training effectiveness (*trngEff*), the total number of trained teachers (*AcEmerTeachers*, denoting that the MCP trained teachers at schools considered to be in academic emergency), adoption fraction (*adoptionFraction*), and contact rate (*contactRate*) are all parameters. These parameters can be changed as new information is acquired from researchers, program implementers, or data.
Dynamic Variables

Dynamic variables inform the ways that parameters interact over time and influence the flow rates. In this case, adoption from training \((adoptionFrmTraining)\) and adoption from word of mouth \((adoptionFrmWOM)\) are dynamic variables. The adoption from training variable changes based upon the training effectiveness parameter and the number of teachers who are not successful implementers. The adoption from word of mouth variable changes based upon an equation involving the product of the contact rate and adoption fraction variables along with the product of the number of successfully using teachers and not successfully using teachers, along with the inverse of the total number of teachers being trained (the specific equation for this variable is shown in Table 21, described below).

Description of Model Dynamics

The full model is displayed in Figure 10 below. In the model, all trained teachers begin as non-using teachers, meaning that they are not successful users of MCP techniques. The number of these teachers is informed by the parameter \(AcEmerTeachers\), denoting the number of teachers in academic emergency. Teachers move from this stock to the stock of UsingTeachers, or those who are successfully implementing the program, each year based upon the becomingUser rate.

Each year, the becomingUser rate is informed by adding together two sets of teachers – teachers who are successfully trained that year, and teachers who were not successfully trained but have begun to successfully use MCP techniques based upon their interactions with other teachers. The number of teachers who successfully become users
each year due to training is informed by the training effectiveness rate. The number of teachers who begin successfully using the program each year due to interaction with other teachers is based upon the contact rate and the adoption fraction.

The contact rate is the number of teachers that a teacher encounters each year, while the adoption fraction is the likelihood that those interactions will result in the teacher successfully using the program. Policymakers and researchers who use this model can change the number of teachers who are trained or the contact rates, for example, based upon their own unique contexts.

Figure 10. Model of MCP Program Implementation

Table 21 below illustrates the equations for and relationships among the components in the implementation model that are described above. This table was

Table 21. Formulas and Concepts for MCP Implementation Model

<table>
<thead>
<tr>
<th>Formulations and Comments</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trained Teachers</td>
<td></td>
</tr>
<tr>
<td>[ NT(t) = NT(0) + \int_0^t -BU(s)ds; ] [ NT(0) = n - UT(0) ]</td>
<td></td>
</tr>
<tr>
<td>The stock of Non-Using Teachers (NT) declines as the number of Using Teachers (UT) increases. The Becoming User (BU) flow moves teachers from Non-Using Teachers to Using Teachers. The initial number of Non-Using Teachers is equal to the total population of teachers who receive training, n.</td>
<td></td>
</tr>
</tbody>
</table>

| Trained Teachers          |       |
| \[ UT(t) = UT(0) + \int_0^t BU(s)ds; \] \[ UT(0) = 0 \] |       |
| The number of Using Teachers (UT) accumulates as the Becoming User (BU) flow moves teachers from Non-Using Teachers to Using Teachers. There is no outflow from the Using Teachers stock. The initial number of Using Teachers, given by UT(0), is assumed to be 0. |

| Trained Teachers/Year     |       |
| \[ BU(t) = AT(t) + AW(t) \] |       |
| Becoming a User is the rate at which teachers who move from being a Non-Using Teacher (NT) to a Using Teacher (UT). These transitions occur due to either Adoption from Training (AT) or Adoption from Word of Mouth (AW). Becoming a User is equal to the sum of Adoption from Training and Adoption from Word of Mouth. |

| Trained Teachers/Year     |       |
| \[ AT(t) = TE \ast NT(t) \] |       |
| Continued |
Table 21 continued

Adoption from Training (AT) depends on the number of Non-Using Teachers (NT) and the Training Effectiveness rate (TE).

Trained Teacher/Year

\[ AW = c \left( \frac{UT(t)}{n} \right) * AF * NT(t) \]

Adoption from Word of Mouth (AW) is equal to the product of the number of teachers a teacher contacts in a given school year, \( c \), the probability that any such contact is a Using Teacher (UT), given by the fraction of Using Teachers in the total population, \( n \), and the probability of adoption given such a contact with an adopter, \( AF \).

\[ c = 10 \]

The contact rate, \( c \), is the number of other teachers a teacher encounters within a particular year to exchange ideas and best practices. It is assumed that a teacher has this type of interaction with 10 other teachers per year.

Trained Teachers

\[ n = 10,000 \]

The population of trained teachers, \( n \), is assumed to be 10,000.

Training Effectiveness

\[ TE = .31 \text{ to } .35 \]

The effectiveness of training, \( TE \), denoting the percent of Non-Using Teachers (NT) who become Using Teachers (UT) due to training alone; it varies in the models simulated below between .31 and .35.

Adoption Fraction

\[ AF = .01 \text{ to } .02 \]

The adoption fraction is the fraction of times an interaction between a Non-Using Teacher (NT) and a Using Teacher (UT) results in the Non-Using Teacher becoming a Using Teacher. This varies in the models simulated below between .01 and .02.
Feedback Loops

The model contains two important feedback loops. A positive feedback loop occurs when a change to one part of the model reinforces the change elsewhere in the same direction, which, in turn, leads to more of the initial change. A negative or balancing feedback loop occurs when a change in one direction to a part of the model leads to a change in the opposite direction to another part of the model.

The model contains a positive feedback loop; an increase in the number of teachers who successfully implement the MCP will increase the number of teachers who use the program based upon adoption from word of mouth. Word of mouth or components of a collaborative culture result in more teachers successfully using MCP techniques if more teachers are successfully using the MCP because this creates more opportunities for teachers who are not users to come into contact with them. The model also contains a negative or balancing loop; an increase in the adoption from training dynamic variables will increase the number of teachers who become successful users, which decreases the number of non-using teachers and thus decreases the number of teachers who become users due to the adoption from training dynamic variable.

Model components that are a part of a feedback loop are considered endogenous to the model. They influence but they are also affected by other components of the model. Model components that are not a part of a feedback loop are exogenous; they influence other components of the model but assumed to not be influenced by other factors in the model. In this model of MCP implementation, exogenous factors include the training effectiveness, number of teachers in academic emergency who are trained in
MCP techniques, adoption fraction, and contact rate. These factors affect the model but are not themselves affected by other factors in the model. The endogenous factors are adoption from word of mouth, using teachers, non-using teachers, and becoming a using teacher. These factors not only influence the model but also are themselves influenced by the model. See Table 22 for the list of exogenous and endogenous components of the model.

Table 22. Endogenous and Exogenous Model Components

<table>
<thead>
<tr>
<th>Exogenous Components</th>
<th>Endogenous Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training Effectiveness</td>
<td>Adoption from Word of Mouth</td>
</tr>
<tr>
<td>Number of Teachers in Academic</td>
<td>Non-Using Teachers</td>
</tr>
<tr>
<td>Emergency Who Are Trained</td>
<td></td>
</tr>
<tr>
<td>Adoption Fraction</td>
<td>Using Teachers</td>
</tr>
<tr>
<td>Contact Rate</td>
<td>Becoming a Using Teacher</td>
</tr>
</tbody>
</table>

Using the Model to Inform Program Implementation Decisions

Policymakers can use the model to determine the most effective allocation of their resources devoted toward program implementation. MCP decision-makers can determine the desired balance of resource allocation between training and school culture to ensure better implementation of the program. For example, program administrators have three options about how to allocate resources: they can devote resources toward promoting a more collaborative culture within schools to increase the adoption fraction; they can devote resources toward improving training alone to increase the training effectiveness; or they can devote resources in a manner that improves both the adoption fraction and training effectiveness.
Using Resources to Improve the Adoption Fraction

MCP program administrators can focus their resources on improving culture among individuals within a school to improve the adoption fraction, i.e., the portion of teachers who end up using the program after encountering other teachers who use it. For example, program administrators can simulate this scenario with the model by assuming that the training effectiveness rate is 31 percent, the contact rate is 10, and changing the adoption fraction from .01 to .02. This means that 31 percent of teachers who are trained will end up using MCP techniques that year; each teacher contacts 10 other teachers in a given year, and the likelihood of adopting the program from an interaction is 1 or 2 percent. As shown in Figure 11 below, this change in the adoption fraction results in a change in the number of years required until 90 percent of teachers successfully use the program from 6.2 years to 5.4 years. (AnyLogic software is used to perform this simulation and the others below.)

Figure 11 illustrates the number of using teachers of MCP techniques (in green) and non-using teachers (in orange) over time, measured in years. Ninety-percent of teachers have implemented the program once the green curve moves higher than 9,000 teachers on the y-axis.
Figure 11. Relationship Between Adjusting the Adoption Fraction and Number of Successful Implementers Over Time

With current (status quo) adoption fraction of .01 and training effectiveness at .31, time to 90 percent adoption is 6.2 years

Changing adoption fraction to .02 and keeping training effectiveness at .31, time to 90 percent adoption is 5.4 years
Using Resources to Improve Training Effectiveness

MCP program administrators can also focus their resources solely toward improving the training of teachers in effective MCP techniques, thereby increasing the rate of teachers who successfully use the program. MCP program administrators can simulate this scenario by changing the training effectiveness parameter in the model from .31 to .35, and by assuming that the adoption fraction and contact rate among teachers are .01 and 10, as before. Figure 12 below illustrates that this change reduces the time it takes for 90 percent of teachers to use the program from 6.2 years to 5.6 years.
Figure 12. Relationship Between Adjusting the Training Effectiveness and Percent of Successful MCP Implementers

With current (status quo) training effectiveness of .31 and adoption fraction of .01, time to 90 percent adoption is 6.2 years

Changing training effectiveness to .35 and keeping adoption fraction at .01, time to 90 percent adoption is 5.6 years
Using Resources to Improve Both the Adoption Fraction and Training Effectiveness

The MCP program administrators can also simulate a scenario in which they allocate resources to improve both the adoption fraction and the training effectiveness. They can change the adoption fraction from .01 to .02 and change the training effectiveness from .31 to .35, as above, which results in a change from 6.2 years to 4.9 years until 90 percent of teachers are successfully using MCP techniques. See Figure 13 below.
Figure 13. Relationship Between Adjusting the Adoption Fraction and Training Effectiveness and MCP Implementation Over Time

With current (status quo) training effectiveness of .31 and adoption fraction of .01, time to 90 percent adoption is 6.2 years

Changing the adoption fraction to .02 and training effectiveness to .35, time to 90 percent adoption is 4.9 years
Table 23 below summarizes the results listed above. In particular, it shows the consequences of changing the training effectiveness or adoption fraction in terms of the number of years it takes 90 percent of teachers to successfully use MCP techniques. As previously described, the scenario that permits the shortest time for 90 percent of teachers to implement the program involves adjusting both the adoption fraction and training effectiveness rate.

Table 23. Simulated Time Required for 90 Percent of Teachers to Implement MCP due to Changes in Training Effectiveness and Adoption Fraction

<table>
<thead>
<tr>
<th></th>
<th>Number of Teachers Trained</th>
<th>Contact Rate</th>
<th>Training Effectiveness Rate</th>
<th>Adoption Fraction</th>
<th>Time to 90% Adoption (years)</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case</td>
<td>10,000</td>
<td>10</td>
<td>.31</td>
<td>.01</td>
<td>6.2</td>
<td>All</td>
</tr>
<tr>
<td>Adjusting Adoption Fraction</td>
<td>10,000</td>
<td>10</td>
<td>.31</td>
<td>.02</td>
<td>5.4</td>
<td>Figure 2</td>
</tr>
<tr>
<td>Adjusting Training Effectiveness Rate</td>
<td>10,000</td>
<td>10</td>
<td>.35</td>
<td>.01</td>
<td>5.6</td>
<td>Figure 3</td>
</tr>
<tr>
<td>Adjusting both Adoption Fraction and Training Effectiveness Rate</td>
<td>10,000</td>
<td>10</td>
<td>.35</td>
<td>.02</td>
<td>4.9</td>
<td>Figure 4</td>
</tr>
</tbody>
</table>
Discussion

Policymakers can use systems thinking and systems models to determine the best ways to implement programs. In the case of the MCP, program administrators can use these models to determine the most effective allocation of resources to the factors that are related to successful implementation of the MCP. For example, MCP administrators can simulate the effects of devoting resources toward changing only the adoption fraction, changing only the effectiveness of training, or both, based upon various assumptions about the rates at which teachers contact each other and the number of teachers within a school.

This type of modeling allows decision-makers to capture reinforcing and feedback dynamics associated with various decisions. For example, this model captures the positive feedback loop that arises among the adoption from word of mouth variable and the number of successful users. As more teachers become successful users of the MCP, more teachers who are not successfully using the program will begin to do so based on their interactions with these teachers, thereby creating even more teachers who are successful users.

Decision-makers can gather and use implementation data to calibrate and validate the model. These data can be used to inform and change the model parameters based upon various scenarios by adjusting the parameters until they are consistent with the data. Moreover, this model’s structure can be amended through collaboration with MCP program administrators and teachers by using their knowledge to add or remove variables or to change the nature of their interactions.
In the future, more variables can be added to this model, including institutional variables described in the conceptual framework chapter of this dissertation (Chapter 2). For example, factors like the race of a teacher can be added as additional parameters or dynamic variables (one that changes over time) that inform the training effectiveness dynamic variable. Moreover, one could add other dynamic variables regarding regulations or pedagogical traditions at individual schools. Finally, researchers and policymakers may wish to include more variables based upon MCP and teachers’ knowledge and experiences.
Chapter 6: Conclusion

This dissertation develops a framework to explore how assumptions influence policy arguments, decisions, and behavior, and uses this framework to understand how assumptions might be changed to achieve policy goals, including more equal distribution of resources.

The first essay (Chapter 2) provides a framework for researchers to understand how decision-makers acquire explicit and implicit assumptions that are used to formulate policy arguments. I introduced participation by service recipients from underrepresented groups as a possible way to change assumptions of service providers and thus influence their decisions regarding the delivery of services to various groups. This framework can be used to explain and understand how inequality may unintentionally arise as the government provides services. Moreover, this chapter illustrates how factors identified by various streams of literature used to explore assumptions and behavior – representative bureaucracy, path dependency, and institutional theory – interact with one another and thus influence policy decisions.

The second essay (Chapter 3) explores whether participation by service recipients from underrepresented groups is associated with more equal outcomes. I used the Math Coaching Program (MCP), a participatory, student-centered learning program, as a case study to examine its relationship to student test scores. I found, using a multi-level model
to address the nested nature of the data, that student participation through the MCP is positively associated with test scores for black students; student gender did not appear to influence this association. I did not find a relationship between the MCP and white student scores, and the association between the program and test scores did not differ statistically significantly between white and black students.

The positive association between the MCP and outcomes for black students provides evidence for the conceptual framework developed in Chapter 2 - that contends that participation by minority groups may lead to improved outcomes for those groups. These results also highlight the importance of separately examining samples of black and white students. In this case, white students’ needs may already be so embedded within decision-making structures that the MCP was not associated with their scores. However, further evidence is needed to support this claim because the difference in program effects between black and white students is not statistically significant.

The third essay (Chapter 4) uses the Competing Values Framework (CVF) and teachers’ responses to open-ended questions to understand the contexts in which participation by service recipients can be successfully incorporated into an organization’s decision-making structure. I found that coaches who perceived that their schools were more collaborative were better able to implement the MCP. In addition, coaches reported that teachers’ discomfort with the program and their time constraints hindered successful implementation, while regular contact with other coaches and MCP staff improved implementation. These findings indicate that perceived school culture may be relevant to successful implementation of the MCP and similar programs that elicit participation from
service recipients; moreover, they emphasize that program implementation varies in different contexts.

The fourth essay (Chapter 5) uses a systems model to illustrate the consequences of assumptions regarding how school culture and training interact to influence MCP implementation. This model can be used to simulate the consequences of distributing resources between training and organizational culture. The model illustrates feedback loops and that variables related to school culture result in more people successfully using the MCP techniques as more teachers effectively implement the MCP; the model simulations indicate that successful implementation is more likely if resources are distributed both to training and school culture. Moreover, this model can be altered to simulate the consequences of other policy decisions.

The results reported in this dissertation should be interpreted in light of certain limitations. First, the MCP may not be representative of all programs that encourage participation by those from underrepresented groups. Second, the MCP may not have the same association with test scores of students from other minority groups that it has with black students. Third, the data used to analyze the relationship between the MCP and student test scores were limited and came from teachers who were willing to provide test scores. While these teachers could be those who were already more successful, the fact that the program was not positively associated with white student scores suggests otherwise. Fourth, the sample used to relate collaborative school culture to implementation scores is relatively small. Finally, the variables used in the simulation
model are limited; they focus primarily on training effectiveness, contact rate, and adoption fraction.

Scholars should further explore student-centered learning programs as a potential intervention to achieve more equal outcomes in education, as well as other forms of participation. The program appeared to be positively related to both black and white student scores, and was not negatively related to the scores of either group included in the analyses. Researchers should examine the relationship between other student-centered learning programs and minority student outcomes using larger, more representative samples that include diverse minority groups. In addition, ethnographic research, including interviews with those who implement or participate in these types of programs, may provide further insight into the mechanisms underlying the relationship between participation by underrepresented service recipients and more equal service delivery. More broadly, researchers may also wish to explore other types of programs that encourage participation by those from underrepresented groups in contexts other than education.

As scholars and practitioners examine the relationship between participation by service recipients and service delivery outcomes, they may consider how those who implement the program influence program evaluation. For example, in the case of the MCP or other student-centered learning programs, teachers most open to implementing the MCP may be those who already have some sort of participation in their classrooms, therefore reducing discernable program effects. On the other hand, teachers most open to
implementing the program may be those who are most devoted and willing to change, thus increasing researchers’ ability to evaluate the program.

In addition, researchers and practitioners can benefit from understanding the circumstances in which they can successfully implement participatory programs. They may wish to build upon the systems model to understand the consequences of various implementation decisions before enacting the program. In addition, they can evaluate their ability to implement the program under various circumstances to better inform the systems model and program implementation.

Practitioners and researchers should also consider organizational culture in the implementation of student-centered learning and similar programs that encourage participation by members of underrepresented groups. To better understand the contexts in which this type of participation is successful, scholars may wish to explore the relationship between other types of perceived school culture and implementation of participatory programs with larger and more representative samples. Moreover, scholars can study the relationship between implementation scores and outcome variables to further understand the link between programs like the MCP and student outcomes.

Also, coaches reported that teachers were often resistant to implementing the program. These results show that service providers should consider the circumstances in which their organizations are more responsive to participation by underrepresented groups. For example, Schneider & Ingram (1993) argue that policy decision-makers are more open to participation from groups that have political power and are more willing to direct resources toward these groups. Further analyses may apply Schneider & Ingram’s
framework and explore the effectiveness of participatory interventions. More broadly, these results indicate that we should examine the role of culture, in general, and socially constructed assumptions, in particular, in the implementation of programs.

Finally, practitioners, researchers, and service recipients can work together to create more elaborate systems models and better understand the implementation process by including variables, such as race of the teachers, described in the Chapter 2. By working together to construct this type of model, assumptions become explicit and open to evaluation and consideration by all who are involved in the service delivery process, including service recipients, which can result in better and more equitable service delivery.
References


AnyLogic MultiMethod Simulation Software and Solutions. [www.anylogic.com](http://www.anylogic.com)


Bates, D.M., Machler, M., & Bolker, B. (2012). lme4: Linear mixed-effects models using S4 classes. R package version 0.999999-0.


Mathematics Coaching Program. mcp-coaching.osu.edu


Misuraca, G., Geppert, L., & Kucsera, C. (Forthcoming). “Deconstructing social policy innovation though the use of complex systems theory: a methodology for modeling and simulation of the impact of ICT-enabled social innovation.” In Gil-Garcia, J.R., Pardo,


Appendix A: Sample Math Coaching Program Problems for Students

Problem 1: How could an ice cream parlor use the idea of mode to help him run his business? Explain.

Problem 2: Daniel wins a prize if he rolls an even number on a die. He rolled three odd numbers in a row. He is certain he will roll an even number next. What is wrong with Daniel’s reasoning?

Problem 3: Define the following terms in the following circumstances: Mean, mode, median range

1. Favorite candy bar
2. Shoe size
3. Test scores

Problem 4: Brad’s mom wants to buy carpet for the family room. What information will he need to get the carpet and why is that information necessary?
Problem 5: Jessica has three pies. She offers you one-fourth of the apple pie, two-fifths of the cherry pie, or three-eighths of the pecan pie. If you want to get the most pie, which choice should you make?

Problem 6: Determine three different formulas you could use to find the perimeter of a rectangle. Test your formulas on the following rectangle:

10 cm

6 cm
### Appendix B: Chapter 3 Tables and Figures

#### Tables

Table 24. Comparison Tests Relating Models with and without MCP for Black Students

<table>
<thead>
<tr>
<th>Black Students</th>
<th>Whether MCP in Model</th>
<th>Deviance</th>
<th>AIC</th>
<th>BIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model without Reading Score</td>
<td>Model with coached variable</td>
<td>8677.6</td>
<td>8697.6</td>
<td>8746.4</td>
</tr>
<tr>
<td></td>
<td>Model with no coached variable</td>
<td>8686.9**</td>
<td>8704.9</td>
<td>88748.7</td>
</tr>
<tr>
<td>Model with Reading Score</td>
<td>Model with coached variable</td>
<td>8378.5*</td>
<td>8400.5</td>
<td>8454.2</td>
</tr>
<tr>
<td></td>
<td>Model without coached variable</td>
<td>8382.8</td>
<td>8402.8</td>
<td>8451.6</td>
</tr>
</tbody>
</table>

Difference in deviances significant for *p<.05, or **p<.01
Table 25. Comparison Tests Relating Models with and without Gender Interaction

<table>
<thead>
<tr>
<th>Black Students</th>
<th>Whether Reading Score in Model</th>
<th>Whether Gender Interaction in Model</th>
<th>Deviance</th>
<th>AIC</th>
<th>BIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model without Reading Score</td>
<td>Model with interaction</td>
<td>8676.9</td>
<td>8698.9</td>
<td>8752.5</td>
<td></td>
</tr>
<tr>
<td>Model with no interaction</td>
<td>8677.6</td>
<td>8697.6</td>
<td>8746.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model with Reading Score</td>
<td>Model with interaction</td>
<td>8376.3</td>
<td>8400.3</td>
<td>8458.8</td>
<td></td>
</tr>
<tr>
<td>Model without no interaction</td>
<td>8378.5</td>
<td>8400.5</td>
<td>8454.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 26. Model with Gender Interaction for Black Students

<table>
<thead>
<tr>
<th>Black student math scores</th>
<th>Model without Reading Score Coefficient (Standard Error)</th>
<th>Model with Reading Score Coefficient (Standard Error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>408.8*** (2.2)</td>
<td>409.0*** (1.7)</td>
</tr>
<tr>
<td>Math disability (1 denotes students with a disability)</td>
<td>-25.4*** (3.0)</td>
<td>-12.8*** (2.3)</td>
</tr>
<tr>
<td>Student gender (female=1)</td>
<td>-1.5 (2.1)</td>
<td>-3.5*** (1.6)</td>
</tr>
<tr>
<td>Teacher coached (1 denotes teacher was coached)</td>
<td>7.9** (2.6)</td>
<td>5.9* (2.3)</td>
</tr>
<tr>
<td>Year</td>
<td>-2.8 (1.2)</td>
<td>-2.8** (1.0)</td>
</tr>
<tr>
<td>Reading Score (centered)</td>
<td></td>
<td>0.6*** (0.0)</td>
</tr>
<tr>
<td>Gender*Teacher Coached</td>
<td>-2.4 (2.8)</td>
<td>-3.9 (2.6)</td>
</tr>
<tr>
<td>Variance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>155.9</td>
<td>189.9</td>
</tr>
<tr>
<td>Student</td>
<td>411.7</td>
<td>152.1</td>
</tr>
<tr>
<td>Teacher (Intercept)</td>
<td>130.7</td>
<td>62.6</td>
</tr>
<tr>
<td>Teacher (Slope)</td>
<td>42.2</td>
<td>16.2</td>
</tr>
</tbody>
</table>

***p<.001, **p<.01, *p<.05; N=968, groups: 569 (student) 96 (teacher)
Table 27. Comparison Tests for Gender Interaction for Black Students

<table>
<thead>
<tr>
<th>Black Students</th>
<th>Whether Reading Score in Model</th>
<th>Whether Gender Interaction in Model</th>
<th>Deviance</th>
<th>AIC</th>
<th>BIC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model without Reading Score</td>
<td>Model with gender interaction variable</td>
<td>8676.9</td>
<td>8698.9</td>
<td>8752.5</td>
</tr>
<tr>
<td></td>
<td>Model with no gender interaction variable</td>
<td>8677.6</td>
<td>8697.6</td>
<td>8746.4</td>
<td></td>
</tr>
<tr>
<td>Model with Reading Score</td>
<td>Model with gender interaction variable</td>
<td>8376.3</td>
<td>8400.3</td>
<td>8458.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Model with no gender interaction variable</td>
<td>8378.5</td>
<td>8400.5</td>
<td>8454.2</td>
<td></td>
</tr>
</tbody>
</table>
Table 28. Comparison Tests Relating Models with and without MCP for White Students

<table>
<thead>
<tr>
<th>White Students</th>
<th>Whether Reading Score in Model</th>
<th>Whether MCP in Model</th>
<th>Deviance</th>
<th>AIC</th>
<th>BIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model without Reading Score</td>
<td>Model with coached variable</td>
<td>107,764</td>
<td>107,784</td>
<td>107,858</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Model with no coached variable</td>
<td>107,765</td>
<td>107,783</td>
<td>107,850</td>
<td></td>
</tr>
<tr>
<td>Model with Reading Score</td>
<td>Model with coached variable</td>
<td>103,288</td>
<td>103,310</td>
<td>103,391</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Model without coached variable</td>
<td>103,289</td>
<td>103,309</td>
<td>103,382</td>
<td></td>
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</tbody>
</table>

Difference in deviances significant for *p<.05, or **p<.01
Table 29. Comparison Tests Relating Models with and without the MCP for White Students with School Random Effects

<table>
<thead>
<tr>
<th>White Students</th>
<th>Whether Reading Score in Model</th>
<th>Whether MCP in Model</th>
<th>Deviance</th>
<th>AIC</th>
<th>BIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model without Reading Score</td>
<td>Model with coached variable</td>
<td>107,730</td>
<td>107,752</td>
<td>107,833</td>
<td></td>
</tr>
<tr>
<td>Model with Reading Score</td>
<td>Model with no coached variable</td>
<td>107,730</td>
<td>107,750</td>
<td>107,824</td>
<td></td>
</tr>
<tr>
<td>Model with Reading Score</td>
<td>Model with coached variable</td>
<td>103,268</td>
<td>103,292</td>
<td>103,381</td>
<td></td>
</tr>
<tr>
<td>Model with Reading Score</td>
<td>Model without coached variable</td>
<td>103,269</td>
<td>103,291</td>
<td>103,372</td>
<td></td>
</tr>
</tbody>
</table>

Table 30. Comparison Tests Relating Models with and Without Teacher Coached and Race Interaction Variable

<table>
<thead>
<tr>
<th>Whether Teacher Coached*White in Model</th>
<th>Deviance</th>
<th>AIC</th>
<th>BIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model with variable</td>
<td>111,652</td>
<td>111,686</td>
<td>111,813</td>
</tr>
<tr>
<td>Model without variable</td>
<td>111,653</td>
<td>111,685</td>
<td>111,804</td>
</tr>
</tbody>
</table>
Table 31. Comparison Tests Relating Models with School Random Effects with and Without Teacher Coached and Race Interaction Variable

<table>
<thead>
<tr>
<th>Whether Teacher Coached*White in Model</th>
<th>Deviance</th>
<th>AIC</th>
<th>BIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model with variable</td>
<td>111,633</td>
<td>111,669</td>
<td>111,803</td>
</tr>
<tr>
<td>Model without variable</td>
<td>111,633</td>
<td>111,667</td>
<td>111,794</td>
</tr>
</tbody>
</table>

Figures

Figure 14. Level 1 Residuals Corresponding to Model with Reading Score for Black Students
Figure 15. Level 1 Residuals Corresponding to Model Without Reading Score for Black Students

![Residuals](image)

Figure 16. Normality of Level 1 Residuals for Model with Reading Score for Black Students

![Normal Q-Q Plot](image)
Figure 17. Normality of Level 1 Residuals for Model without Reading Score for Black Students

Figure 18. Normality of Teacher Random Intercept for Model for Black Students with Reading Score
Figure 19. Normality of Teacher Random Intercept for Model for Black Students without Reading Score

![Normal Q-Q Plot]

Figure 20. Normality of Teacher Random Slope for Model with Black Students with Reading Score

![Normal Q-Q Plot]
Figure 21. Normality of Teacher Random Slope for Model with Black Students without Reading Score

![Normal Q-Q Plot for Teacher Slope](image)

Figure 22. Normality of Student Random Intercept for Model with Black Students with Reading Score

![Normal Q-Q Plot for Student Intercept](image)
Figure 23. Normality of Student Random Slope for Model with Black Students without Reading Score
Appendix C: Chapter 3 Figures
Figure 24. OCAI and Implementation Survey for Teachers

THIS SURVEY WILL BE ONLINE

School Culture

Assessment Survey

[Sponsored by the Mathematics Coaching Program at The Ohio State University]
(In Email request) You are being asked to complete this survey to help improve the success of the Mathematics Coaching Program. We would like to let you know that there is a low risk of breach of confidentiality, but all efforts will be made to ensure that your responses to the items on this survey are kept confidential. We will not link your name to anything that you say in any public presentation or publication.

Your participation is voluntary. If you decide not to participate, there will be no penalty or loss of benefits to which you are otherwise entitled. You can, of course, decline to answer any question without any penalty or loss of benefits to which you are otherwise entitled.

Your personal ID number is ____.

Please complete the following survey by: (will be asked to complete in the next 2 weeks after email is sent out). Again, you have the option to not answer any question.

If you have any questions, feel free to contact:

Patti Brosnan (brosnan.1@osu.edu)

Nicole Thomas (Thomas.1450@osu.edu)
Preliminary Questions

1. Please enter your personal ID number sent in the email requesting you to complete the survey _______ (open space)

2. What is your gender? _______ (open space)

3. What is your age? _______ (open space)

4. What is your race? _______ (open space)

5. How many years have you taught? _______ (open space)

6. What is your highest level of education? _______ (open space)

7. At which grade level(s) have you taught? _______ (open space)

8. What factors affect your salary? (Examples include tenure or merit, among others) _______ (open space)

9. How long has your school had its principal? _______ (open space)

School Culture Assessment Instrument

Instructions for completing the assessment.

The purpose of this assessment is to assess six key dimensions of school culture. In completing the instrument, you will be providing a picture of the fundamental assumptions on which your school operates and the values that characterize it. There are no right or wrong answers for these items, just as there is no right or wrong school culture. Every school will most likely be described by a different set of responses. Therefore, be as accurate as you can in responding to the items so that your resulting cultural diagnosis will be as precise as possible.

You are asked to rate your school in six items. The assessment consists of six items. Each item has four alternatives. Divide 100 points among these four alternatives, depending on the extent to which each alternative is similar to your own school. Give a higher number of points to the alternative that is most similar to your school. For example, on item 1, if you think alternative A is very similar to your school, alternatives B and C are somewhat similar, and alternative D is hardly similar at all, you might give 55
points to A, 20 points to B and C, and five points to D. Just be sure your total equals 100 points for each section.

Note, that the left-hand response column for each item is labeled “Now”. These responses mean that you are rating your organization as it is currently. Complete that rating first. When you have finished, think of your school as you think it should be in five years in order to be successful. Complete the instrument again, this time responding to the items how you would like your school to be. Write these responses in the “Preferred” column. Your responses will thus produce two independent ratings of your school’s culture – one as it currently exists and one as you wish it to be in five years.

### The School Culture Assessment Instrument

#### 1. Dominant Characteristics

<table>
<thead>
<tr>
<th></th>
<th>How my school is now</th>
<th>How I would like my school to be</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>My school is a very personal place. It is like an extended family. People seem to share a lot of themselves.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>My school is a very dynamic entrepreneurial place. People are willing to stick their necks out and take risks.</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>My school is very results-oriented. A major concern is with getting the job done. People are very competitive and achievement-oriented.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>My school is a very controlled and structured place. Formal procedures generally govern what people do.</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2. Organizational Leadership</td>
<td>How my school is now</td>
<td>How I would like my school to be</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>A</td>
<td>The leadership in my school is generally considered to exemplify mentoring, facilitating, or nurturing.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>The leadership in my school is generally considered to exemplify entrepreneurship, innovation, or risk taking.</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>The leadership in my school is generally considered to exemplify a no-nonsense, aggressive, results-oriented focus.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>The leadership in my school is generally considered to exemplify coordinating, organizing, or smooth-running efficiency.</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Management of Employees</th>
<th>How my school is now</th>
<th>How I would like my school to be</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>The management style in my school is characterized by teamwork, consensus, and participation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The management style in my school is characterized by individual risk-taking, innovation, freedom, and uniqueness.</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>The management style in my school is characterized by hard-driving competitiveness, high demands, and achievement.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>The management style in my school is characterized by security of employment, conformity, predictability, and stability in relationships.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total 100 100</td>
<td></td>
</tr>
</tbody>
</table>

### 4. Organization Glue

<table>
<thead>
<tr>
<th></th>
<th>How my school is now</th>
<th>How I would like my school to be</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>The glue that holds my school together is loyalty and mutual trust. Commitment to my school runs high.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>The glue that holds my school together is commitment to innovation and development. There is an emphasis on being on the cutting edge.</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>The glue that holds my school together is the emphasis on achievement and goal accomplishment.</td>
<td></td>
</tr>
</tbody>
</table>
The glue that holds my school together is formal rules and policies. Maintaining a smooth-running school is important.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>The glue that holds my school together is formal rules and policies. Maintaining a smooth-running school is important.</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

5. **Strategic Emphases**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>My school emphasizes human development. High trust, openness, and participation persist.</td>
<td>How my school is now</td>
</tr>
<tr>
<td>B</td>
<td>My school emphasizes acquiring new resources and creating new challenges. Trying new things and prospecting for opportunities are valued.</td>
<td>How I would like my school to be</td>
</tr>
<tr>
<td>C</td>
<td>My school emphasizes competitive actions and achievement. Hitting stretch targets and winning in the marketplace are dominant.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>My school emphasizes permanence and stability. Efficiency, control and smooth operations are important.</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
### 6. Criteria of Success

<table>
<thead>
<tr>
<th></th>
<th>How my school is now</th>
<th>How I would like my school to be</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>My school defines success on the basis of the development of human resources, teamwork, employee commitment, and concern for people.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>My school defines success on the basis of having the most unique or newest products. It is a product leader and innovator.</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>My school defines success on the basis of winning in the marketplace and outpacing the competition. Competitive market leadership is key.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>My school defines success on the basis of efficiency. Dependable delivery, smooth scheduling and low-cost production are critical.</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

### 7. School Environment
This assessment examines how you experience your school. Please give a description what you considered to be “your school” as you responded to the above items (examples include your department, your principal, the teachers in your school, or all of these options).

Your response:

<table>
<thead>
<tr>
<th>8. Implementation of the MCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who or what aided you in implementing the ideas used in the Mathematics Coaching Program?</td>
</tr>
<tr>
<td>Your response:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9. Implementation of the MCP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who or what hindered you in implementing the ideas used in the Mathematics Coaching Program?</td>
</tr>
<tr>
<td>Your response:</td>
</tr>
</tbody>
</table>
10. *Implementation of the MCP*

If you are still a direct participant in the Mathematics Coaching Program, who or what do you think will aid you in continuing to implement the ideas used in the Mathematics Coaching Program? (Leave blank if you are no longer a direct participant)

Your response:

11. *Implementation of the MCP*

If you are no longer a direct participant in the Mathematics Coaching Program but continue to use the ideas from the Mathematics Coaching Program, who or what aided you in continuing to implement the ideas used in the Mathematics Coaching Program? (Leave blank if you are still a participant).
<table>
<thead>
<tr>
<th>12. <em>Implementation of the MCP</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>If you are still a direct participant in the Mathematics Coaching Program, who or what do you think will hinder you from continuing to implement the ideas used in the Mathematics Coaching Program? (Leave blank if you are no longer a direct participant).</td>
</tr>
<tr>
<td>Your response:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>13. <em>Implementation of the MCP</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>If you are no longer participating in the Mathematics Coaching Program, who or what hindered you from continuing to implement the ideas used in the Mathematics Coaching Program?</td>
</tr>
<tr>
<td>Your response:</td>
</tr>
</tbody>
</table>
Figure 25. Description of Participation Implementation Score

The evaluators ranked these values between 1 and 4, with 0 meaning “not evident”. For the participation question, a 1 signified:

“-[Teacher/Coach] or book in charge/leading, providing, confirming
-[Teacher] or [Coach] centered
-[Student]-complying, superficial participation
-Classroom is clearly coaches’ or teachers’”

A 2 signified:

“Some opportunities but limited”

A 3 signified:

“Gaining more opportunities”

A 4 signified:

“All [students] actively engaged in constructing mathematical knowledge
-High level of interaction between [Teacher/Coach], [Student/Teacher/Coach], [Student/Student] and [Student/Math]
-[Teacher] and [Coach] monitoring, circulating, acting as facilitators of learning
-Activities, questions, investigations are responsive to student needs, etc.
-[Students] are asking questions and initiating tasks”
Table 32. Additional Results

<table>
<thead>
<tr>
<th>Dominant Adhocracy</th>
<th>Bottom 50\textsuperscript{th} Participation</th>
<th>Top 50\textsuperscript{th} participation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom 50\textsuperscript{th}</td>
<td>6</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>Top 50\textsuperscript{th}</td>
<td>7</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>19</td>
<td>32</td>
</tr>
</tbody>
</table>

Fisher’s exact: $\sim1$

<table>
<thead>
<tr>
<th>Dominant - Market</th>
<th>Bottom 50\textsuperscript{th} Participation</th>
<th>Top 50\textsuperscript{th} participation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom 50\textsuperscript{th}</td>
<td>4</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Top 50\textsuperscript{th}</td>
<td>7</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>16</td>
<td>27</td>
</tr>
</tbody>
</table>

Fisher’s exact: $0.252$