2020

Educator Perceptions of Participation in a Vertical Professional Learning Community

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
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2020

Abstract

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by

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Walden University

August 2020

Abstract

Many researchers have studied best practices within school-based professional learning communities (PLCs). Practitioners need to understand more about different PLC configurations, such as vertical PLCs across schools, and how leaders influence implementation and outcomes. The purposes of this case study were to understand vertical PLC participant perceptions of leadership and school improvement, educator growth, and the effectiveness of the vertical PLC structure. The conceptual framework incorporated leadership of change, commitment to continuous improvement for individuals and organizations, and support of active and compelling adult learning. A collaborative, vertical PLC structure in a medium-sized public school district in a Mid-Atlantic state in the United States was the focus of this study. Research questions addressed the perceptions concerning leadership, educator growth, and the usefulness of the vertical structure. Data were collected through detailed interviews with 6 participants. A combination of a priori and open coding was used to support thematic analysis. Themes identified included alignment of practices, collective problem-solving and decision-making across grade bands and levels (shared leadership), collective responsibility for all students across levels, and the value of the vertical structure. PLC participation led to positive personal and professional growth experiences. Positive social change implications may include replication of the vertical PLC as a leadership and school improvement model across the school district. In addition, participants stated that the efforts of the PLC should influence students' performance in high school and beyond.

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Dedication

This dissertation is dedicated to all students and educators who have struggled, had challenges, made mistakes, and had failures, yet through it all they set goals, demonstrated perseverance, and got back on track again.

Acknowledgments

With much gratitude, I wish to thank my loving family for their support. They have encouraged me and inspired me to work hard on my goals throughout my whole life. Thank you, Dad, Mom, Dylan, Mike, and Nene. A huge thank you to my friends who are so deep inside my heart: Gina, Joelle, Martha, Joan, Arlene, and Terri. Each of you has listened and offered support along the way. In addition, I want to thank two very special people, Dr. Dawidowicz and Dr. Dawson, for their wisdom, assistance, kindness, and encouragement. I am so fortunate to have worked with them! Last, I want to acknowledge my Walden University G-Force study group, a wonderfully supportive team of friends and colleagues including Andrew, Everett, Jamila, and Tiawana. Thank you to each of you!

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Chapter 1: Introduction to the Study

School districts hire principals to foster necessary conditions for school

improvement by influencing the growth and learning of staff members and students

(Gantt Sawyer, 2017). In their role as school-based leaders, principals have the potential

to make a positive difference for both teacher and student outcomes, although not all

principals have the same knowledge, preparation, and skill sets (Williams & Welsh,

2017). Applications of Kouzes and Posner's (2017) leadership research indicate that the

demonstration of specific leadership practices, termed *transformational* in nature, may

accomplish many principals' goals to reform schools. Further application of Kouzes and

Posner's research suggests that principals, as lead learners and teachers in their schools,

may bring forth change by (a) modeling the way, (b) inspiring a vision, (c) challenging

the process, (d) enabling others to act, and (e) encouraging the heart.

Specifically, effective school leaders demonstrate the ability to craft a vision and

align all practices to it, enlist stakeholder support and commitment to the vision, and

facilitate resources to support staff and student growth (Davis, Darling-Hammond,

LaPointe, & Meyerson, 2005; The Wallace Foundation, 2013). These research findings

highlight principals' multifaceted roles and responsibilities and suggest that developing a

shared leadership model is one purposeful way for principals to promote staff members

as coleaders of school improvement (Stein, Macaluso, & Stanulis, 2016; Leithwood et al.,

2007; Neumerski, 2013; The Wallace Foundation, 2013). Principals also may need help

with setting a collective expectation for all students and teachers. This expectation is that

schools are learning organizations in which continuous growth and improvement for all is

expected, valued, and supported (Coburn, Mata, & Choi, 2013; Higgins & Bonne, 2011; Hord & Sommers, 2008; Kalkan, 2016; Morales-Chicas & Agger, 2017; The Wallace Foundation, 2013).

Principals may choose to implement a professional learning community (PLC) as the context for school improvement. As the lead teacher within a PLC, a principal may choose to direct appropriate professional development for teachers with the goal of influencing student outcomes by targeting teachers' instructional practices (Higgins & Bonne, 2011). Professional development assumes that a change is needed in some aspect of the school or teacher practice to shape instructional practices (Higgins & Bonne, 2011; Leithwood et al, 2007). As part of a shared or hybrid leadership model, principals may select, hire, or train teachers to serve as leaders or coleaders of reform efforts, lead content teams, and deliver professional development in PLCs (Higgins & Bonne, 2011; Hopkins, Spillane, Jakopovic, & Heaton, 2013).

Furthermore, through shared or distributed leadership, principals may foster the development of positive community practices, or *habits*, such as (a) a collective fidelity to the expectation that schools are learning organizations in which continuous growth and improvement for all students and teachers is expected, valued, and supported (Coburn et al., 2013; Higgins & Bonne, 2011; Hord & Sommers, 2008; Kalkan, 2016; Morales-Chicas & Agger, 2017; The Wallace Foundation, 2013); (b) effective communication (Higgins & Bonne, 2011); and (c) deprivatization of instructional practices through a shared commitment to collaboration (Hord & Sommers, 2008). Another leadership consideration is the design or structure of the PLC itself. Lesser studied structures include

geographically clustered and cross-level PLCs (Anderson, 2014; Chikoko, 2007).

In this chapter, I present the problem statement, purpose of the study, and research questions, followed by a discussion of the conceptual framework utilized for this study. Additionally, the nature of the study, definitions, assumptions, and limitations are also provided. The chapter concludes with a summary and transition to the literature review in Chapter 2.

Background

It is unknown whether PLCs, as an intervention context, may support effective teaching and learning outcomes for individuals and school teams (Martin, Polly, Mraz, & Algozzine, 2018; Polly et al., 2013; Vescio, Ross, & Adams, 2008; Voelkel & Chrispeels, 2017). Dhillon and Vaca (2018) and Mayne (2017) reported that leadership of school improvement and change efforts vary. Examples of differences include the efforts of a leader to mediate the variety of perceptions, attitudes, experiences, and practices found within school teams. These are measured by individual and collective fidelity to the goal of a PLC, alignment to the leader's vision, sharing of lessons, and use of student work to guide practice and collective responsibility for student results (Koşar, Kilinç, Koşar, Er, & Öğdem, 2016; Voelkel & Chrispeels, 2017).

Leaders also may encounter teachers who are unsure of their ability to impact student learning. The findings of Frimer (2017) and Polly et al. (2013) did not reveal a relationship between elementary teachers' instructional efficacy and student achievement. As a result, leaders may need to provide specific instructional and capacity-building assistance to teachers to positively influence student learning. The role of principal as

leader of school improvement efforts is a critical one because principals can design, select, or direct professional development for their staff members within a PLC.

A uniqueness of the PLC under study is that it encompasses seven schools that feed totally or partially to the enrollment of one high school. It is possible for teacher leaders and teachers to collaborate collegially across geographic boundaries or school levels in a cluster approach to influence student achievement in the community of the cluster (Anderson, 2014). One such way is to create a geographic or vertical cluster that may serve as the intervention context to foster growth in teaching practices, collaboration, and self-directed professional development (Chikoko, 2007). In this study, a principal created a vertical cluster PLC to serve as the context by which a common instructional goal was established to improve mathematics in an entire geographic community. The vertical PLC was brought to fruition by teachers, leaders, and administrators working together across schools to address the problem of low mathematics achievement. By applying effective leadership strategies, leaders sought to influence staff and student outcomes.

At the onset of the PLC, on standardized measures of mathematics proficiency, the high school and feeder cluster of schools all had mathematics standardized test scores below the district's mean score for Grades 3–8, Algebra 1, and Geometry. Some of the schools in the cluster had the lowest mathematics scores or were tied for the lowest score, and in every reported grade, some of the cluster schools scored in the lowest quartile of the district. The findings of this study informed leaders of the school district about perceptions of the usefulness of the vertical structure as a recommendation for a future

leadership or mathematics professional development model.

<p style="text-align:center">**Problem Statement**</p>

Principals may select a PLC as the reform context for professional learning when they desire to improve teachers' instructional practices for the goal of positively influencing students' performance (Vescio et al., 2008). It is unknown whether participants' experiences within a PLC are influenced by the leadership of the PLC, the organizational design of a PLC, or the opportunities for collaboration that may or may not have occurred in the selected structure. In a medium-sized, public school district in a Mid-Atlantic state in the United States, one vertical geographic PLC was put in place by school principals within a low-performing cluster of schools to address the problem of low student performance in mathematics. The leaders sought to understand more about how to address this low performance issue through the demonstration of effective leadership strategies to influence school improvement efforts. Although principals are able to influence student performance in schools (Hattie, 2009; Hitt, Woodruff, Meyers, & Zhu, 2018; Leithwood, Seashore Louis, Anderson, & Wahlstrom, 2004), principals are also expected to exercise leadership to create reforms explicitly designed to yield both teacher and student performance outcomes (Higgins & Bonne, 2011).

In PLCs, leadership practices that may contribute to increased staff and student outcomes include fostering a collective commitment to accountability, promoting a shared leadership and responsibility for all students' success, and providing opportunities for collaboration and direct support (Voelkel & Chrispeels, 2017). From their meta-analysis of 11 PLCs, Vescio et al. (2008) established that student-centered and data-

informed professional learning teacher participation may yield positive outcomes for students. By contrast, Martin et al. (2018) established a disconnect between the intentions of professional learning, the teachers' commitment to learning, and any changes to instructional practice resulting from the professional learning. Chikoko (2007) and Anderson (2014) concluded that the design of the reform context itself may be an important factor for leaders to consider when attempting to maximize both student and teacher outcomes. They separately presented two different, lesser-known PLC structures, a geographically clustered PLC and a geographic and cross grade level PLC, as viable options for bringing forth school reform efforts.

In my study, school leaders chose to create a vertical PLC that encompasses a combination of seven geographically clustered elementary and middle schools that totally or partially feed one high school's enrollment. It was unknown if school principals' use of effective leadership practices within a PLC focused on mathematics are perceived as influential on staff or student learning for a vertical PLC community whose schools all scored below the district mean in a mathematics proficiency standardized test for Grades 3–8. Whether participants in the PLC perceive any usefulness of the vertical structure itself for influencing student or staff goals was also unknown.

Purpose of the Study

The purposes of this case study were to understand vertical PLC participants' perceptions of (a) leaders' efforts to improve their students' mathematics achievement, (b) educator growth or behaviors while engaged in improvement efforts with the PLC, and (c) the effectiveness of the vertical PLC context. In this study, I focused on

experiences within a newer, vertical model of PLC. This study addressed whether this vertical type of PLC might be one to recommend as a leadership and school improvement model for mathematics across the school district.

Research Questions

Research Question 1: What are the beliefs of school leaders and PLC participants on the leadership practices demonstrated by the leaders in the vertical PLC?

Query 1: Please describe your perceptions of any demonstrated leadership in the vertical PLC focused on mathematics.

Research Question 2: How do PLC participants describe their own or others' growth or behaviors while engaged in the school improvement efforts for mathematics within the PLC?

Query 2: Please describe your perceptions of the experiences you had within the vertical PLC focused on mathematics.

Research Question 3: How do PLC participants perceive the usefulness or effectiveness of the vertical PLC focused on mathematics improvement?

Query 3: Please describe the usefulness of the vertical structure of the PLC.

Conceptual Framework

Three key concepts were combined to frame this study: effective leadership of change; commitment to continuous improvement for individuals and organizations; and support of active, potent adult learning. Each concept was inherent in the study, which centered on bringing reform to many diverse individuals from seven different schools who were all connected at regular intervals through leadership meetings, professional

development, and cross-school visits to mathematics classrooms.

First, Kouzes and Posner's (2017) decades of research with leaders around the world revealed what is needed to foster and sustain change in organizations. The five research-based effective leadership practices identified in The Five Practices of Exemplary Leadership Framework is an essential part of understanding this study. Connected to this are the interactive components found within The Shared Responsibility Framework of Social Interactions for Collective Investment (SRF; Abery et al., 1999). The SRF illustrates what happens when individuals interact with each other and how their ways of doing and being may intersect or conflict with others' cultures (Abery et al, 1999). In this study, it was unknown whether any communication opportunities designed to vertically share knowledge in response to identified teacher and student strengths and needs were perceived as worthwhile by participants. I used the SRF to explore how the individuals' intersections of values and beliefs may affect commitment to school improvement initiatives.

Hord and Sommers' (2008) Five Dimensions of a PLC, which is a model for understanding the degree to which participants are operating as a PLC, was also included as part of the conceptual framework of this study. Since school leaders may choose a PLC as the context for intentionally bringing together diverse adults for learning and growth (Hord & Sommers, 2008; McGee, Wang, & Polly, 2013), it may be expected that the diverse adults will not necessarily bring shared values, goals, and communication preferences to the PLC. The conceptual framework comprised a combination of all three concepts (see Figure 1).
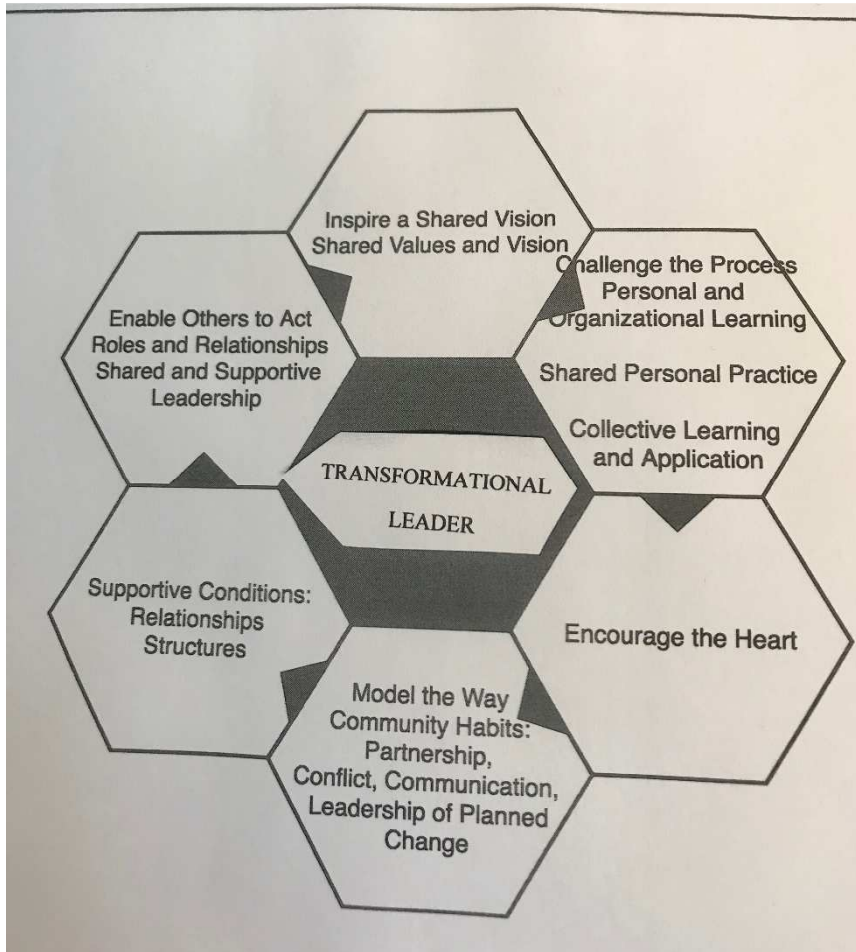
Figure 1. Unified framework. A representational model of the exploration of perceptions of transformational leaders.

Nature of the Study

A qualitative case study was an appropriate approach because qualitative data were used to answer the research questions of this study. The case was bounded by the one vertical PLC, across elementary and middle schools that are aligned as a cluster with one high school, in place in the school district at the time of this study. I asked personnel from the school district's mathematics office and staff from seven schools (i.e., two

middle schools and five elementary schools) to participate in this study. Participants shared their perceptions of the leaders' efforts to improve their schools' mathematics achievement, their own and others' growth or behaviors while engaged in PLC mathematics improvement efforts, and the usefulness of the lesser-studied vertical PLC as the context for change.

Definitions

Cluster model: A collection of schools that are brought together for a common purpose, including, but not limited to, shared decision-making, communication, support structures, professional learning, or school improvement (Bray, 1987).

Collective responsibility: The construct used to describe a single person's commitment to an initiative that may be characterized in a PLC as demonstrated care, effort, and investment to a transformation of an organization, culture, or practice (Abery et al., 1999).

Community habits: An umbrella term that describes the supported, developed, and unconsciously reinforced individual and collective actions, thoughts, feelings, and behaviors of students, teachers, administration, culture, and school (Abery et al., 1999).

Hybrid leadership: This type of leadership is developed by tapping the talents of diverse staff members (Higgins & Bonne, 2011).

Vertical professional learning community (PLC): Within this case study, this was two middle schools and five elementary schools that are assigned by the school district as a cluster of schools within a shared school community that provides an extended learning organization that embraces teachers and students (Chikoko, 2007).

Assumptions

The first assumption was that the school district would provide an accurate list of PLC participants; I confirmed PLC participation prior to and during the interviews. Another assumption was that the participants were honest and open about their roles as school leaders, school district mathematics leaders, or teachers. The final assumption was that all participants were honest with their responses and reported honest beliefs, experiences, and perceptions from their participation in the vertical PLC focused on mathematics.

Scope and Delimitations

The case study selected for this study was one of a vertical PLC with a focus on mathematics because the cluster of schools participating had some of the lowest average percentages of mathematics scores in the school district at the time of the study. The case study was delimited by the sharing of educator perceptions and experiences with leadership as well as their perceptions of personal and others' growth within the vertical PLC focused on mathematics and the usefulness of the vertical PLC structure. Participation in this study was delimited by the following three criteria: (a) verified membership in the PLC; (b) verified role as an administrator, mathematics leader, or teacher; and (c) voluntary participation in the interview process. I invited participants to participate in the study, but it was their choice whether or not to do so. Since the qualitative case study involved only one cluster, it is unknown whether the findings of the study might apply to other PLCs, vertical PLCs, content areas, or leadership of mathematics improvement case studies.

Limitations

The number of participants was limited to volunteers. The PLC participants represented a range of demographics, various teaching experiences, and different teaching and leadership positions from elementary through middle school and central office mathematics leaders. I selected a purposive sample from the central office and school-based mathematics leaders, middle and elementary school leaders, and teacher volunteers based on the participant's role. Because the participants were limited to volunteers, I had no control over who would participate in this study or what their perceptions or experiences within the PLC, leadership, growth, or behaviors would be. I also had no control over the amount of time it took participants to respond to their invitation to participate or agree to an interview date and time.

Personal bias was considered as I was a public-school educator and administrator for over 30 years. Additionally, I had been an administrator, a leader, and member of the vertical PLC focused on mathematics. Because of this, the high school mathematics teachers and administrators were eliminated from the study to avoid any perceptions of bias. As the study began, I had no preconceived notions about the PLC participants' beliefs, experiences, or perceptions. The qualitative case study design with a focus on one vertical PLC had a finite number of possible participants from which to sample, so. applicability to other studies was limited.

Significance

This case study had social change implications. In the United States, many students who are economically disadvantaged are not successful on standardized

measures of mathematics achievement (Kotok, 2017; National Center for Educational Statistics, 2019, 2020a, 2020b; Organisation of Economic Co-operation and Development, 2014). Strong leadership is needed to influence teachers and the lives of current and future students. Effective principals may influence student and teacher outcomes through their ability to demonstrate transformational leadership behaviors (Kouzes & Posner, 2013). By choosing to lead efforts to challenge the status quo of high achievement for some students but not for all, principals can exercise leadership to influence individual and organizational instructional practices geared toward accelerating individual students as well as the progress of student groups (Kouzes & Posner, 2013).

Principals may also enable others to act alongside them by fostering informal and formal shared leadership and structured and unstructured professional development opportunities to assist teachers with growing instructionally to meet all students' needs. Although principals may hire competent teachers who know their learners and content well, a benefit of this study was that it could provide insights into what may happen to teachers' instructional practices and growth when school leaders bring kindergarten through 8th grade teachers together in a vertical PLC structure (see Lowenberg Ball, Thames, & Phelps, 2008; Robinson & Lewis, 2017). According to the National Council of Teachers of Mathematics (2010) and Shulman (1986), providing targeted, content-specific, and pedagogical professional development for teachers is foundational to improving students' mathematical outcomes (Lowenberg Ball et al., 2008).

The findings of this study contributed to the literature on PLCs; however, it was focused on a lesser-studied vertical PLC structure in mathematics. Principals may choose

a PLC as the context for positively influencing student outcomes (Hord & Sommers, 2008). The results of this study contributed to the leadership field by expanding existing research on the perceptions of leadership efforts within a vertical PLC and participants' perceptions of the usefulness of the vertical PLC as the context for change and school improvement. Lastly, the perceptions of PLC experiences centered on change and growth in mathematics school improvement efforts were also explored.

Ning, Lee, and Lee (2015) found a strong correlation between students' improved outcomes and classroom engagement when teachers collaborate. Nevertheless, other researchers found there was not a relationship between elementary student achievement and teacher beliefs or instructional practices (Frimer, 2017; Polly et al., 2013). The reauthorization of Every Student Succeeds Act has legislated the importance of each student having equal access to rigorous curriculum and quality teachers regardless of economic status (Saultz, White, McEachen, Fusarelli, & Fusarelli, 2017; U.S. Department of Education, 2015). This study filled a gap in the literature about what may happen when leaders bring cross-age and cross-school mathematics teachers and leaders together for professional development and collaboration opportunities within a vertical PLC structure.

Summary and Conclusions

In a medium-sized, public school district in a Mid-Atlantic state in the United States, a vertical PLC was put in place by school principals within a low-performing cluster of schools as a school improvement initiative to address the problem of low student performance in mathematics. All students in this cluster of schools did not meet

grade-level proficiency standards. To understand more about how to address this issue through the leadership of a lesser-studied type of PLC, a vertical PLC focused on mathematics was the focus of this qualitative case study. Perceived leadership actions included attempts to develop a shared accountability and responsibility culture through fostering collaboration, setting vision and structures, fostering communication, and learning about teaching and learning. Using professional development to improve teacher practices and student outcomes was a priority for the cluster leadership. Data indicated that too many students in the cluster lacked adequate mathematics skills compared to their school district and national peers.

In this study, I explored vertical PLC participants' perceptions about the usefulness of the vertical PLC model and their experiences and perceived changes to instructional practices or student outcomes. School district personnel planned to utilize this research for further study of the leadership of other cluster PLCs in the school district.

Chapter 1 was an introduction to the subject of this study. This introduction included the background, the problem statement, and the purpose of the study. Furthermore, the chapter included the research questions along with the conceptual framework that guided this research study. The nature of the study, definitions, and assumptions were revealed and discussed. The chapter also contained the scope and delimitations, as well as the limitations and the significance of the study. Chapter 2 will be a review of the literature surrounding the topics contained in this research study.

Chapter 2: Literature Review

In this study, I focused on principal, district, and teacher leaders from a geographic, vertical cluster of five elementary and two middle schools who sought to improve mathematics in their greater geographic community by instituting a reform effort through a PLC to positively influence staff and student achievement. The PLC leaders sought to demonstrate effective leadership practices, such as modeling leadership behaviors; setting a vision for the PLC, staff, and student outcomes; and challenging the status quo of poor mathematics achievement and teacher isolation, in order to establish collective responsibility and accountability for the success of all staff and students.

PLCs are widely accepted in the literature as effective ways to bring forth positive outcomes in schools. Hord and Sommers (2008) outlined five components that comprise a PLC: (a) shared beliefs, values, and vision; (b) shared and supportive leadership; (c) collective learning and its application; (d) supportive conditions; and (e) shared personal practice. Prior researchers have cited positive teacher perceptions about the benefits of PLCs, specifically personal content growth, collaborative practices, and improvement in demonstrated instructional practices (Bryk, 2015; Budgen, 2017; Christiansen & Robey, 2015; Ciampa & Gallagher, 2016; Courtney, 2018; Darling-Hammond, Hyler, & Gardner, 2017).

In some contexts, students' classroom and summative assessment growth have occurred either as a result of quantitative data or through perceptions that teacher self-efficacy holds promise for influencing student achievement (Hopkins et al., 2013; Hord & Sommers, 2008). Additionally, researchers have shown that school culture is

influenced through PLC actions demonstrated by the congruence to the vision of the school and through the development of positive community habits that foster shared leadership, accountability and responsibility for staff, and student results (Binkhorst, Poortman, McKenney, & van Joolingen, 2018; Darling-Hammond, Wilhoit, & Pittenger, 2014; Forrester, 2018; Lomos, Hofman, & Bosker, 2011). Due to the perceived benefits described above, school leaders may choose PLCs for reasons of reformation.

PLC participants indicate that there is evidence of collective responsibility as a result of PLC participation (Valckx, Devos, & Vanderlinde, 2018) as well as perceptions that the individual themself and their PLC colleagues are capable of growth and learning (Osmond-Johnson, 2017). Developing teacher leadership within school reform is hypothesized as a possible way to foster individual and collective responsibility, promote expertise within the PLC, and promote deprivatized practices (Scornavacco, Boardman, & Wang, 2016). Unified habits of collective investment may be observed, such as partnership, conflict, leadership, and planned change (Abery et al., 1999).

One challenge is that PLCs are not all conceptualized in the same way. In some studies, PLCs are bound by one school or team, while others have multiple PLCs or multiple foci within the same school. A lesser-known PLC organization is a vertical PLC in which the focus is on geographically close participants from across grade levels who cluster for a specific instructional, resource, political, or school district change (Bray, 1987). In Chikoko's (2007) multicase study of five geographically clustered schools in Africa, participant perceptions did not suggest that outcomes of the clusters were totally successful. Chikoko cited that resistance to change, political factors, and issues with

school resource allocations were noted among participants. Chikoko's findings were in alignment with those of Ford and Youngs (2018) that showed a mere physical collection of people, geographically close or otherwise, were not synonymous with an effective PLC.

Although prior researchers suggested that PLCs may serve as the context for professional development for teachers, it was unknown if the specific organization or type of PLC may influence teachers' perceptions of professional learning outcomes. Birkhead, Suh, Gerasimova, and Seshaiyer (2017) suggested that teachers can struggle to communicate with each other about content, pedagogy, and developmental appropriateness across grade-level boundaries. In an Irish study of 471 teachers, Prendergast, O'Meara, O'Hara, Harbison, and Cantley (2019) identified several challenges after determining the perceptions of transition barriers between primary and secondary mathematics programs in the same school district, including (a) a lack of teacher knowledge about learning progressions, (b) the variance in pedagogy between the levels, and (c) a lack of communication across various grade band teachers.

Prendergast et al.'s (2019) study was significant because the difficulty in grasping the concepts that build in rigor from grade to grade, such as learning progressions, represented the broader, overall lack of understanding, standardization of practices, and expectations between grade levels and teachers' learning across schools. Remedies suggested by both primary and secondary study participants to foster collegial practices and improve mathematics instruction included the provision of collaboration time, communication structures, and content professional learning. For this reason, in the

current study, I explored the perceptions of PLC participants regarding the leadership of

and their engagement in a mathematics improvement intervention within a vertical PLC

comprised of elementary and secondary schools from a close geographic area and across

grade levels.

In this chapter, I provide the literature search strategy and a description of the

conceptual framework. In addition, I discuss what is known and unknown about PLCs as

an intervention context for change in schools, the perceptions of PLC participants within

a vertical PLC, and the perceptions of the leadership of a vertical PLC to influence

change to teachers' mathematics instructional practices. The purposes of this case study

were to understand vertical PLC participants' perceptions of (a) leaders' efforts to

improve their students' mathematics achievement, (b) educator growth or behaviors

while engaged in improvement efforts with the PLC, and (c) the effectiveness of the

vertical PLC context. In this study, I addressed whether the leadership of this vertical

type of PLC might be one to recommend as a leadership or mathematics professional

development model for teachers and school leaders across the school district.

Literature Search Strategy

I accessed online databases, such as EBSCO, Google Scholar, SAGE, Education

Source, ProQuest, and others, through the Walden University, Loyola University of

Maryland, and the University of Maryland, College Park libraries. A sampling of the

search terms used are: *PLC, teacher, educator, principal, effective leadership,*

transformational leadership, distributed leadership, teacher leadership, mathematics,

change, collective responsibility, teacher talk, accountable talk, student achievement,

elementary, vertical teams, clusters, secondary, adult learning, effective teaching, pedagogy, and *perceptions.* After reviewing the literature on the topic retrieved through the database search, I discerned a repetition of themes. The focus was narrowed based on the peer-reviewed research. In addition, to better understand the needs of 21st-century learners in an increasingly diverse U.S. school student population, I broadened the scope of the research to include international studies to present a global picture of the research.

Conceptual Framework

In this study, I focused on a vertical PLC concentrated on mathematics that was put into place by school leaders to address the problem of low mathematics achievement in the school district. Principal, teacher, and central office leaders were asked to share their perceptions of leadership, experiences of growth and change within the PLC, and usefulness of the PLC as an intervention context. A unification of the following three key constructs framed this study: effective leadership of change, commitment to continuous improvement for individuals and organizations, and supporting adult learning through collaboration and alignment. This unified model best supported this study because an attempt was made to bring mathematics reform to diverse people across seven different schools who were intentionally connected by school leadership to a vertical PLC context.

An essential part of school improvement is the impact of a leader. Because of this, I included Kouzes and Posner's (2017) Five Practices of Exemplary Leadership Framework, which was derived from a study of leaders around the world that revealed what was needed to foster and sustain change in organizations, in the conceptual framework of this study Strategies within this framework connect to the interactive

components found within SRF, which illustrates what happens when individuals interact with others and how their ways of doing and being may intersect or conflict with others' cultures (Abery et al., 1999). In this study, I used this combined model to explore how the values, beliefs, and actions of leaders and participants may affect their commitment to school improvement initiatives. Lastly, school leaders may choose a context for change within their schools to deliberately bring adults together to maximize opportunities for learning and growth and may choose to implement a PLC (Hord & Sommers, 2008; McGee et al., 2013). I purposefully combined all three concepts to inform the exploration of leader and participant perceptions.

Literature Review Related to Key Concepts and Variable

As a context for exercising their leadership influence and for developing the leadership of others to raise the achievement of all staff and students, principals may choose to create PLCs at their schools. Prior PLC researchers have stated some positive teacher perceptions about the benefits of PLCs, specifically concerning content knowledge and instructional practice growth, increased collaborative practices, and improvement in developed individual and collective capacity toward school goals (Bryk, 2015; Budgen, 2017; Christiansen & Robey, 2015; Ciampa & Gallagher, 2016; Courtney, 2018; Darling-Hammond et al., 2017). The possibility of influencing a school culture positively may be an additional reason for principals to choose to implement a PLC. An alignment of staff actions to the articulated vision may occur through experiences provided in a PLC (Binkhorst et al., 2018; Darling-Hammond et al., 2014; Forrester, 2018; Lomos et al., 2011). Additionally, artifacts that represent collective learning,

shared accountability, and responsibility for all staff and student results can be observed

in the communal culture of a PLC (Binkhorst et al., 2018; Darling-Hammond et al., 2014;

Forrester, 2018; Lomos et al., 2011).

As a lesser-studied construct, participants in the vertical PLC may or may not

yield the potential collaborative or instructional benefits as other PLC participants have

experienced (Hord & Sommers, 2008). In the case of the vertical PLC under study, many

leaders across schools and school levels came together to form a leadership team of the

PLC. The perceptions of principals' demonstrated leadership behaviors in vertical PLCs

also are lesser studied, as are the abilities of the vertical PLC leaders to foster change,

confront conflict, and communicate across the vertical context. For these reasons, in the

literature review findings that follow, I begin with how principals may foster adult

growth in the specific vertical context followed by the specific leadership actions

principals may attempt to align PLC participants to their collaborative vision for a

successful vertical mathematics improvement initiative.

Supporting Effective Adult Learning and Professional Learning Communities

Leaders may choose a PLC as the context for change at their schools. Effective

PLCs have five specific components, including (a) shared beliefs, (b) values and vision,

(c) shared and supportive leadership, (d) collective learning and its application, and (e)

supportive conditions and shared personal practice (Hord and Summers, 2008). Prior

researchers have described some teachers' favorable perceptions about PLC experiences,

including content learning, collaboration, and changes to instructional practices (Bryk,

2015; Budgen, 2017; Christiansen & Robey, 2015; Ciampa & Gallagher, 2016; Courtney,

2018; Darling-Hammond et al., 2017). Additional researchers have described PLC participants' perceptions of communal responsibility and accountability, as congruence to the vision, aligned actions, and shared leadership of the school (Binkhorst et al., 2018; Darling-Hammond et al., 2014; Forrester, 2018; Lomos et al., 2011). These findings suggest that actions describing effective PLC components can be perceived by participants about themselves and others within the PLC.

Commitment to Continuous Improvement and Inspiring a Shared Vision

Within a PLC, inspiring a shared vision may be evidenced by perceptions of learning and growing together in a community. Kouzes and Posner (2010) stated that effective leaders can create and describe an exciting vision of the future of their organization. They added that when the vision shared with followers is attractive and meaningful, it may help to inspire followers to want to join the leader to make the vision a reality.

Developing a PLC within or across schools is an example of how principals, as leaders of schools, may set a compelling vision for their schools or school teams with the hope of fostering an individual and communal commitment to the vision to positively influence teaching and learning outcomes (Hord & Sommers, 2008). Poor student performance data caused a sense of urgency to improve both teachers' instruction (Darling-Hammond & Snyder, 2015) and eliminate achievement gaps for students who were underperforming on local mathematics tasks, national assessments, and international mathematics measurements such as the Program for International Student Assessment and Trends in International Mathematics and Science Study (Kaufman, Stein,

& Junker, 2016; Ker, 2016; Lewis, 2017). Leadership was needed to make improvements. However, setting a vision is necessary to determine the nature of the change, how the vision may come to fruition, and how others may be involved throughout the process.

PLCs are proven mechanisms for communicating a change to teachers and for setting expectations for shared community habits. These habits include aligning efforts to the school vision, examining student-level data to inform instruction, and committing to the shared responsibility of success of each teacher and student in the school (Hord & Sommers, 2008). Specific strategies for communicating a shared vision for the optimal future of a school may include fostering inquiry, creating opportunities to learn others' perspectives, and reflecting individually and collectively on the progress of the PLC (Hord & Sommers, 2008). This may be termed building a planned change habit (Abery et al., 1999).

Research conducted by Karada and Öztekin (2018) found that when teachers perceived that their leader was transparent, trustworthy, and self-aware, there is a positive relationship between the leader and the school culture. They also found that when the leader exhibited behaviors, termed authentic leadership behaviors, that positive effects to the school culture occurred. This was reported by teacher perceptions. Crafting a culture in which participants want to work alongside a leader is part of what is needed to encourage all participants to grow, learn, and reflect on their commitment to the shared vision for the future. What principals and teacher leaders may share within a PLC, however, is the belief that the goal of a PLC may be to raise the performance of all

teachers. Effective teachers who can demonstrate a knowledge of students, content, and exhibit a collective responsibility for all students' success are needed in every classroom (Robinson & Lewis, 2017).

Participants included principals from the cluster schools who worked together to set a vision for a vertical PLC focused on mathematics. The intent was to set a unified vision across the vertical cluster, not just for one school or level. The goal was to align school improvement efforts for all participants to the vision. Perceptions of participants' experiences were gathered as a part of the study. Inspiring a shared vision for a culture that develops, values, and sustains positive community habits throughout the change process may be one of many important jobs of a school principal. Reflective dialog, collaboration, commitment to a shared vision, and focus on student work and results were associated with perceptions of a successful school and student achievement (Lomos et al., 2011).

Supporting Effective Adult Learning and Fostering Positive Community Habits

Throughout this cluster PLC structure, an underlying intended goal was to bring a vertical PLC innovation to the schools to foster commitment and collaboration among mathematics teachers and leaders in order to influence adult and student learning. PLC leaders specifically designed professional learning opportunities to facilitate opportunities for mathematics teachers and leaders to collaborate in order to influence learning and growth. Researchers have shown that merely bringing staff together in the same room for professional learning does not necessarily yield a genuinely collaborative culture (Ford & Youngs, 2018).

Viewing collaboration as a continuum, researchers described that the sharing of space was a beginning step and the more developed step was portrayed as collegial, including the communication within the shared space coupled with working together toward an accepted vision and goals (Ford & Youngs, 2018). Although one intention for leaders may be to create such a collegial structure, the culture may not develop authentically and may appear contrived. Ford and Youngs' (2018) research found that it is possible for staff members to still receive some benefit within the contrived collegiality. Their findings identified a demonstration of internalization of shared practice, a marker that a school is operating as a PLC.

One component of the unified conceptual framework is the SRF. Although the original study of the SRF involved only one school, there were multiple people within the study with different roles, beliefs, and communication styles. The SRF described what happens within a reform context. By contrast, a second component of the unified conceptual framework is Kouzes and Posner's (2017) research, the Five Practices of Exemplary Leadership Framework. This included thousands of people across diverse organizations and countries to gain understanding and describe how effective leaders improve the outcomes of their organizations. A significant factor of the study was the numbers of schools and diverse participants who comprised the vertical PLC.

Although two components of the unified framework, the SRF and the Five Practices of Exemplary Leadership Framework, illustrate the myriad of challenges that exist to develop and sustain positive community habits for growth and change for a group of diverse people within a PLC, examining the context itself may be equally important. It

is imperative to determine whether a PLC that has been established is operating in name only or if the PLC is an effective one. A valid instrument may be needed to determine the degree to which a PLC may be termed an effective PLC (Dogan, Tatik, & Yurtseven, 2017).

As such, the Professional Learning Communities Assessment Revised was developed and proven to be a valid and reliable measure across an international study as well as in the U.S. The Professional Learning Communities Assessment Revised measures whether a PLC is operating in name only or is in fact an effective PLC according to the six dimensions of the instrument that align with Hord and Sommers' (2008) PLC dimensions. Turkish researchers, in their study to (a) validate, (b) adapt, and (c) apply the Professional Learning Communities Assessment Revised, found that it was appropriate to be used to measure participants' perceptions of PLC functioning.

The Professional Learning Communities Assessment Revised includes measures of individual and organizational capacities (Dogan et al., 2017). This non-Western study of 45 teachers was informative because it showed the Professional Learning Communities Assessment Revised test's adaptability across diverse participants. Additionally, findings from Dogan et al. (2017) were relevant because they revealed a significant direct effect from organizational capacity, defined as Supportive Conditions: Relationships, on interpersonal capacities for collective learning and application and shared personal practice. Although the impact of departmental meetings predicted a commitment to shared practice and learning, the researchers did not find a statistically significant direct effect from individuals' learning to interpersonal capacities.

The unified framework was important because as the model suggests leading a change or reform effort is challenging (Abery et al., 1999). Kellar and Slayton's (2016) research supported the SRF's ideas and suggests that current models of determining effective school leaders are inadequate because they do not acknowledge the complicated, multifaceted processes involved in leading change. Kouzes and Posner (2017) stated that leaders need to administer specific actions to lead their organizations. Moreover, Kouzes and Posner's findings suggested that personal and organizational learning are not separate processes and that to isolate one aspect of change within an organization is not adequate. The unified framework may support the understanding that principals may consider developing structures such as PLCs to develop individuals and the organization at the same time.

Effective Leadership of Change and Leadership Styles

Because of inconsistencies found in prior research studies with which actions are perceived as fostering meaningful adult learning and growth, a focus is made on participants' perceptions of leadership and experiences of growth and change within the selected context of the vertical PLC. PLC participants may include teachers, content or team leaders, researchers, school district staff, and administrators. However, within a school PLC, the lead learner is the principal (Shen, Ma, Cooley, & Burt, 2016). As a lead learner, the principal must accept responsibility to lead by example, supporting program coherence by modeling learning behaviors such as inquiry, reflection, and analysis of data while working alongside teachers in professional learning (Jones & Thessin, 2017; Vinson, 2018).

According to Lochmiller and Acker-Hocevar (2016), principals served as lead learners and teachers and sought to influence outcomes using distributed leadership and the development of community habits for instructional collaboration and shared responsibility. Lochmiller and Acker-Hocevar's study, although small, highlighted the premise that in these five schools, principals made choices to impact teaching and learning in some way by using their own perceived leadership strengths and styles. In other words, continuous improvement is not solely a process for organizations; instead, it may pertain to the persons within the organization as well (Kouzes & Posner, 2017).

Leithwood et al. (2007) indicated that developing oneself and others may be viewed as one of the essential functions of school leadership. Principals may demonstrate specific leadership practices that have been shown to make improvements to teachers' practices, school culture, and student outcomes (Kouzes & Posner, 2017). Some of the PLC leaders' intentions were to develop and promote a community leadership habit, which is essential to bring forth change in an organization (Abery et al., 1999).

Berkovich (2018), in a meta-analysis of transformational leadership conducted a case study and found that common perceptions about effective leadership practices and styles were culturally and methodologically biased and often are not supported by empirical data. According to Berkovich, there is frequent limiting of effective principal descriptions to three categories and a prevalence in the literature for terming effective leaders as transformational, transactional, or a combination of the two approaches. Berkovich also found that the construct of a universally preferred transactional, transformational, or combination leadership style is culturally narrow and may reflect a

dominant group preference for behaviors. Furthermore, Berkovich found that in some cases, a lack of principal involvement may impact school effectiveness as much as a transformational or transactional leader. Lastly, Berkovich posited that it may be necessary, instead, for principals to change their leadership style based on the situation or task, which is known as transactional.

Vinson's (2018) study findings, from 71 schools and 1,500 teachers in one school district, stated that participants were able to observe their leaders' actions. Participants in the study perceived evidence of what they termed transformational leadership actions. The aim of Vinson's study was to identify the roles of principals for establishing supportive conditions to ensure the effectiveness of PLCs and to assess the degree to which the principals' leadership styles was an influence on their functioning. These findings were also consistent with the research findings of Dhillon and Vaca (2018) that suggested the importance of the leader.

Dhillon and Vaca (2018) found that leadership of school improvement and change efforts vary and are dependent on the leader. Similarly, Kouzes and Posner's (2013) The Five Practices of Exemplary Leadership Framework also uses the term transformational leadership to describe how leaders can influence individual or organizational change. Their research suggested the ability to demonstrate five specific leadership actions that may serve to change people the beliefs and actions of people. These leadership actions included (a) model the way, (b) inspire a shared vision, (c) encourage the heart, (d) enable others to act, and (e) challenge the heart. Since the Five Practices of Exemplary Leadership Framework suggests that leadership may be impactful to both individuals and

organizations, consideration of the applicability of the unified framework to this research study is foundational. As in this study, PLC leaders sought to influence instructional change centered on mathematics within a geographic cluster of low performing schools.

Kouzes and Posner (2013) also found that leaders who can demonstrate these five specific transformational practices are considered by their followers and stakeholders to be more effective than those who do not demonstrate the five practices. Within schools, Kouzes and Posner's work may apply to school leaders and their PLCs. As such, the leader principals and follower teachers may perceive a principal's ability to demonstrate the five effective leadership practices to bring forth change in their organizations, the schools.

Vanblaere and Devos (2016) studied 48 Belgian principals and 495 veteran teachers. Their methodology echoed Kouzes and Posner's (2017), asking subordinates to provide perceptions of leadership practices. Within Vanblaere and Devos' study, veteran teachers' perceptions of their leaders' words and actions revealed that subordinates were able to identify the existence of transformational leadership behaviors. Importantly, as in this study, participants were asked to identify perceptions of leadership behaviors as well as identify perceptions of impact to the actions of participants such as the ability to demonstrate shared personal practice

An inherent significance of the five leadership behaviors may be that effective leaders do not leave to chance the inspiring of their followers to make changes. Kouzes and Posner (2017) found that effective leaders need to learn how to become a leader themselves first before leading others or hoping to inspire followers to join them in an

implementation of a reform or shared vision within their organizations. Principals may also seek feedback on their leadership behaviors to model reflective and growth practices.

Shen et al. (2016) found that a principal's leadership efforts can be evaluated accurately via self and teacher perception measures suggesting alignment with Kouzes and Posner's (2017) research. This was gathered by leader and subordinate feedback on the ability of leaders to inspire others to want to follow him or her. When subordinates, in this case teachers, perceived their principal to demonstrate effective instructional or transformational leadership, their perceptions of collective responsibility increased. This suggested the potential for increasing student achievement (Vanblaere & Devos, 2016). Furthermore, this research further holds promise for school reform efforts by concluding that leaders and subordinates can accurately perceive either instructional leadership or transformational leadership behaviors. Additionally, it is possible to gather perceptions about specific leader influences on teacher behaviors. These are often goals and processes connected with PLCs such as municipalization of practice, instructional dialog, and collaboration. In this study, interview queries were used to gauge PLC participants' perceptions of PLC experiences to include leadership behaviors.

Effective Leadership of Change and Shared and Supportive Leadership

Although principals may select teacher leaders as coleaders of reform, and previous research findings show promise for potential impact, there is variability of teacher leader performance in PLCs. Prior research study findings suggested differences exist between the teacher leaders' skills, amount of trust created between the leader, principal, and staff, and nature of PLC and non-PLC responsibilities assigned to them by

the principal or school district (Lawson et al., 2017; Scornavacco et al., 2016).

A PLC may be a possible context for a leader to shift teachers' mindsets and commitment to a culture of shared responsibility and accountability. Findings from research (Hallinger & Murphy, 2013; Leithwood et al., 2004; Sheng, Wolff, Kilmer, & Yager, 2017) suggested that the impact of an effective principal's leadership may be attributed to positive student outcomes and follows in strength just behind teacher impact. Researchers posited that an effective principal, together with shared leadership, may be able to develop teacher capacity, shape the culture, foster student growth, and improve teacher behaviors (Binkhorst et al., 2018; Gantt Sawyer, 2017; Young, Jean, & Mead, 2018).

Oftentimes, a principal will foster the development of teacher leaders to assist with the shared leadership function of developing self and others. In their study of teacher leader and principal dynamics, Scornavacco et al. (2016) found that bringing and sustaining changes to a culture takes more than one person and is challenging. Principals may seek help from within their schools by utilizing the talents of credible, trustworthy teacher leaders to provide job-embedded professional learning such as assisting teachers to make changes, modeling positive community habits, and ensuring participant fidelity to the positive community habits that have been established. With credible teacher leader partners, it is possible for partnership habits to develop, be sustained, and increase in number and type as staff capacity grows to positively influence instructional outcomes (Scornavacco et al., 2016). This finding was important because, when followers perceive the leader is credible, trustworthy, and honest, they believe the message and are inspired

to join in with the efforts of the leader (Kouzes & Posner, 2017).

Kouzes and Posner (2017) found that school leaders need to distribute and share leadership within an organization to influence change. In schools, an application of Kouzes and Posner's research suggested that principals may similarly need to share leadership so that teacher behavior is impacted and student achievement is influenced. In PLCs, a principal will often foster the development of teacher leaders to assist with this process by utilizing trustworthy, credible teachers to provide job-embedded professional development and bring forth change. However, just naming staff members as coleaders may not be enough to realize change.

Scornavacco et al. (2016) indicated that the effectiveness of enabling others to share in the leadership might impact a lack of definition or awareness of the shared leaders' roles and responsibilities. Scornavacco et al. found that teachers do not always perceive the teacher who has been selected or labeled as a coleader in the school as someone to whom they can go to for support. The teacher leaders reported perceptions of confusion and inconsistency. This indicated varying levels of support, noninstructional duty assignments, and diversity in expectations for delivering content and professional development (Scornavacco et al., 2016). This research suggested that when principals are enabling others to act, they also may need to attend to communicating the desired community habit of sharing the leadership within the PLC. This is done by individually working with the teacher leaders to set expectations, roles, and responsibilities to ensure fidelity to the expectation for distributed leadership.

By contrast, Kouzes and Posner (2017) found that leadership is not limited to

those with specific titles. The work of the informal school and classroom leaders within a PLC is essential. Researchers have indicated that teacher actions within a classroom have the greatest impact on student achievement (Hallinger & Murphy, 2013; Hattie, 2009; Leithwood et al., 2004), yet most teachers function as solo practitioners and do not collaborate or visit other teachers' classrooms. Principals and teacher leaders cannot do all the work that is needed to influence teachers' instructional practices and raise student achievement. Empowering informal leaders and teachers to assist their colleagues is a critical part of enabling others to act (Kouzes & Posner, 2017).

Effective Leadership of Change and Enabling Others to Action

Hord and Sommers (2008) stated that evidence of shared and supportive leadership is important within a PLC. Wenner and Campbell (2017) focused on teacher leaders in their multiyear study. Wenner and Campbell conducted a meta-analysis of 54 teacher leadership studies over a period of 10 years. Their findings revealed similarities to those of Scornavacco et al. (2016) about the variance found within PLCs with defining teacher leadership, the roles, and the nature of coleaders' work. A different finding, however, centered on self-efficacy levels. Specifically, their meta-analysis suggested that some teacher leaders struggle to develop trust with peers and administrators and the quality and amount of support varied from principals. In their study, Wenner and Campbell did not report any findings from the meta-analysis that were associated with student achievement. This may be attributed to the variance of expectations and realities of coleaders within schools and PLCs.

Huggins, Lesseig, and Rhodes (2017) supported the findings from Wenner and

Campbell (2017); however, Huggins et al. explored the person serving as coleader in a distributed leadership model. Huggins et al. expanded the notion of enabling others to act as they found that often principals are the ones who select coleaders. They studied who is selected and who might be considered a teacher leader by other teachers, specifically in a PLC. Instead of focusing on expected veteran teacher choices to share in the leadership, Huggins et al. focused on four teachers who were described as early career teachers; teachers new to the profession. The Huggins et al. study differed from the findings of Wenner and Campbell and Scornavacco et al. (2016), as it not only focused on a little studied group of teachers in shared leadership research, the "early career" teacher, but also on a PLC focused on algebraic argumentation in mathematics.

The findings of Wenner and Campbell (2017) and Scornavacco et al. (2016), however, were in alignment with the prior studies about the need for principal support for coleader success. When principal support occurred, the early career teachers perceived that they were functioning as teacher leaders in the school. The researchers posited that their findings illustrated the need for principals to consider diverse, in this case, early-career teachers when selecting leaders. A second finding observed that, possibly due to the newness of the early career teachers to the school culture, their presence and efforts positively disrupted some negative teacher networks and practices and found differences from analyses (Scornavacco et al., 2016; Wenner & Campbell, 2017).

In this study, principals selected diverse leaders to lead formal and informal professional learning with a vertical cluster PLC focused on mathematics. There was limited research on participants' perceptions of shared leaders who were selected by

school leaders in a vertical cluster PLC. However, there were some studies with hybrid leadership.

Others can be enabled to act with hybrid leadership throughout the different phases, such as the implementation, monitoring, and evaluation of the development of a PLC. Hybrid leadership explores a diversity of participants, perhaps a recursive model of leadership by having many teachers lead at different points of an intervention, suggesting a difference from a hierarchical mindset. In a small case study of three mathematics leaders and one principal, Higgins and Bonne (2011) found that collective responsibility was perceived when a hybrid model, as opposed to a traditional hierarchical model of leadership, was observed.

Participants described feelings of self-directed personal and organizational learning when the hybrid model was perceived to have been utilized. Another study focused on the special role of enabling content teachers to act within a school. Specifically, one elementary school was the focus of a study conducted over a period of 3 years. The definition of hybrid leadership was expanded to include department chairs, content leaders, and informal leaders (Hopkins et al., 2013). Specifically, there was the perception that communication patterns developed within this model that fostered specific dissemination of mathematics content and values. Attending to any conflict habits in the culture is essential as change occurs (Abery et al., 1999; Hopkins et al., 2013).

Abery et al. (1999) and Hopkins et al. (2013) found that communication within an organization can be described. Abery et al. and Hopkins et al. also found that some of the

leaders were brokers of information about mathematics teaching and learning and were sought out for professional learning while others were not. Abery et al. and Hopkins et al. also discovered that hybrid leadership, specifically through informal teacher communities within the school termed teacher networks, was associated with changing teacher beliefs and practices. Kouzes and Posner (2017) describe this as expanding the competence of everyone in an organization through the development of trusting, positive relationships. Within this study, perceptions of the existence of hybrid or informal leadership are unknown.

Commitment to Continuous Improvement, Shared Responsibility for Staff and Student Results Culture

Kouzes and Posner (2017) reported additional benefits to organizations when followers perceive belief and trust in the effective leader. This is demonstrated by perceptions of shared ownership, pride, attachment, and alignment to the vision and values of an organization. Because of the need for principals to make their schools the best they can be through engagement in continuous improvement, a principal's leadership of change processes may be illustrated through the lens of Kouzes and Posner's Five Practices of Exemplary Leadership Framework. Additionally, SRF is a theory model of interactive components that was applied over a 6-year collaborative effort between a university, school district, and one school to understand a change process for a school.

The SRF uniquely describes the interpersonal and communicative processes that may happen between people engaged in school reform. The SRF contains the following components: (a) vision, (b) abstraction ladder, (c) proposed practice (data and values), (d)

communication (processes and content), (e) personal and organizational learning, and (f)

roles and responsibilities. Abery et al. (1999) suggested that the model, although applied

to only one school, is appropriate to be considered in other settings in which change is

being implemented within a group. The model illustrates how the complex social

interactions between the people's own cultures, cultures of others, and organization may

influence the degree of commitment to a change and its subsequent outcomes.

In other words, the SRF indicates how individuals' biases, values, and actions

impact their ability to make meaning from the articulated values and visions of the

organization. As was the case of the collaborative effort within which the SRF was

created, Abery et al. (1999) stated that it is possible for persons to state support for a

proposed change. However, their actual actions and words do not necessarily support or

align with the intended change goals. Also, the SRF also implies that persons will

unconsciously align themselves to same minded people which may lead to unique

cultures and coalitions within organizations which are sometimes termed networks or

coalitions.

The SRF assumes that it is possible for organizations to develop new community

habits, cultures, or ways of acting and thinking. Because of this, it is important for leaders

to bring to the attention of an organization any conflict, issues, or concerns that are

impeding individual or organizational progress. The SRF suggests four specific

community habits that may be developed either in support or against a proposed change.

These habits include partnership, conflict, leadership, and planned change habits. Abery

et al. (1999) posited that to develop and sustain an organization's collective commitment

to a change or reform effort, community habits which support the change or reform must be developed and sustained. For example, when the interaction of roles, responsibilities, and communication occurs, a community habit for partnership may occur. This means that individuals and coalitions may be able to demonstrate shared accountability toward the change goals because effective communication has served to make expectations and agreements clear.

Although the collaborative effort data did not report "wholly successful" results for their specific reform, it did report some key findings that suggest an applicability of the SRF to other change efforts. Specifically, the researchers revealed some key "lessons learned" (Abery et al., 1999, p. 77). These lessons included:

- The value of reflection throughout a change process (planned change habit),

- The importance of intentional partnering with others to assist with leading change (partnership habit),

- The necessity to communicate well and to address conflict as it arises (conflict habit), and

- The critical need to shift from a sole leader to a shared leadership model, as appropriate, being responsive to individuals and the organization at the same time (leadership habit).

The SRF illustrates how fostering a commitment to continuous improvement is challenging because change requires individuals who are willing to lead and to work with others to learn and grow for the sake of themselves and the organization.

Commitment to Continuous Improvement and Encouraging the Heart

Kouzes and Posner (2017) found that leaders need to foster individual and collective empathy, hope, and responsibility to maximize the potential for success for change efforts. Leaders advocate for the practices that lead to various successes. Applying this to schools, principals may seek to change or deepen the level of care of all teachers to embrace collective responsibility and accountability for all staff and student successes. Within the United States, school district leaders are struggling with how to address the local and international achievement gap for mathematics (Kaufman et al., 2016). As mentioned in the introduction, many students are living in poverty in the United States, and data for many of these students reveal poor mathematics performance.

There is a sense of urgency to improve mathematics achievement for the large numbers of U.S. students who are behind on international mathematics measures such as the Program for International Student Assessment, and for whom their test scores reveal a lack of mathematics skills to adequately prepare them for college or careers in the competitive global marketplace of the 21st century (Ker, 2016; Lewis, 2017). To build momentum to end the achievement gap, school leaders may apply Kouzes and Posner's (2017) findings to encourage the heart leadership practices by praising and recognizing individual teaching excellence in their schools. This lifts those teachers who are making a positive difference for students who are underperforming within and across schools.

In a comparative study of United States and high performing Singaporean Grade 8 students from the 2011 Trends In International Mathematics and Science Study, data indicate that most of Singapore's Grade 8 students score at the advanced levels on Trends

In International Mathematics and Science Study, whereas most U.S. students score at the low and intermediate levels (Ker, 2016). Findings suggested that teacher confidence in teaching mathematics was a common factor that influenced mathematics achievement for both countries. These findings may suggest that leaders can encourage the heart of teachers by setting the conditions for desiring a collective community responsibility for improving instruction which may improve confidence in teaching.

Researchers reported that differences may be attributed to a likely contrast between the two countries' internal beliefs and value systems. An example provided was that mathematics performance in the United States was connected to school composition and resources whereas expectations and motivation were linked to Singaporean success (Ker, 2016). Findings suggested that within the United States there exists a need to improve students' mathematics performance (Ker, 2016). School leaders cannot just rely on others to raise achievement. Prior research by Kouzes and Posner (2010) indicated that developing the ability of a leader to encourage the heart of himself or herself, as well as with stakeholders, showed promise for making improvements. A leader's application of encouraging the heart in schools may include the demonstration of the belief that all students are capable learners as evidenced by a collective accountability culture for all students' achievement.

Part of accepting responsibility for student outcomes is knowing the learners' history of successes and challenges. From their study of nine veteran teachers, Robinson and Lewis (2017) reported results consistent with Shulman's (1986) findings that effective teachers need to demonstrate a knowledge of their students. Robinson and

Lewis suggested an additional expectation is necessary for urban teachers. They found a need for teachers of urban students explicitly to show students kindness, care, and respect in addition to demonstrating a collective responsibility for all students' growth. Lowenberg Ball et al. (2008) added to the definition of an effective teacher by specifying actions for teachers of 21st-century learners such as demonstrating flexible thinking to avoid applying only one kind of content knowledge.

Effective teachers work also to improve their craft. In a one school district case study, data from 30 teachers' self-reports indicated that modeling of effective teaching from peers, receiving specific and relevant feedback from a trusted observer, and demonstrating a desire to improve was integral in improving instruction (Donahue & Vogel, 2018). Although this study took place in a medium-sized, public school district in a Mid-Atlantic state in the United States, the findings were significant, because student demographics revealed many students who face challenges such as living in poverty were not being successful in mathematics. Additionally, student perceptions of teachers were not gathered in this study as part of participant perceptions.

Not all teachers express the desire to grow their instructional practices and some resist change or blame other teachers or students for poor performance. Leading instructional improvement, change, and fostering the development of new positive community habits may not be easy for principals. A barrier to effective communication, shared instructional practices, evidence of a growth mindset, and shared responsibility for all students' success may be teacher resistance to change. Gantt Sawyer (2017) conducted a study of mathematics teachers and found that the teachers' personally held beliefs and

prior experiences, including their upbringings, impacted their acceptance of change efforts as well as their perceptions of others' willingness to change.

Gantt Sawyer (2017) also found that some of the beliefs of teachers were not student centered. The study illuminated that, through professional development, encouraging the heart may occur. Consistent with Gantt Sawyer, Forrester's (2018) Australian multischool case study findings revealed changes in teacher behaviors because of the reflective practices provided within the specific context of examining student data. Forrester observed the shaping of positive community habits including increases in collective responsibility for all students' achievement, development of teachers' knowledge and capacity, active participation, and acknowledgment of reform coherence which may be reflective of the encourage the heart leadership practice.

By contrast, Morales-Chicas and Agger's (2017) analysis of the High School Longitudinal Study of 2009 reported a connection between the development of collective responsibility and student achievement within the data. Specifically, their results suggested that the absence of collective teacher responsibility for students' mathematics achievement was a predictor for males' final grades in repeated algebra courses. This suggested a need to develop a school-wide culture of shared responsibility, teacher agency, and positive climate for all students to possibly influence student learning.

Consistent with the promise of the development of community habits to influence learning organization participants, in more current research, Penner-Williams, Diaz, and Gonzales Worthen's (2017) conducted a mixed methods study that centered on a diverse student population, of English as a second language learner collaboration. The findings of

Penner-Williams et al. emphasized the idea that establishing a positive risk-taking culture held benefits for developing teachers' capacity for cultural responsiveness toward linguistically and culturally diverse students. This capacity development potential suggested that the development of community habits may show promise for a wide range of students.

It is imperative that all students have access to the best teachers possible, because teachers influence student achievement (Saultz et al., 2017). Three factors have been shown to increase the likelihood of students reaching the highest achievement outcomes: (a) teacher quality, (b) teacher capacity for developing positive teacher student relationships, and (c) professional development quality that the teacher receives (Hattie, 2009). Robinson and Lewis (2017) rejected the notion that there is a "universally" accepted agreement about what constitutes an effectual teacher because students have diverse needs (p. 124).

Robinson and Lewis (2017) argued that determining teacher effectiveness through the lens of student performance scores or by teacher degrees and certifications is a culturally destructive practice, suggesting that the development of a shared culture in which all participants accept responsibility for learning, reflection, and growth for adult and student learners is critical. What is known from the research is that it is possible to develop the capacity to encourage the heart, and that using professional development as the method of communication about desired new practices shows promise with some populations and contexts. In addition, the idea of expanding the notion of community to include participants from within and outside of the school was associated with possible

evidence of the encouraging the heart collaboration and positive perceptions about instruction and outcomes.

Commitment to Continuous Improvement and Challenge the Process

School leaders face challenges in schools and need to create a sense of urgency for successful changes to occur (Kouzes & Posner, 2010). In the United States, students, especially those receiving free or reduced meals, are not successful on standardized measures of mathematics achievement (Kotok, 2017; National Center for Educational Statistics, 2019; Organisation of Economic Co-operation and Development, 2014; U.S. Department of Education, 2015). The reauthorization of the Every Student Succeeds Act of 2015 has legislated the importance of all students having access to rigorous curriculum and quality teachers regardless of economic status (Saultz et al., 2017; U.S. Department of Education, 2015). When students, student groups, and schools do not make sufficient progress on local, state, or national standards, lead learners and teachers are needed to exercise leadership of instructional reforms. A PLC may be one structure to support the reform efforts (Binkhorst et al., 2018; Darling-Hammond et al., 2014; Forrester, 2018; Lomos et al., 2011).

Introducing new materials, pedagogy, or curricula often happens through professional development at the school site of this study. Principals play an important role in enacting such instructional changes with adults and may model the way, serving as the lead learner (Davis et al., 2005). Bringing changes to instruction is dependent upon helping teachers learn to keep doing what works for students and to change what is not adequate for student outcomes (Darling-Hammond et al., 2017).

Within the United States., school districts are struggling with how to address the local and international achievement gap for mathematics (Kaufman et al., 2016; Ker, 2016; Kotok, 2017). Current performance levels indicate a need to make changes and one option could be to use a PLC as the context for professional development. Research suggested that one way to influence both staff and student outcomes is to improve the quality of the teachers' classroom instruction through professional learning (Hord & Sommers, 2008). Hattie (2009) found that increasing the numbers of effective teachers through quality professional learning increases the likelihood of higher achievement results for students.

Theories of change suggest that for principals to enact any reform with teachers, such as a mathematics improvement initiative, principals need to model the way. This is done by serving as the lead learner of the PLC and demonstrating an awareness of adult learning theory (Mirci & Hensley, 2010). Effective principals explicitly can recognize and understand reform efforts, identifiable structures, and the involvement of diverse processes and people in learning and reflection tasks throughout change efforts (Mirci & Hensley, 2010).

Knowles, Holton, and Swanson (2015) reported that principals need to apply adult learning theory when they want to maximize the learning of their adult staff members. This is done by fostering essential actions during the learning, helping adults to see relevance, activating prior knowledge, and providing connections to some immediate application of their learnings to their work. Mirci and Hensley (2010) stated that principals who lead change with adults need to be mindful of their own beliefs, values,

and worldviews. These factors impact principals' ability to transform change and lead innovations. Mirci and Hensley posited that the inability of a principal to model the way as they lead their communities through change by applying reflective processes may suggest a disconnect in their thinking between reflective practices and the associations of change to the complex persons involved in the change, this includes the principals themselves. Because school teams and PLCs often are the contexts for change, principals need to work with the people involved to assist them in changing their thinking, as well as making changes to their practices (Mirci & Hensley, 2010).

Consequently, assessing the readiness of participants for change, and differentiating supports once the reform efforts have started is an essential leadership action (Mayne, 2017). Mayne's (2017) research suggested that change leaders benefit from being able to recognize and apply a meaningful theory of change to their reform efforts. Mayne posited that applying Davies' criteria for change may be helpful. This may include examining processes for considering the plausibility of outcomes, processes, and the assumptions underlying the change structures.

Just as principals need to evaluate the readiness of teachers within a change effort, they also need to be aware that PLCs are not static and should assess the stages of the learning organization's readiness for reform and respond accordingly (Jones & Thessin, 2017). In other words, it is not enough for principals merely to attend to the needs of the adults within a change model, they must attend to the organizational needs of learning organizations as well. Effective principals are forward thinkers (Kouzes & Posner, 2017). The focus of Jones and Thessin's (2017) research was to determine whether schools were

actual learning organizations comprised of PLCs. Jones and Thessin's findings acknowledged the fluidity of change processes within PLC development, including the evidence to suggest that principals themselves must adapt, shift, and respond both to their teachers and the organization during reform efforts. Principals who attend to the leadership of change evaluate staff to determine whether they are committed to the planned changes and may see more significant growth. The SRF terms this process as developing a community habit of leadership and leadership of planned change (Abery et al., 1999).

Jones and Thessin (2017) found that principals who can apply a change model to their schools may have the opportunity to recognize different phases of growth in persons as well as in the organization. In their singular high school case study, participants included one principal, seven teachers, and PLC leaders representing 37 different PLCs within the school. Document analyses, interviews, and surveys were used to have participants describe their experiences going through change phases in a PLC. Subsequently, Jones and Thessin used a three-part model of change that guided each PLC assessment of change readiness or stage, including creating the content for change, implementing the change, and sustaining the culture for change. Within each of the three stages corresponding leadership behaviors were identified such as observation of (a) the principal as a change agent, (b) the principal who supports a learning culture by leading learning behaviors, and (c) the principal who insists that student work and data guide decisions throughout the change process. The findings determined that collective responsibility is likely to occur during Phase 3 of change and sustainability. Researchers

highlighted the essential role of the principal to lead, monitor, and sustain change efforts of persons and their schools which is one role of principals engaged with PLCs

A third anchor for continuous improvement can be gleaned from a summary of the research by Hord and Sommers (2008) which stated that PLCs are an innovative way to support teachers and principals with fostering the development of positive community habits such as collective responsibility, shared leadership, and municipalization of practice. Inherent in the PLCs and the SRF is the reality that PLCs are comprised of diverse people with differing perspectives, instructional styles, and beliefs about students.

The SRF describes the complex nature of leading change within a reform environment. The model posits that the development of positive community habits such as collective responsibility, accountability, individual, and group dynamics, and communication play an essential part in a reform or intervention (Abery et al., 1999). One significant job of a school principal is to lead and manage individuals and groups within a school through reform and change processes (Higgins & Bonne, 2011; Ning et al., 2015). One choice a school leader may make is to form a PLC as the context for continuous improvement.

Commitment to Continuous Improvement and Enable Others to Action Across Schools

Yet another researcher explored the idea of enabling others to act by expanding the learning organization beyond a single school. I explored the consideration of the community context itself along with a geographically close cluster PLC concept to the notion of how shared personal practice might be implemented. Anderson's (2014) case

study was bounded by three urban high schools and found specific barriers to enabling others to act. These barriers were community challenges, school district policies, and teacher retention that served to hinder the effectiveness of a PLC. Anderson advocated for the consideration of implementation of both the support of grouping schools within a community together in a geographic cluster and the utilization of a scientific approach to change within the PLC efforts. Anderson hoped this would increase the likelihood of enabling others to act through improving the communication about systematic processes and positive results for a larger number of participants. Other researchers studied scientific approaches to enable researchers to act in order to curb variance and increase PLC outcomes.

Bryk (2015) suggested that a promising practice for ending variance in teacher, student, and school performance is the development of a networked improvement community. The study advocated using scientific methods within it to foster teachers' growth and end the variance associated with teacher isolation. Similarly, Harris (2018) studied the use of a specific scientific tool, Plan-Do-Study-Act, to assist with ending teacher variation of data analysis. In the study of eight elementary and middle school teachers, perceptions of teacher participants' experiences with using the scientific model were gathered. Harris identified a gap in the literature finding that databased decision-making is promoted as a collaborative activity for teachers. However, there is little known about how the Plan-Do-Study-Act model is applied to the process.

Although PLCs show benefits for teacher collaboration, variance exists for how others are enabled to act to influence change. These studies supported the theme that

enabling others to act is a leadership practice that is fostered and perhaps is replicated and repeated throughout some schools and PLCs through distributing leadership in novel and hybrid ways. In this study, a PLC focused on mathematics was studied and perceptions of participants' experiences within the PLC was gathered for analysis and study findings.

Even with research-based evidence of variance in practice within and among PLCs, principals may intentionally choose to create PLCs in their schools to confront the status quo and to challenge the process and culture that exists in their schools. As prior researchers have demonstrated, building a collective responsibility culture for results is an indicator that a PLC is working because such a culture may indicate the fostering of individual and collective commitment is an effort (Abery et al., 1999). Researchers have shown that specific PLC benefits, including reducing teacher isolation and privatization of practice, may occur and may provide the structure to facilitate loyalty and commitment to efforts and interventions (Cherkowski & Schnellert, 2017; Hord & Sommers, 2008; Vescio et al., 2008).

According to the research by Hord and Sommers (2008), leadership that fosters supportive conditions, such as those described above for change, is just one of the five dimensions that describe effective PLCs. The other four dimensions that describe effective PLCs are (a) shared beliefs, values, and vision; (b) collective learning and its application; (c) shared personal practice; and (d) shared and supportive leadership. A note of caution is that although PLCs can be defined using the five dimensions in practice, all PLCs do not function in the same way. Furthermore, this may suggest the need for a principal to challenge the process and confront variance in practice, inequities, and

observed lack of positive community habits. Although a school, content, or vertical team is labeled as a PLC, it does not mean the PLC participants function as one.

PLC participants, by virtue of membership in a PLC, do not necessarily understand the purpose, goals, or activities of the PLC. Subsequently, participants can enact practices with uneven fidelity and can demonstrate variance of implementation and alignment, impacting PLC effectiveness. The findings of one study described such variance by reporting the differences in perceptions about the PLC's purpose, alignment to the principal's vision, attitudes about the PLC's effectiveness, use of student work, and willingness to demonstrate a shared responsibility for student results (Voelkel & Chrispeels, 2017). Campbell and Stohl Lee's (2017) work found similar variances, reporting results that suggested there were differences between teachers' willingness to discuss, share, and use student work samples in their PLCs. This 3-year mathematics standards implementation study raised questions about the possible reasons for the apparent lack of a collective responsibility or accountability culture within the PLCs.

Koşar et al. (2016) delineated many of the differences among their practices and beliefs, specifically as evidenced by the suggested time and talents that may be needed to build individual and collective fidelity to the purpose of a PLC. Leadership that fosters supportive conditions for collective learning, application of learning, and shared personal practice are additional indicators of an effective PLC (Hord & Sommers, 2008; Redding, Cannata, & Taylor Haynes, 2017). Challenging the current status quo of privatization of practice is a skill that leaders may demonstrate to hopefully influence changes in teacher practices and student outcomes. Providing teachers with time to collaborate may be an

effective way to bring forth positive change to instruction (Budgen, 2017; Christiansen & Robey, 2015). Budgen (2017) conducted action research on two cluster schools in Australia and suggested that teachers perceive value in learning from each other to improve teaching and learning processes.

Further, the researchers described evidence of the teachers' focus on instruction and student needs through PLC professional learning and indicated perceptions of possibly influencing student outcomes. Additional researchers found that PLCs that implemented professional learning was impactful for teachers and students (Forrester, 2018; Metz et al., 2016). Metz et al. (2016) revealed a connection to professional learning and mathematics pedagogy. In this 5-year study, findings showed that teachers' perceptions of the potential for student achievement increased when teachers reported applying changes from professional learning centered on pedagogy, specifically moving from a defined set of teacher centered instructional moves to demonstrating defined student-centered pedagogy described as active learning, engagement in structured variation tasks, and demonstration of Standards for Mathematical Practice. The researchers sought to understand the relationship between student achievement, professional learning, teachers' mathematics knowledge, and the promise of student outcomes similar to this study which centered on Standards 3 and 4 of the Standards for Mathematical Practice.

McGee et al. (2013) prior research findings also focused on outcomes from professional learning. In their 3-year study of elementary mathematics standards implementation, McGee et al. included 22 participants. The findings found influences on

student outcomes from teachers' knowledge and from their beliefs about instructional practices, pedagogy, and curriculum. They concluded that evaluating the results was an essential element in change efforts.

Principals may need to challenge the process by enlisting teachers' support to confront existing norms for collaborative planning expectations. Additional research supported this idea because researchers found that not all teachers are willing to take the risk of sharing student work or test results although they may provide information about the nature of instruction or student learning that occurred (Campbell & Stohl Lee, 2017; Voelkel & Chrispeels, 2017).Teachers reported working in teams and independently to examine programmatic, demographic, and other data for instructional decision making. Campbell and Stohl Lee's (2017) study of a large urban school district concluded that student-level data sharing is not a typical practice for teachers working in collaborative teams.

Conversely, Lomos et al. (2011) considered whether teachers could commit to sharing student work. They found that teacher behaviors in professional learning within PLCs were associated with student achievement and with teacher perceptions of working in an effective school. An effective school was defined in the study as a strong school. Researchers defined a strong school as one that they perceived demonstrated specific teacher actions such as focusing on student work, demonstrating thoughtful and collaborative dialogue, and showing evidence of fidelity to the school vision. The aforementioned actions influenced their self-efficacy, beliefs about the quality of their school, and student outcomes. These studies suggested that challenging the process for

collaboration may influence personal beliefs about students and learning. It may also influence teachers' ability to see the need for change.

McNeill, Butt, and Armstrong (2016) purported research involving an extension of the school mathematics PLC in order to widen the likelihood of shared personal practice. McNeill et al. included participants from outside of a single school including cross school and community participants. Perceptions indicated positive feelings, although no increases in students' mathematics achievement were reported. Other researchers outside of the mathematics field also have studied the impact of PLCs that stretch beyond a single school site.

In a literacy study, Ciampa and Gallagher (2016) investigated the perceptions of a convenience sample of 11 teachers, five administrators, and four literacy coaches across three elementary and two secondary schools in Canada. From their study of the influence of vertical team teaching on teacher's individual and shared literacy instructional practices, Ciampa and Gallagher found that professional learning was beneficial to teachers. Study participants' perceptions included the existence of a common language centered on literacy instruction within a positive, collective risk-taking culture in which barriers to effective literacy instruction were addressed. Participants reported valuing specific strategies such as peer coaching and mentoring, elicitation of teachers' perspectives in professional learning, and engagement in reflective practices influenced their behaviors. This study illustrated the importance of communication within a reform effort applied to a subject other than mathematics and, in this case, found that the communication was able to occur across schools suggesting a second possible benefit.

This benefit is that vertical collaboration shows promise for professional learning.

The collaboration also supported collective accountability and a climate for addressing effective instruction of individuals and the collective group. This is relevant to this study as peer coaching and mentoring were provided, and a goal of this study was to improve the instruction of each teacher as well as the collective cluster-wide group. This study sought to investigate the experiences of participants in a vertical mathematics PLC. It was unknown if participants would perceive evidence of a collective accountability culture.

An accountability culture may include the assumption by PLC leaders that teachers can be taught to grow as instructors and improve their practices when provided with quality, professional learning. Challenging the process may mean changing the culture of how teachers are expected to learn and grow. Reid and Reid (2017) found that teachers can be taught to improve their mathematics literacy skills. Reid and Reid studied preservice teachers and found that the teachers' mathematics content knowledge can increase. However, pairing that knowledge with real experience in a practicum setting to apply that knowledge is necessary. Preservice teachers reported that the safe environment of having effective mathematics pedagogy modeled, and then practicing in the safe preservice setting, gave them the confidence to apply what they had learned with students. Although Reid and Reid did not study professional teachers, their findings may apply to school PLCs.

Darling-Hammond et al. (2017) reported findings from a meta-analysis of 30 years of studies centered on effective professional learning, student results, and

instructional practices. The researchers defined effective professional development as "structured professional learning that results in changes to teacher practices and improvement in student learning outcomes" (Darling-Hammond et al., 2017, p. 1). Perhaps an unintended or unrealized consequence, but a significant finding, is the connection between teacher practice and the improvement to student learning. The improved teacher practices are reflected in the following five professional development themes in the majority of studies. The themes that were found include that it (a) is content based; (b) takes into account adult learning needs; (c) is sustained over time at the job site; (d) uses best practices for pedagogy for adults to include the use of mentoring, peer coaching, and reflection strategies; and (e) is supported by the school and school district leadership and research.

In addition, Jacob, Hill, and Corey (2017) reported that the professional learning provided by job-embedded coaches contributed to an increase in the teachers' mathematics content knowledge. However, no improvement to student learning was reported. Courtney (2018) reported a different outcome. Courtney studied 15 teachers from two middle schools and three elementary schools in a mixed methods study in which the researcher was an embedded participant. Surveys, observation protocols, teacher pre- and posttest mathematics content knowledge, accountability to the practices, and student assessment data were triangulated to investigate the benefits of job-embedded professional learning by mathematics coaches to changes in teacher practices or influences to the rigor of instruction. Courtney's findings showed a positive relationship between an increase of teacher knowledge from the professional learning and the rigor of

mathematics instruction provided to students.

Teachers reported increased self-efficacy for their instruction and perceived improved demonstration of the Standards of Mathematics Practices by students. Teachers in this study perceived that the professional learning provided by the mathematics coaches was effective. Teachers cited a collegial and collaborative climate, supportive follow-up for learning and practicing standards of mathematics practice, and modeling of student-centered instruction as being beneficial. Additionally, teachers reported specific instructional practices that were changed as a result of the job-embedded professional development. One example of a learned instructional practice was defined by Thompson (2009). This instructional practice is a didactic triad. This tool, described as a combination of three pedagogical moves, includes (a) unpacking the mathematics standards to the level of what kids must know and do, (b) designing aligned lesson plans to maximize learning, and (c) providing appropriate materials for the rigorous instruction provided to be of benefit to improving teacher instruction.

Part of implementation of challenging the process behaviors is communicating the desired goal and ensuring that teachers can align and commit their beliefs and actions to the goal. Principals may choose a PLC structure to develop the shared capacity of their teachers in order to develop shared beliefs, vision, and values within their schools (Hord & Sommers, 2008). In a study involving a change in beliefs about the nature of mathematics pedagogy, Polly et al. (2013) studied 35 teachers and 494 students in mathematics classrooms and found a significant correlation between teacher beliefs and instructional practices.

According to Polly et al. (2013), two categories of teaching practices were defined. These teaching practices included instruction that was teacher centered and student centered. Small gains were observed in mathematics achievement as measured by classroom-based assessment when teachers used student-centered pedagogy. This pedagogy was defined as discovery and connectedness methods. Nevertheless, the researchers found that teacher beliefs about mathematics content were not associated with their pedagogy. It is unclear whether the content knowledge of a teacher increases with improvement in pedagogy, nor does it imply that these changes impact and influence student achievement. It is incumbent upon the principal to ensure instructional changes lead to improved student achievement, a component of the fifth dimension of a PLC.

In professional learning, providing content to teachers in "traditional ways" may not be enough, and challenging the process by providing specific learning centered on the standards of mathematical process may be needed to foster community habits in pedagogical and communication practices. According to Lowenberg Ball et al. (2008), the mathematics proficiency of a teacher does not necessarily translate into student learning in the classroom. Changes are needed to influence the improvement of mathematics instruction for students' benefit. Challenging the process through innovative or new professional development in PLCs may be an important choice to focus on the specific mathematics pedagogy that makes a difference in the classroom.

Lowenberg Ball et al. (2008) suggested implementing professional learning that develops not only teachers' mathematical content knowledge but provides the pedagogy and communication skills necessary to apply that content knowledge in classrooms. Since

they showed that the prior knowledge of a teacher in mathematics is not enough to help all students succeed in mathematics, a principal may foster a positive community habit of everyone in a school learning and growing through the use of a PLC as the vehicle for change and growth. Since it cannot be assumed that teachers will have the content or specialized mathematics knowledge necessary when they enter a school, a climate of being willing to learn as a teaching professional may be established to meet the needs of students. Lowenberg Ball et al. found that teachers must know their content well enough to explain it to students, model effective pedagogy and be able to respond to students' questions through knowledge of vertical learning progressions and big picture mathematics concepts.

Similarly, O'Connor and Michaels (2019), in an in vivo study of two sixth-grade classes, found students' academic scores improved in one class in which the teachers structured academic discourse but not in the other class that was without academic discourse. Teachers' academic talk influenced student outcomes. Another study was conducted by O'Connor, Michaels, Chapin, and Harbaugh (2017) over a period of 1 year in 2015. This study was an in vivo study wherein students in Grades 4 through 7 in a high poverty Northeastern school district found that productive academic talk used by teachers to promote student discourse contributed to students' demonstration of mathematics reasoning and increased students' mathematical learning. The academic teacher talks influenced student outcomes. In summary, challenging the existing professional development content, delivery models, and specificity of pedagogy in mathematics may be an effective way to influence student learning broadly defined as an academic

discourse within the context of the classroom.

Commitment to Continuous Improvement and Model the Way

According to Stein et al. (2016), it is the job of a principal to develop a learning organization. Focusing attention and efforts on the process of providing professional development may not be enough to bring forth change. Stein et al. found that a principal's leadership style and the ability to self-reflect on his or her impact on the school culture are two necessary leadership practices needed to make changes happen. Stein et al. reported that the ability of a principal to lead, learn, and reflect by example might impact the level to which teachers feel confident about their instructional efficacy. This suggests that the development of positive community habits may impact perceptions about instructional delivery and how it impacts students. Other variables that may impact a principal's effort to build community habits is the impact of time, leadership, and school district policies (Coburn et al., 2013).

Coburn et al. (2013) specified the outcome of these collective influences over a span of 3 years. Coburn et al. reported that over a period of 2 years, collaborative processes replaced noncollaborative routines at the schools. Furthermore, Coburn et al. described the effect of time and leadership to shift teachers' networks from grade or content team connections to those characterized by professional relationships across the school and the intentional seeking out of experts in the building for assistance. The findings of Coburn et al. suggested that considering the inclusion and impact of community habit builders from outside of the school shows promise for teacher development, as teachers acknowledged the perceived benefits from working within and

across their assigned team or grade level. This suggests that there is some benefit to vertical teaming and learning. It was unknown if fostering the valuing of all PLC participants by modeling the way, was a perceived experience in this study which was centered on a vertical cluster PLC.

Consequently, assessing the readiness of participants for change and differentiating supports once the reform efforts have started is an essential leadership action (Mayne, 2017). In Mayne's (2017) research, change leaders were identified as benefiting from being able to recognize and apply a meaningful theory of change to their reform efforts. Setting an example by using a research-based model to frame a change or intervention may be helpful, because many include processes for examining the plausibility of innovations as well as an examination of underlying structures and beliefs about the change itself. Mayne's research also added that it is beneficial for principals to recognize that change development or resistance can happen in phases, which may be useful knowledge for principals who are trying to model the way by supporting their teachers during reform efforts such as those described by Jones and Thessin (2017).

It may not be enough for principals merely to attend to the needs of the adults within a change model because they need to attend to organizational needs as well. In their study to determine whether one school could be described as a learning organization comprised of 37 PLCs, Jones and Thessin (2017) illustrated that besides acknowledging the fluidity of change processes within PLC development, principals must model the way and be flexible. Adapting, shifting, and responding to both teachers and the organization during reform efforts may be necessary. Jones and Thessin also suggested that principals

need to simultaneously assess the readiness of the individual and the ever-changing PLC and respond appropriately. Principals who are in tune with the needs of both their adults and their learning organization may see more significant growth within the change process when they can assess progress or resistance toward the change or reform effort goal. According to Jones and Thessin, it is possible for principals to determine within which phase a collective commitment to a change occurs. It was suggested that it may be important for principals to apply change models to inform their actions while leading change.

In another research study supporting this same foundational role of the principal in establishing supportive conditions for change, Vinson's (2018) study of 71 schools and 1,500 teachers found that participants perceived a specific leadership style, transformational leadership, as supportive of change at their schools. Vinson referenced three specific actions they perceived as helpful such as (a) building program coherence to the PLC, (b) providing support and resources, and (c) establishing trusting relationships. Vinson's study and the prior research by Mirci and Hensley (2010) supported Jones and Thessin's (2017) findings in that principals themselves must model, adapt, and shift their leadership actions to respond to their teachers and organization within change initiatives.

These findings also are consistent with the research of Dhillon and Vaca (2018) that suggested that leadership of school improvement and change efforts varies and is dependent on the leader. Dhillon and Vaca's study involved seven schools, comprised of content and grade-level teams of mathematics teachers across the elementary and middle schools with seven different principals. It is unknown how the participants perceived the

leaders' ability to model the way and participant perceptions were gathered to learn of their experiences within the PLC focused on mathematics.

Effective Mathematics Instruction and Standards of Mathematical Practices 3 and 4

In this study, the cluster leadership sought to explore the possibility of improving both student and teacher growth by focusing on leadership efforts and professional development provided within a vertical PLC. Leaders planned, monitored, and evaluated the transfer of new learnings within the PLC - mathematics content, modeling of powerful mathematics lessons, manipulative use, and pedagogy. However, participants also learned to use a three-part tool to predict students' prior knowledge and anticipate possible mathematics responses with the goal of engaging students in the learning process. The three-part model, which was adapted by one of the mathematics resource teachers from a National Council for Teachers of Mathematics (NCTM) source, represented the expected practice for daily mathematics instruction.

First, teachers collaborated and then independently completed the three-part tool and used this as a steppingstone to help them understand student strengths and errors in mathematics, foster academic talk with students, and model standards of mathematics practice. The tool had a specific focus, to develop teachers' use of structured academic talk through questioning and student-led conversations. According to Martin et al. (2018), teachers perceived the most significant value in mathematics professional development when it was designed to give them a voice in instructional decision making in identified need areas.

Some teachers may need to change their attitudes, perceptions, and pedagogy to

influence students' mathematics outcomes positively. According to Cannata, Redding, and Rubin (2016), developing teachers' ability to use specific student level classroom data for evidence of student growth is needed. It is believed that teachers struggle not only to observe, monitor, and respond to demonstrations of students' mathematical thinking in the classroom, but they also have difficulty with fostering critical student-to-student-academic talk about mathematics within lessons (Marsh, 2012; NCTM, 2010; O'Connor & Michaels, 2019).

Fostering the expectation for academic communication in the classroom was part of the design of professional learning in this study. Specifically, the application of two Standards for Mathematical Practice was taught and modeled by teacher leaders with the goal of implementation of the pedagogy and practices to the classroom. Specifically, leaders taught Teacher Practices 3 and 4 with the guidance that Teacher Practice 4 is a condition for fostering Teacher Practice 3 in a mathematics classroom. Teacher Practice 4 can be described as the actionable teacher academic talk that is used to model and facilitate productive academic conversations among students about how students are using and connecting mathematical representations to real-world situations in mathematics classes, which is termed Teacher Practice 3 (NCTM, 2010). Some recent studies have looked at academic talk in mathematics classrooms.

According to O'Connor and Michaels (2019), in an in vivo study of two sixth-grade classes, the academic scores of students were found improved in one class in which teachers structured academic discourse and not in the other class without student talk. In another study by O'Connor et al. (2017), a yearlong in vivo study was conducted.

Participants included students in Grades 4 through 7 in a high poverty Northeastern

school district. It was found that productive academic talk used by teachers to promote

student discourse contributed to students' demonstration of mathematics reasoning and

increased students' mathematical learning. There is a gap in the research, and it cannot be

determined if teachers can learn academic talk and how to apply it to the classrooms with

students as a result of having professional learning on academic talk within a vertical

PLC focused on mathematics.

Summary and Conclusions

The review of literature in Chapter 2 included research centered on professional

learning communities, leadership of school improvement behaviors, and complex

communication and cultural factors that intersect when diverse people work together in a

reform effort. The unified framework which grounded this study suggested that the

development of community habits may occur in collective settings such as leadership,

partnership, conflict, and communal responsibility. An individual's understanding of,

commitment to, and faithful implementation and monitoring of the reform effort is

referred to as their communal responsibility. The principal, as the lead learner, is held

accountable for establishing this shared responsibility culture and for cultivating

commitment from all staff to lead an effective reform (Gantt Sawyer, 2017).

A principal's role is multifaceted and according to Gantt Sawyer's (2017) meta-

analysis of leadership research, a principal is required to support all staff throughout

change initiatives in addition to resetting academic goals as needed. The role of a

principal may be to demonstrate transformational leadership behaviors, as described by

Kouzes and Posner (2017), which may impact student and staff outcomes. Specifically, within a vertical cluster, a principal may need to develop the capacity for support, share awareness of responsibility, and distribute leadership (Chikoko, 2007).

In a multisite case study of five primary schools in South Africa, Chikoko (2007) studied cluster participants' perceptions of threats to the cluster's effectiveness. By interviewing participants, Chikoko found that the cluster model did not serve the participants well in terms of one of their stated objectives. That objective was to build a sustained, continuous improvement culture. Barriers to the success of the cluster included a teacher improvement focus and no focus on the development of the leaders, a waning of resources and professional development efforts, and a demonstrated resistance to change. It was found that the "presence of a cluster structure" was not enough to generate change (Chikoko, 2007, p.56). An identified gap in the literature was that of an understanding of participants' experiences within a vertical, geographically close PLC focused on mathematics.

Another recurring theme was planning purposeful opportunities for staff and student growth using the structure of a PLC. It was well accepted that PLCs can provide avenues to bring forth positive change (Budgen, 2017; Christiansen & Robey, 2015); however, Campbell and Stohl Lee (2017) found that little was known about how participation in PLCs supported growth in schools. PLCs could be appropriate contexts for meaningful professional development in which time to learn and share instructional practices to meet students' needs were intentionally planned (Hord & Sommers, 2008).

Voelkel and Chrispeels (2017) found that differences in perceptions about the

effectiveness of school teams existed within and across schools. Voelkel and Chrispeels found differences with the PLC's purpose, alignment to the principal's vision, attitude, sharing of lessons, use of student work to guide practice, and willingness to demonstrate a shared responsibility for student results. In professional, job-embedded contexts, researchers suggested that supporting professional development was essential, but evaluating the effectiveness and efficiency of efforts and results was also important (McGee et al., 2013).

The last theme to emerge was the focus on specific professional development for mathematics. Reid and Reid (2017) found that teachers could be taught to improve their mathematics literacy skills. Reid and Reid studied preservice teachers and found that preservice teachers' mathematics content knowledge could increase. However, pairing that knowledge with real experience in a practicum setting to apply that knowledge was necessary. The preservice teachers reported that the safe environment of having effective mathematics pedagogy modeled and then practiced in the safe, preservice setting gave them the confidence to apply what they learned with students.

Metz et al. (2016) conducted a 5-year study to understand the relationship between student achievement, professional learning, and teachers' mathematics knowledge. Metz et al. found that the potential for student achievement increases was perceived when teachers moved from exercising solely teacher-centered instruction to varied pedagogy in which students were active learners, engaged in structured variation tasks, and demonstrated Standards for Mathematical Practice. The context for the change efforts was a critical decision.

Prior researchers suggested that teachers seldom discuss mathematics content, student work, or achievement results within the context of PLCs (Campbell & Stohl Lee, 2017; Voelkel & Chrispeels, 2017). Cannata et al. (2016) studied a large urban school district and found that teachers reported working in teams and individually to examine data for instructional decision making. Variance existed as to the degree student data, such as work samples, outputs, demographics, program implementation, and perceptions were utilized. Cannata et al. cited barriers to teachers' use of data that may inform school-wide improvement.

Marsh (2012) conducted a meta-analysis of school improvement reforms and found variance in the data that were used by educators to inform the success of their interventions. Marsh found that although schools and school districts spend considerable resources supporting the use of data in PLCs, there is a need to create a safe climate for educators to examine and analyze quantitative classroom student level data that reflects student and organizational growth rather than spend the majority of time analyzing qualitative data about their knowledge and skills. In their mixed methods Dutch study, researchers found that in 130 schools, 130 teachers and 3,000 students investigated the relationship between mathematics departments which they defined as PLCs and student achievement. In their study, they focused on the construct of department because most secondary schools organize teacher collaboration and instruction in that way (Lomos et al., 2011). This was determined by using questionnaires, linear modeling, and student Trends in International Mathematics and Science Study results. Findings included some positive, significant results for the influence of mathematics PLCs on student

achievement.

Kruse, Louis, and Bryk (1995) determined whether some mathematics departments were PLCs. In doing so, Kruse et al. differentiated the extent to which the departments met the definition that the researchers applied in four different ways. The four ways included terming departments as professional community schools ($n = 40$ schools), deprivatization of practice schools ($n = 13$ schools), collaborative activity schools ($n = 33$ schools), and nonprofessional community schools ($n = 31$ schools). This definition was utilized to examine the degree to which departments demonstrated the "five interconnected variables of a professional learning community" and investigated whether schools termed as professional community schools were associated with student achievement as measured by Trends in International Mathematics and Science Study data (Kruse et al., 1995, p. 723).

Lomos et al. (2011) found that teacher actions within mathematics departments were associated with their construct of successful school and student achievement. These actions could be described as (a) reflective in their dialogue, (b) collaborative, (c) committed to a shared vision, and (d) focused on student work and success. Another researcher found that there was not a relationship between elementary student achievement and teacher beliefs or instructional practices (Polly et al., 2013). In summary, mixed findings were found regarding the effectiveness of leaders within a PLC to bring forth change. There was also limited research about the effectiveness of vertical communication and community habits within a vertical PLC focused on mathematics.

Chapter 2 was a review of the literature exploring the topics for this research

study. Chapter 3 will include a description of the research study methodology that aims to gather the perceptions and experiences of PLC participants within a vertical PLC that was focused on mathematics. Understanding their perceptions about their own and others' growth, leadership actions, and effectiveness of the vertical structure will extend the current knowledge related to PLCs, vertical PLCs, and leadership.

Chapter 3: Research Method

The purposes of this case study were to understand vertical PLC participants' perceptions of (a) leaders' efforts to improve their students' mathematics achievement, (b) educator growth or behaviors while engaged in improvement efforts with the PLC, and (c) the effectiveness of the vertical PLC context. In this study, I focused on experiences within a newer, vertical model of PLC. This study addressed whether this vertical type of PLC might be one to recommend as a leadership and school improvement model for mathematics across the school district.

Chapter 3 includes six sections: (a) the research design and rationale; (b) the role of the researcher; (c) methodology, including participant selection, instrumentation, and procedures for recruitment, participation, and data collection; and a data analysis plan; (d) trustworthiness; (e) ethical procedures; and (f) a summary of the chapter. This study was centered on the unified framework, which served as a foundation to understand (a) the complex social interactions that occur as individuals work with others, (b) effective leadership behaviors, and (c) the structure of a vertical PLC as a context for growth and change. Within this qualitative case study, I individually interviewed volunteer participants using a three-item instrument with probes (see Appendix A) to gain insight into their perceptions of the experiences in the PLC, including leadership of the PLC and the usefulness of the vertical structure. This instrument was also used to determine any changes they believed occurred within the PLC for students, teachers, or administrators.

Research Design and Rationale

The following research questions guided this case study:

Research Question 1: What are the beliefs of school leaders and PLC participants on the leadership practices demonstrated by the leaders in the vertical PLC?

Query 1: Please describe your perceptions of any demonstrated leadership in the vertical PLC focused on mathematics.

Research Question 2: How do PLC participants describe their own or others' growth or behaviors while engaged in the school improvement efforts for mathematics within the PLC?

Query 2: Please describe your perceptions of the experiences you had in the vertical PLC focused on mathematics.

Research Question 3: How do PLC participants perceive the usefulness or effectiveness of the vertical PLC focused on mathematics improvement?

Query 3: Please describe the usefulness of the vertical structure of the PLC.

Qualitative research is appropriate for social sciences studies when three criteria are met: (a) a research topic has a broad scope, (b) a localized context is utilized to study a phenomenon, and (c) multiple sources of data are explored (Yin, 2012). Although case studies can be qualitative or quantitative, I employed a qualitative case study design in this study. Because case studies permit the incorporation of multiple perspectives, data sources, and direct participant viewpoints, this approach differs from other research methodologies (Yin, 2012) and was the one I selected for this study. Case studies are defined as "empirical inquiries that investigate a current phenomenon in which the boundaries between phenomenon and context are not clear" (Yin, 2012, p. 13).

This qualitative case study was bounded by the one vertical PLC in place in the

school district, including both elementary and middle schools, at the time of this study. Single case studies can yield important interpretations and are significant in that the interpretations may be localized to a specific context, generalizable, or may add to existing ideas in some way (Bazeley, 2013; House, 2008; Stake, 1995; Yin, 2012). Case studies also may serve a social justice purpose because their flexible design may enable participants to speak for themselves, sharing their voices and perspectives (House, 2008). Qualitative researchers may use inclusive, culturally responsive practices to seek to understand stakeholder experiences and perceptions to provide answers to their research questions, which may include appreciating the diversity of individuals, settings, values, cultures, and programs involved in their studies (House, 2008). This qualitative case study contributed to the existing research on PLCs and was focused on the "insider's point of view," characterizing the value of gathering individuals' perceptions of the reality of their own lived experiences and interactions with others (Bazeley, 2013, p. 27; Stake, 1995).

Furthermore, Bazeley (2013) concluded that qualitative case study research is the best approach when researchers need a flexible design that supports the acknowledgment of the meaning or realities that are created and may change as a result of intersections between individuals' own experiences and social interactions. Because of these descriptors, this case study may be viewed from both a transformational and epistemological perspective because individuals' perceptions are unique, yet possibly changeable, depending on their lived experiences and interactions with others (see Bazeley, 2013). All persons, regardless of power or status in society, are eligible and are

welcomed to provide their perspectives in qualitative research (Bazeley, 2013; House, 2008).

I considered other research approaches, such as the critical realist and pragmatic; however, these approaches were not chosen because they either incorporate causation or the testing of theories, which was not appropriate for the aims of this study. I also considered a program evaluation study; however, this study did not center on a quantitative, "grand explanation" of many unique, descriptive cases; this study was one case study bounded by one type of PLC (see Stake, 1995, p. 40).

Role of the Researcher

My role as the researcher was to recruit participants from an approved list provided by the school district and collect and analyze data in an unbiased manner. I was a retired administrator who formerly worked in the PLC and school district. There was no conflict of interest in this case study because I was no longer employed by the school district in which the study takes place. I had some prior personal and professional relationships with some of the PLC participants due to being previously employed with the school district; however, I did not have any supervisory relationships with any of the PLC participants at the time of this study. I did not create the idea for the PLC, but I was a part of the PLC leadership team that led the PLC development and vision. To avoid any perceptions of bias, teachers and administrators from the participating high school were eliminated from participation in the study.

I verified the participants' membership in the vertical PLC focused on mathematics before and during the interviews. In an attempt to limit personal bias,

injecting my personal opinions or experiences into the data that were gathered from the participants was refrained from. I was open to ideas that were different from my own and attempted to demonstrate this openness as well as "sensitivity to data that contradict" or differ from my personal beliefs and views (see Yin, 2012, p. 56). Some of the text analysis features of NVivo software were used to ensure that any potential bias was minimized. Qualitative researchers must be open to "expected and unexpected patterns and relationships" when analyzing data (Stake, 1995, p. 41).

Methodology

I conducted one-on-one telephone interviews with three school leaders, one mathematics teacher leader, and two district-level leaders as well as one paired telephone interview. No classroom mathematics teachers volunteered to participate in the study, although the plan was to include up to six volunteers across the elementary and middle school grade bands. Purposive sampling was used to approach maximum variation across the central office, school, and school-based mathematics leaders. The goal was to get volunteers from across the three levels of the vertical PLC with different roles, including administrator, mathematics leader, and teacher.

The context and nature of the one case study, the nature of the research questions, and the diversity of school levels and roles were considered when calculating the purposive sample (see Bazeley, 2013). Bazeley (2013) asked 14 researchers how many participants were enough for sample size and saturation, finding that sample size was variable and depended on the research purpose; however, they opined that 12 cases met the saturation criteria for descriptive cases. I had to reconsider my data analyses and

conclusions because so few teachers participated.

Participant Selection

I asked potential participants from seven schools (i.e., two middle and five elementary schools) to volunteer for this study. An eligible participant list was established by the school district before being verified by me for possible inclusion into the sample pool. The inclusion criteria were: (a) verified membership in the PLC; (b) verified role as an administrator, mathematics leader, or teacher; and (c) voluntary participation in the interview process.

Instrumentation

Using the list provided by the school district, I e-mailed central office mathematics leaders, school leaders, mathematics leaders, and mathematics teachers, inviting voluntary participation for an in-person or telephone interview. For the interviews, I had three primary queries with probes. The three items were taken directly from the research questions and the probes were developed in alignment with the unified framework for content validity (see Appendix A). Probes were created and checked for alignment with all three parts of the unified framework, including (a) leadership practices, (b) elements of an effective PLC, and (c) complex people and processing issues during reformation. Upon receipt of responses from possible participants with their interest in joining the study, delineated by membership in the PLC and role in the PLC, I scheduled interviews with 7 participants. One participant did not give permission for the interview to be included in the study. A sample of interview questions and probes that were used to discern participants' perceptions of leadership practices, PLC experiences,

and effectiveness of the vertical PLC structure is provided in Appendix A.

Procedures for Recruitment, Participation, and Data Collection

I solicited school district approved, eligible, and voluntary participants through e-mail, using a uniform cover letter and explanation of the study, which included notification of school district approval for the study. I allowed a minimum of 24 to 48 hours for participants to review the description of the study and criteria for participation before signing the consent form. There was clear communication that participation was voluntary and that participation could be rescinded at any time. Participant responses were de-identified for confidentiality. I will keep a list of participants and pseudonyms separate from the study for 5-years as required by the university. If the minimum number of participants had not been met during the first selection of participants, I would have continued to e-mail potential participants on a bimonthly basis until the required number of participants was reached. The same cover letter, approval letter, and participant agreement to participate was used for each e-mail.

I conducted the telephone interviews at a time that was convenient for the participant. The location was a quiet and confidential area chosen by the participant. Before the interview began, I verified consent, PLC participation, and asked permission to audio record the interview. The volunteer was welcomed and asked the questions and possible probes. After the interview, I accurately transcribed the participant responses to all questions and probes asked. The transcriptions and my initial interpretations were then offered to participants for their review to ensure accuracy of their interviews and for member checking purposes. Following each interview, I recorded the interview details

and any interview-reflective notes to the research journal folder in NVivo. The reflective notes were recorded as memos in NVivo to minimize any perceptions of researcher bias due to my prior employment in the school district. Participants were considered as having exited the study as a participant by either declining to participate, withdrawing their consent to participate at any time, or by completing the interview and approving the accuracy and initial interpretation of the transcript.

Data Analysis Plan

Participants were asked to respond to a series of questions and probes within approximately 30 to 40 minutes, by telephone interview to limit a possible educator time burden. I audio-recorded the interviews and utilized the Otter transcription application and personal cellular phone to record and transcribe responses. I verified the automated transcription by personally reviewing each interview recording and transcription.

Interviews were entered into NVivo software to assist with analyzing, sorting, and coding data into relevant themes. I attended a 3-day professional development with a certified NVivo trainer to learn how to use the full capability of the software to manually and automatically code and to check codes using tools such as Word Clouds, Coding Stripes, and more. A combination of a priori and open coding were used. The purpose of coding is a way to glean as many insights and understandings as possible from data (Richards, 2015). Coding allows researchers to label, sort, and organize data so that researchers can identify, compare, and revisit themes, connections, and perceptions between and within categories (Maxwell, 2005; Richards, 2015). Qualitative research coding processes allow the researcher to formulate theoretical concepts (Maxwell, 2005).

The coding analysis tools was used in tandem with coding processes, as together they served to bring out the big ideas of the "coherent whole" of connected communication, relationships, and practices (Maxwell, 2005, p. 79).

NVivo software was utilized to collect the transcripts of interviews and actual participant responses. Files within cases and codes were set up using the participants' responses. The following steps were used to analyze, code, and sort data:

1. Import data.

2. Use memos to record additional information about data or interview not captured in the transcription or recording.

3. Code data to identify patterns and themes within the agreement.

4. Use the analysis themes and learnings to discern findings and answers to the research questions.

Discrepant data were not found. Potential surprises in data may emerge as strong themes, or some data may be evaluated and considered to be outlier data. I was open to different perspectives of the volunteers and expected that some data would not be anticipated initially. I used the publicly available Partnership for Assessment of Readiness for College and Careers (2016) data accessed from the State Department of Education website from the years 2016 to 2018. This includes the time period of the vertical PLC.

I analyzed and described student and teacher demographics within the vertical cluster of schools as well as student performance data such as proficiency levels in mathematics and trends within grade levels and across schools. The student data

involving students' mathematics Partnership for Assessment of Readiness for College and Careers (2017) included data for most students. The data reflected some participation exemptions for students with disabilities whose individualized education plans require alternate assessments and for some other students who were English language learners in their first year in a U.S. school (Pearson, 2019, p. 29). I described participants' perceptions of any changes in student achievement within the discussion. Working with student data was part of participating in the PLC; these data were addressed within this case study.

Trustworthiness

Trustworthiness and subsequently selected strategies of a research study are dependent upon the purpose of the study (Bazeley, 2013, p. 406).

Credibility

I utilized procedures that were standard per the qualitative tradition such as extended contact with the study's volunteers and reflective journals (Connelly, 2016, p, 435). I presented a theoretical triangulation of the data related to the central phenomena, leadership, adult learning, and the vertical structure of PLC (Bazeley, 2013) in order to establish credibility. Before the study, I field tested the introduction, questions, and probes from Appendix A with colleagues unrelated to the school district or study. I verified each volunteer using the school district provided list before the interview began.

Also, transparency of data was addressed by providing participants with a written copy of all responses made during the interview to ensure my initial interpretations and their responses were accurately reported and recorded (Bazeley, 2013). Participants were

asked to review the draft of the findings to check for the accuracy of their own data used in the findings and for viability in the setting. In addition, I demonstrated openness to seeking themes and explanations from data by using a software tool for coding which provided affirmation or discrepancy from the codes and themes I initially discerned.

Dependability

I utilized procedures to ensure dependability such as keeping a research journal of processes, dates, and interview notes to reduce any potential bias. Also, I created reflective memos to record insights after each interview. Hard copies of all notes and journals were kept to "create and maintain an audit trail" to present "stability of conditions" in the study (Connelly, 2016, p. 435). I made every effort to keep all data organized and to record process, content, and results as accurately as possible.

Confirmability

I utilized two software tools to assist with keeping the research process clear, transparent, and streamlined. A research journal was created to record solicitation of volunteers, outcomes, and saturation attempts. Confirmability reflects the degree that findings are consistent and can be repeated (Connelly, 2016, p. 435).

Transferability

I followed a written protocol for the solicitation, collection, and organization of data in order to be as transparent as possible with the processes used and the data collected (see Bazeley, 2013). In addition, the study's location, participants, and findings were described and presented as clearly as possible (Connelly, 2016).

Ethical Procedures

The Walden University Manual for Research was used to guide this study, and Institutional Review Board approval number 08-23-19-0756218 was obtained as part of the process. I signed a Partner Organization Agreement. In order to safeguard the identity of the school district and participants, demographic and response data were de-identifiable. In addition, in consideration of my prior employment in the school district, it was important to this study that respondents were asked to participate voluntarily. No incentives were provided to participants for participating in the interviews; however, a standardized thank you was sent electronically to thank participants for their participation. Hard copies of data collected will be kept secure for 5 years then will be discarded safely. Researchers have a research imperative to be sure that their actions and study findings are not erroneously interpreted (Stake, 1995). Researchers must be open to alternative interpretations from their own (Yin, 2012). I made every effort to refrain from bias while collecting and analyzing data during this research study.

Summary

Chapter 3 includes the research method, design, rationale, methodology, trustworthiness, and ethics for this qualitative case study bounded by one vertical PLC focused on mathematics. Criteria for up to 12 voluntary participants' involvement in the study was established and the role of the researcher was to verify the criteria as a part of the interview process. I solicited participants' responses to a three-item interview with probes and to record verbatim participants' responses (see Appendix A). I did not interject bias or power relationships into the interview process or questions. NVivo

Software was used as a resource tool for coding and development of themes from the

responses, and the Otter Application was used to assist with recording and transcription. I

will report the setting, data analysis, findings, and evidence of trustworthiness in Chapter

4.

Chapter 4: Reflections and Conclusions

The purposes of this case study were to understand vertical PLC participants' perceptions of (a) leaders' efforts to improve their students' mathematics achievement, (b) educator growth or behaviors while engaged in improvement efforts with the PLC, and (c) the effectiveness of the vertical PLC context. In this study, I focused on experiences within a newer, vertical model of PLC. This study addressed whether this vertical type of PLC might be one to recommend as a leadership and school improvement model for mathematics across the school district. The following three research questions guided this study:

Research Question 1: What are the beliefs of school leaders and PLC participants on the leadership practices demonstrated by the leaders in the vertical PLC?

Research Question 2: How do PLC participants describe their own or others' growth or behaviors while engaged in the school improvement efforts for mathematics in the PLC?

Research Question 3: How do PLC participants perceive the usefulness or effectiveness of the vertical PLC focused on mathematics improvement?

In this chapter, I review the setting, participant demographics relevant to the study, data collection, how the data were recorded, data analysis, the results, and evidence of trustworthiness.

Setting

This study took place in a medium-sized, public school district in a Mid-Atlantic state in the United States. Throughout the study, I communicated with volunteer

participants via e-mail, using the Leader Consent Form for requesting written consent for participation in the study. Participants were interviewed over the phone once written consent was obtained for the interview. In the course of the interview, three participants indicated that there had been some recent staffing reductions and changes in school assignments in the school district, but the influence of this on the study is unknown. I assigned a participant number and code to each participant to protect identities (see Table 1).

Table 1

Summary of Volunteer Participant Demographics

ID	Participant type	Gender
P1	School leader, principal	Female
P2	School leader, principal	Female
P3	School leader, principal	Male
DML1	District leader, mathematics	Male
DML2	District leader, mathematics	Male
MTL1	Teacher leader, mathematics coach	Male

Data Collection

Adhering to the school district's research agreement, I contacted the individuals who were identified for possible participation in the study. Two potential volunteers were approved to be interviewed together by the school district. Not all individuals from the identified list of potential participants gave their consent to join this study. After 2 months of repeated attempts, six individuals agreed to be interviewed. After the

participants indicated their written consent to be interviewed for this study, I waited a minimum of 24 hours before responding and scheduling an interview. In some cases, a date and time convenient for the participant was scheduled soon after, in other cases, this process took much longer. There were some minor technology issues with phones and audio quality, but all issues were resolved quickly because I had completed a tutorial on how to use the audio-recording application. All interviews took place over a 2-month period from November to December and at a time that was convenient for the participant.

I conducted all interviews over the telephone and asked all participants queries aligned to the research questions that were approved for this study. Participants' responses were transcribed using an audio-recording transcription application (see Table 2). Following the interview, I created a written transcript of the interview and double checked it against the audio recording for accuracy because the transcription application did not always transcribe speakers' words accurately. Once the transcript was verified, I sent each transcript to the participant involved for review and to follow up with written consent to use their responses as part of the study.

In one case, I accidentally sent the first draft of the transcript that was unchecked for accuracy against the audio recording to one participant, but as soon as the mistake was realized, the corrected version was sent to the participant. I apologized and secured consent to use the corrected version. I only used the transcripts of the volunteer participants for whom written consent had been received for data analysis. The transcripts will be kept for a minimum of 5 years in a secure location in my home, per Walden University guidelines.

Table 2

Sample of Partial Interview Transcript From Participant P3

Question number	Research question or query	Sample response
1	Please describe your perceptions of the experiences you had within the vertical PLC focused on mathematics.	"My reaction, my thoughts about it were overwhelmingly positive."

"The professional learning or the conversations around instruction that happened in that process I also thought were very helpful for us to, number one, meet another grade levels' staff, but also to hear how a focus was going to go from elementary, middle to high and similarities and differences, and so forth." |
| 2 | Thinking back to how the PLC originated, what is your understanding of the purpose of it? | "In a nutshell, the purpose was all about alignment, and being able to kind of pull our collective strengths but also to identify our needs." |

I conducted the interviews per the methodology described in Chapter 3 except for obtaining the participant numbers initially desired for saturation or maximal variation of participant roles. Despite repeated efforts to contact teachers and additional school-based mathematics leaders, I was only able to interview one school-based mathematics teacher leader who was part of the central office and school-based mathematics leaders' group. None of the teachers responded that they were willing to be interviewed; however, maximum variation within the desired groups was reached for the school leaders' levels and roles for the central office and school-based leader group. Even with the limited number of participants, I realized that the data gathered in this case study were sufficient

to meet the saturation levels needed to gather perceptions to answer the research questions because the content, nature of the research questions, and the diversity of school levels and roles had been considered when calculating the purposive sample (see Bazeley, 2013). Bazeley (2013) stated that sample size is variable and dependent on the research purpose.

I asked each of the six participants the three interview queries (see Appendix A), and all six shared responses to the queries. Depending on the participants' responses, sometimes I employed follow-up probes to ask for clarification of terms used, processes described, or share more deeply on their responses. Not all follow-up probes or clarification questions were asked of each participant. In subsequent coding rounds, I noted that some of the respondents shared information for some of the probes as part of answering other questions; therefore, and their responses were later coded under the probe and question themes as applicable.

The last query asked of each participant was to think back to this PLC experience. I asked if there was anything else the participant wanted to add about the vertical PLC that had not been discussed. Five out of the 6 participants chose to add information when prompted by this question. I wanted to be sure that every opportunity was provided for the participants to share. A sample of responses from that last question included:

- Principal 2 (P2) indicated that another vertical model in a different content area was attempted in the school district but was perceived "as not as successful."

- District Math Leader 1 (DML1) perceived the existence of "financial costs of the PLC's work, both in-kind costs and outside sources."

- Principal 3 (P3) said that "if the cluster had been told from top down, you know, you must do it this way, it may not have been as organic or from the group up."

After each interview, I engaged in reflective exercises such as writing notes about the interview and responses. A priori coding was reflected in the summary prepared of what I heard participants say in response to the research queries and probes. Underneath each summary, I added the supporting participants' quote(s) as a check on any researcher bias to ensure that responses were heard and summarized accurately. Next, I began subsequent rounds of coding in which all participants' answers under each research question, probe, and/or framework were compiled to discern themes and patterns in data. I also used NVivo software on my personal computer at home as a tool to assist with the coding process.

Data Analysis

I began the data analysis process by reviewing reflective notes from each interview and organizing and sorting each participant's responses under each of the research questions and probes. The responses were reviewed several times, and I made notes on initial themes, such as perceived collaboration, actions of PLC participants, benefits of the vertical structure for adults and students, and metaphoric language used to describe a participant's experiences in the PLC. Next, I entered text from each participant's responses into NVivo and began a series of coding explorations and

analyses to glean individual insights. For codes that intersected by theme, role, and perception, word frequency charts, coding queries, and matrices were created to refine and expand the understanding of participants' perceptions. I also created word trees and word clouds to check for understanding of connections and larger ideas. The perceptions were also analyzed by participant title and role to discern similarities, differences, and frequencies of responses.

Results

Research Question 1

I asked participants to share their perceptions about the beliefs of school leaders and PLC participants on the leaders' leadership practices in the vertical PLC. After reflecting on the interview transcripts and coding rounds, the following themes emerged.

Evidence of an instructional leadership focus and use of research-based strategies for consistency of practice across the PLC. Participants described a PLC culture focused on the improvement of teaching and learning for both teacher practice and student achievement outcomes. PLC participants observed or participated in informal and formal classroom observations that measured growth in teacher practices within the cluster. In the interviews, participants reported evidence of specific instructional materials used, such as an equity look-for tool and NCTM's (2014) Effective Mathematics Teaching Practices. As an example, MTL1 specified that "from the beginning, a focus of every meeting was academic data, performance data, instructional strategies…conversations came back to how students were performing academically as opposed to other cluster initiatives that focused on other factors."

DML1 stated that the instructional focus also included equity because for students, math "is a divider, and for better or worse, success in mathematics may open or close doors." DML1 also described the district mathematics department's practice for implementing research-based practices to foster teacher and student growth in mathematics. Using the "work of NCTM…we took a look…at what were listed as teacher actions….and student actions," and we looked at the "school district's equity-based teacher actions that support these practices." DML1 stated that they were able to develop an "Equity-based Mathematics Teaching Practices Look-for tool" that was used for collaborative math classroom visits. DML1 described how the yearly school visits often included visiting two lessons per teachers on the day of the visit and involved multiple leaders, including district-level mathematics staff, administrators. math coaches, and math team leaders. DML1 said that the nonevaluative visit data were used to provide information across the teams, schools, cluster, and school district, stating that data "included evidence of best practices aligned with the tool…and two or three recommendations that aligned with the team or department's opportunities for growth."

Together, leaders and teachers participated in school visit debriefing sessions at the end of the visit day. DML 1 added "Individual feedback was written and provided to teachers, as were anonymous data that included the percentage of implementation of each of the eight teaching practices observed." Data were used by the district math office to demonstrate strength and need areas and were perceived as important, and as a result, DML1 stated that PLC staff members were able to set goals around "aligning practices not just for their school, but across all PLC schools." DML1 stated that this process

enabled the PLC leadership to determine "pretty early on to focus on looking at connecting representations." DML1 said that in addition to the nonevaluative classroom visits, PLC participants engaged in peer observations and administrators also observed classes in grade level bands outside of their own schools. Using data, school leaders aligned their professional learning, so that math coaches and teachers did professional learning together.

P1 said that as a leader, using time and resources "smarter and differently" was a value. P1 said the data determined the focus for the PLC and that it was not a top-down district mandate, "This is our data; these are our kids." A resulting theme emerged that the use of research-based practices and data for the collective cluster of kids, along with an instructional focus across the PLC and district were perceived as valuable by participants.

Collaboration occurred and was centered on research-based mathematics pedagogy and instructional practices. Within the vertical PLC, "collaboration" was described by P2 as a "between and across school location and between and across school roles" activity that helped to foster growth. The collaborative partnerships extended beyond the schools and broadened to the mathematics and assessment district offices. Other participants further described the collaboration as "extended, district-wide supportive collaboration as access to people and resources." Specific leadership titles were used (i.e., curriculum expert, data department, and mathematics coach) to delineate who was involved in the collaborative processes of using data, conducting collaborative walk-throughs, and learning mathematics-based pedagogies. P2 described how the school

district professionals came to the PLC to help look at data and to help think about strategies being used. P3 added that it was very "helpful to have everybody together in the same room around those common structures…whether they are the NCTM standards…or Danielson…that helped us all to speak the same language."

The next theme was shared leadership and all six participants perceived demonstrated leadership within the PLC focused on mathematics. There were some similarities and differences in perceptions of the amount of and level of involvement by PLC participants. P3 perceived leaders with different roles were involved in the PLC, including school-based administrators, school district and curriculum leaders, math coaches, and classroom-based teachers. DML1 reported an overview of the PLC's leadership development. He described how two principals began the PLC and then brought in cluster colleagues. DML1 said his perspective of his and others' roles within the PLC from his "consultant, district math leader, and supervisory" lens. He was "brought in at the very ground level" to support the process, sharing that the invitation to become involved in the PLC came early in the process because he "oversees all of the curriculum, assessments, and professional learning for some of the district's grade levels." DML1 "served as an expert to help guide the focus of the PLC." Specifically, DML1's guidance involved the NCTM (2014) Effective Mathematics Teaching Practices, especially the ones "we want all teachers planning for and implementing in every classroom every day, which are based on several decades of research."

By contrast, MTL1 described the important work of the mathematics coaches with the PLC. He felt that math coaches were supported by the PLC principals and school

district leaders, stating that although the "principals had conversations, we had conversations, but we also felt that we had the agency to make some decisions ourselves about what needed to be the focus or what the next step was." DML2 corroborated MTL1's description of the math coaches' leadership by describing the coaches' involvement with collaborative classroom visits. DML2 reported that the "greatest experiences were math coaches' opportunities to visit other math grade band classrooms to see the practices and instruction in action." P1 described how the shared leadership's processes and norms developed, noting that they led to buy-in across the board because there was shared distribution and ownership of the work." For example, P1 indicated that personal strengths were "tapped" and hers was "networking and digging into the data." She perceived other leaders' as having a strong math background, and some strengths in pedagogy and walk-through tool development. She described a climate in which people and processes worked together for school improvement.

Leadership, regardless of title, was perceived in the vertical PLC. Four out of 6 participants recalled that persons without formal titles demonstrated leadership in the PLC. P1 specifically identified teachers as leaders and observed them voluntarily attending data and cluster meetings. In addition, teachers were observed sharing math resources among themselves without direct support from math coaches or administrators. In addition, P1 once observed a "teacher-driven conversation" about across grade level bands' needs and solutions in a professional learning session. An additional "critical" leadership action DML1 recalled was how the math coaches helped to lead the monthly and quarterly PLC professional learning segments. DML2 also observed shared

leadership "multiple times," citing teachers and math coaches' participation in collaborative walk throughs, professional learning, and sharing sessions. P3 credited the math coaches for their leadership of leading the math representations focus.

Although DML2 stated that "already-identified leaders were a part of the whole endeavor and were able to help focus the discussions and draft next steps," P1 remarked on a different perspective. P1 noted that she perceived the experience was helpful for developing "a lot of instructional leadership in our math coaches in a different way than had been utilized or expected, perhaps, before." P1 observed teachers "stepping up to involve themselves in their classrooms as leaders and then within the cluster." An example provided was the cross-school "visits to give feedback." P1 said this experience "actually builds a lot of teacher capacity and teacher leadership" as well as "because…we are tackling these issues for our kids and they are all our kids together." DML1 described his perceptions of the math coaches' leadership as the people on the ground doing the work, collaboratively implementing the practices during the year, and serving as volunteers for summer achievement and acceleration math programs. A theme emerged that participants perceived that shared leadership occurred across job titles, was multifaceted and may have fostered benefits to students and staff.

Effective communication was perceived. Three of the 6 participants described in detail how they and other participants were brought together to collaborate, communicate, and learn within the PLC. Processes, subsequent artifacts, and perceived benefits were shared. As an example, P1 described the PLC's structure as "collaboration-driven" and as "an administrative partnership" citing the schedule and monthly meetings

as artifacts. P1 added that administrators initially scheduled time to be together and quickly included "math coaches to inform our work" and would "tap the school district offices for resources." P3 outlined the nature of the communication processes, remembering that initially an e-mail communication started between the cluster's middle and high schools and then broadened to include the feeder elementary schools. "If my memory serves me correctly, it was a secondary conversation first that then became an elementary, middle, and high school conversation." MTL1 corroborated this sequence, believing that people were brought together to communicate, collaborate, and learn in the PLC when a few people took the lead to suggest a meeting schedule. "A calendar was set up, a Google doc was shared that had information about the dates and locations, and then locations and leaders were rotated."

MTL1 posited that because of the expected rotation of leadership that at some point individuals and groups of leaders all had the opportunity to plan the PLC meetings. Participants described the communication not just in terms of procedural dialog, but in terms of the substance of the conversations. P3 recalled that the PLC participants found "common ground with looking at math practices and… Danielson connections." MTL1 perceived the critical role of "debriefing" communications that occurred after across-school classroom visits. MTL1 stated that the math coach-led debriefing with teachers was "the most valuable in terms of impacting instruction." When queried about the nature of the debriefing, MTL1 described a middle school visit that occurred with teachers from two different feeder elementary schools. "The groups split up and visited classes separately…and in smaller groups we came back together for a 40-minute debriefing

session" with the math coaches and teachers.

MTL1 announced that teachers were able to share "what they observed, what they were encouraged by, and what they saw that might impact their own instruction." MTL1 believes that the conversations, which were facilitated by the math coaches had a stronger "impact" than the visits would have had without the debriefing. Further, the collaboration and communication were perceived to have extended beyond a grade level band or school. Specifically, P3 spoke of the collaborative cross-school visits as "helpful" feeling that without the math coach's leadership from his school, P3's participation and that of the school would have been "greatly reduced." A theme emerged that participants perceived collaboration and communication processes impactful for both adults and students within the PLC.

Research Question 2

Participants were asked to describe their own or others' growth or behaviors while engaged in the school improvement for mathematics within the vertical PLC. After reflecting on the interview transcripts and coding rounds, the following themes emerged:

The PLC experiences were perceived as positive personal or professional growth experiences for the participants. All six participants described specific experiences which added to their own or other PLC participants' knowledge and skills. DML1 stated that "we know when you align practices across schools and you focus in on specific ones that we know are high leverage, you're going to see growth." DML1 cited a positive as the "growth in student achievement and teacher practice." P1 credited the Wallace Foundation materials' usage as helpful for guiding the PLC's work to "tackle

instructional issues and disparities." P1 also said she learned about expectations for both teacher and student learners from the district's assessment office through their shared work with data analysis, trend identification within and across schools, and across-schools and district leaders' collaboration to "create actionable items" based on the data. Further, P1 mentioned the personal growth challenge she experienced as a leader who lacked a personal mathematics background leading a school with some "historical" issues in mathematics performance. From her participation in the PLC and her collaboration with district math leaders, other administrators, school district data office personnel, math coaches, and teachers, P1 cited perceptions of her own personal instructional mathematics growth; so much so that P1 now perceives mathematics as her strongest instructional leadership area.

Research Question 3

Participants were asked to share their perceptions of the usefulness or effectiveness of the vertical structure. Five out of 6 participants responded favorably when asked about their perceptions of the unique vertical structure. Benefits cited for students and adults within the PLC included the resource, practice, and goals alignment. Benefits across levels were insight, problem-solving, and perspectives for focus on learners' needs, and the shared responsibility for student learners. After reflecting on the interview transcripts and coding rounds, the following themes emerged:

Growth in perspective-taking. Development of unique and shared instructional practices are part of the growth in perspective-taking. A theme emerged that participants perceived that mathematics vertical collaboration within a PLC may support new

teaching and learning perspectives. DML2 cited the multiple opportunities for

conversations and for gaining perspectives within the PLC. DML2 said that teachers and

coaches traveled beyond their grade bands and schools to "personally see the teaching

and learning processes in action" and felt the cross grade and school visits were more

beneficial than just hearing about instruction at other levels and grades." P3 perceived his

conceptual vertical mathematics progressions gains as "helpful, referencing the

professional learning and conversations around instruction and the opportunity to see

how the math focus moved from elementary through high school." Similarly, P2

vocalized that the K-12 perspective was helpful to her because she saw "what was

happening mathematically across grade levels and schools" and found applications for

her own school. Likewise, DML2 found the across school, cluster perspective as

beneficial for PLC participants, stating, "It was a good endeavor for lots of different

reasons… it helped shed light on practices, both effective and those that probably needed

some retooling at all grade levels by seeing what colleagues were doing at different grade

levels." P2 brought up the perspective of how the vertical structure might benefit students

as well as adults, offering the value of holding a preschool to high school viewpoint,

sharing that "…if we're really looking at college and career ready you have to start on the

level of preschool…and really look at what is happening and get them to that point…to

leave the school system successful…and college and career ready." P3 later elaborated

and used the phrase "common ground" to describe the shift in perspective that developed

from finding the commonness of need from looking at and discussing the data. P3 stated

he "realized they saw that same thing at the different levels." DML2 posited that the

alignment "helped" and described a belief that "middle schools especially have a different perspective." DML2 offered the perception that middle schools have "different ideas about approaches to math and when they saw what their kiddos were doing in younger grades. they really started to think differently about some of the conversations and questions and explorations they could do." DML2 felt that the middle school teachers "benefitted greatly from …the conversations from these meetings and collaborative classroom walkthroughs across levels and outside of their buildings to see what students were equipped with." He described that a "more cohesive experience was created for kids" because teachers "would do (math) practices in similar ways…we would have conversations in similar ways."

   Collective accountability and responsibility. Participants described beliefs and attitudes about leadership and the nature of adult and student learning in the PLC. DML1 described ending isolative practices, stating the idea of the cluster PLC was "a no-brainer." He found benefit beyond individuals and groups of math leaders, stating, "When we try to address some of our challenges by collaborating across grades, and also across levels…elementary, middle and high school, we have a much better chance, then if we try to solve them within these isolated levels." MTL1 reported feelings that other PLC participants felt "grateful" and connected through in-depth "knowledge" sharing opportunities with "someone that would actually be in the school next year with the kids we were sending." MTL1 said that teachers had a "better connection to where their kids were going… rather than feeling that their kids were being sent off to like just this other place" because relationships had formed across the PLC. Further, MTL1 said the

experiences afforded by the PLC were "really good" and "allowed for connections in schools that I rarely have experienced in other places that I have worked."

Other participants such as P2 offered that the PLC's opportunities "helped us focus on what we needed to do better to send students in a stronger fashion to middle school and then ultimately… to high school." P1 said this vertical structure taught P1 that "all means all, you know that all of those kids in our cluster were our responsibility." P3 posited that the geographic proximity was something unique, as well, for the PLC's vertical structure. Although P3 said that not all schools were 100% feeders to the high school, most were within about "one mile and one half" from each other and his perception was this fostered a communal sense of responsibility for all of the kids in the cluster.

The vertical PLC's diverse content and grade level membership was described as possibly contributing to a communal accountability and responsibility culture. MTL1 pronounced that often PLCs are made up of "all people that teach the same grade level or the same content area in a certain place." MTL1 perceived that the variety of people included in this PLC was different, in that the PLC members brought with them different knowledge, new insights, and specific grade level practices that typically do not occur in a single school. MTL1 said the perception that in single-school PLCs the "conversation tends to be self-perpetuating because people know each other." MTL1 commented on the vertical PLC structure's benefit as possibly being useful for building professional relationships, stating that staff relationships and articulation opportunities were "…useful…it allowed me to meet and get to know a counterpart in another school that I

typically would not know and be able to get information from…" A theme emerged from participants who perceived that the uniqueness of the vertical structure may yield collective responsibility, accountability, and positive relationships.

Alignment of purpose: Increased achievement. Participants expressed a perceived purpose of the vertical PLC focused on mathematics as serving to increase students' achievement across the cluster through K-12 alignment. P1 provided examples of efforts toward this goal, specifically citing examining cross-school data and trends to "prioritize and tackle instructional gaps in mathematics and mathematics instruction." DML2 held a similar perception, commenting that the purpose was to align challenges with solutions. DML2 described working to "find common, well-defined needs and challenges of each of the schools, and finding common approaches that could solve those challenges, be they professional learning or instructional adjustments, things like that." P3's perception was that the purpose was "all about alignment… being able to kind of pull our collective strengths but also to identify our needs." Participants viewed alignment of efforts and goals as central to the vertical PLC, but also expressed alignment of instructional practices to foster and measure student and teacher outcome growth.

Alignment of purpose: Increased, consistent use of research-based mathematics practices to positively influence student achievement. Some perceptions centered on the purpose of the PLC in terms of student outcomes through a vertical alignment lens. Connections appeared to be made between the teachers' instructional practices at all levels to the high school students' performance in the cluster. For example, MTL1 described the following observation, "Because kids in a given high

school come from lots of other middle schools and elementary schools…if there was more alignment between the sending schools…it would ensure more consistent performance of students in high school." P2 explained that the purpose was a goal "to really improve instruction across all levels so that when students came to the high school-level they were better prepared to take…higher level mathematics classes that would then ultimately affect them for heading to college." MTL1's belief was that the PLC's purpose was "that it had to do with the fact that how students performed in high school and the difficulties they were having were not difficulties that could be solved just by the teacher that had those kids." Perceptions emerged that the potential for achievement was connected to alignment.

Alignment of goals across the grade levels to create cluster agreements. Participants described how alignment efforts led to agreements within and beyond the vertical PLC focused on mathematics. DML1 identified how individual-school goal setting broadened to setting aligned cluster-wide goals for all of the schools involved in the PLC. The "data was really important because we were able share it with leaders in all schools, and particularly with the schools that were part of the PLC." DML1 described that "the staff in the PLC schools were able to set some goals around aligning practices, not just within their schools, but across all PLC schools." Further, DML1 stated perceptions of the PLC's participants "aligning these practices across schools and coming to common agreements about what those practices would look like in classrooms, including developing specific walk-through tools." P3 also described the agreement to align the PLC's reform efforts to the school improvement plans. He said this "made a lot

of sense" for this cluster's feeder school system in which "elementary schools feed to middle schools, high school, and so on." DML2 outlined a larger alignment, the creation of "whole district agreements" in which the schools would agree to similar "instructional practices, and math conversations in order to create a more cohesive experience for kids." Perceived alignment actions are described by participant group.

Evidence of Trustworthiness

Credibility

I utilized procedures that are standard per the qualitative tradition such as telephone interview contact with the study's volunteers and reflective journals (Connelly, 2016, p. 435). A theoretical triangulation was presented of the data related to the central phenomena, leadership, adult learning, and the vertical structure of PLC (Bazeley, 2013). In order to establish credibility, I field-tested the introduction questions and probes from Appendix A with colleagues unrelated to the school district or study. I verified each volunteer using the school district provided list before the interview began.

Dependability

I utilized procedures to ensure dependability such as keeping a research journal of processes, dates, and interview notes to reduce any potential bias. Also, reflective memos were created to record insights after each interview. All notes and journals will be kept electronically in NVivo to "create and maintain an audit trail" to present "stability of conditions" in the study (Connelly, 2016, p. 435). I made every effort to keep all data organized and to record process, content, and results as accurately as possible.

Confirmability

I utilized two software tools to assist with keeping the research process clear, transparent, and streamlined. One was an audio recording application and the second was a coding software. A research journal was created to record solicitation of volunteers, outcomes, and saturation attempts. Confirmability reflected the degree that findings are consistent and can be repeated (Connelly, 2016, p. 435).

Transferability

I followed procedures for double checking the accuracy of responses by providing each participant with the copy of the transcript and the opportunity to make corrections to ensure initial interpretations and their responses were accurately recorded (see Bazeley, 2013). I also told each participant that a copy of the transcript would be kept for 3 years as required by Walden University. Openness to seeking themes and explanations from the data was demonstrated by using a software tool for coding which provided affirmation or discrepancy from the codes and themes initially discerned. Initial interpretations were double checked by coding the interpretations with the participants' actual quotes to prevent research bias. I utilized some of the features of the software for assistance and to expand the thinking about themes from the data.

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Summary

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In Chapter 4, I presented the data and analysis, organized by research question. Trustworthiness was established by utilizing standard qualitative research practices. My goals within this case study were to discern PLC participants' perceptions of leadership practices, growth within self and others, and usefulness of the vertical structure. This

study was grounded in the unified framework which combined the work of Kouzes and

Posner (2017), Hord and Summers (2008), and Abery et al. (1999). My findings reflected

multiple coding rounds and resulting themes were derived from participants'

perspectives. In Chapter 5, I will provide an interpretation of the findings, and will share

limitations, recommendations for future study, and positive social change implications.

Chapter 5: Discussion, Conclusions, and Recommendations

The purposes of this case study were to understand vertical PLC participants'
perceptions of (a) leaders' efforts to improve their students' mathematics achievement,
(b) educator growth or behaviors while engaged in improvement efforts with the PLC,
and (c) the effectiveness of the vertical PLC context. I interviewed six participants to find
out their experiences within a newer model of PLC (i.e., vertical) and perceptions related
to the PLC (i.e., effective leadership of school mathematics improvement and participant
growth or change). A unified framework supported this case study of the vertical PLC
focused on mathematics and was comprised of the following concepts: effective
leadership of change, commitment to continuous improvement for individuals and
organizations, and supporting adult learning through collaboration and alignment.

In this chapter, I share my interpretation of the findings and provide the research
questions and connections to the conceptual framework. In addition, I discuss the
limitations of this study, recommendations for further research, and implications for
positive social change.

Research Questions

Research Question 1: What are the beliefs of school leaders and PLC participants
on the leadership practices demonstrated by the leaders in the vertical PLC?

Research Question 2: How do PLC participants describe their own or others'
growth or behaviors while engaged in the school improvement efforts for
mathematics in the PLC?

Research Question 3: How do PLC participants perceive the usefulness or effectiveness of the vertical PLC focused on mathematics improvement?

In the interviews, I asked participants initial and follow-up questions to elicit their perceptions about the range of leadership observed, the nature of practices and growth in the PLC, and beliefs about the usefulness or effectiveness of the vertical structure of the PLC. Several findings were described in Chapter 4, which included: (a) instructional leadership and use of research-based strategies; (b) collaboration centered on mathematics pedagogy and instructional practices; (c) shared leadership; (d) demonstration of leadership by participants without formal leadership titles; (e) effective communication; (f) positive personal and professional growth; (g) growth in perspective-taking; (h) collective accountability and responsibility; (i) alignment of purpose for increased achievement; (j) alignment of purpose for increased, consistent use of research-based mathematics practices; and (k) alignment of goals across grade levels to create cluster agreements. The conceptual framework and literature review from Chapter 2 served to ground my interpretation of the results of this qualitative case study. In the next section, I describe and consolidate my findings from the emergent themes by analyzing participant' responses.

Interpretation of the Findings

Principals may select PLCs as the context for school reform. In this study, diverse leaders and participants from seven schools and district-level offices were intentionally brought together in a vertical PLC to collaborate and learn about the mathematics performance in their schools and among the shared cluster of schools to which they

belonged. According to the unified framework of this study, transformational leadership is depicted as the center of a construct reflective of six specific "connections" of diverse people, attitudes, behaviors, values, and beliefs to leadership. The unified framework provides a visualization of how leaders may choose to foster change and develop individual and organizational capacity for growth, collaboration, communication, and change at the same time. This unified framework, together with the findings from the prior research described in Chapter 2, was used to inform my interpretations and the resulting themes by connecting the findings of the current study to the practices of effective leaders, the markers of effective PLCs, and some key understandings about how individuals and organizations communicate and develop habits that emerge during change.

Inspire a Shared Vision, Shared Values, and Vision

Participant responses primarily from Research Question 3 and related queries determined this theme. Participant responses aligned with the unified framework and the findings from the literature review that showed that effective leaders are able to generate compelling visions that colleagues and subordinates aspire to connect to (Abery et al., 1999; Kouzes & Posner, 2017). Specific strategies identified for communicating a shared vision may include creating opportunities for understanding others' perspectives, asking questions, and reflecting on the progress of the PLC individually and as an organization (Hord & Summers, 2008). These planned change habits may be demonstrated and observed in the organization (Abery et al., 1999).

Collectively, study participants perceived similar, shared purposes of the PLC and identified strategies that reflected evidence of the effective communication of the purpose of the PLC, including (a) alignment of practices to the vision; (b) collective problem-solving and decision-making across grade bands and levels; and (c) using the vertical perspective to improve staff and student performance outcomes using research-based strategies, peer observation and mentoring, and debriefing and reflection on lessons. As an example, P1 described the purpose as collaboratively aligning practices "to prioritize and tackle instructional gaps in mathematics and mathematics instruction." Both DML2 and P3 added additional further descriptors for the purpose, including (a) building capacity for collective problem-solving, (b) participating and sharing the leadership of professional learning, and (c) making requisite instructional adjustments in a well-defined and aligned way to meet initially individual but now community-owned challenges. P2's stated purpose for the PLC was to improve instruction across all levels. Other participants' perceptions centered on improving student outcomes through a vertical alignment lens. For example, MTL1 said if there was more alignment between the sending schools in the cluster, this would ensure more consistent performance of students in high school. P2 likewise desired for all students to be as prepared as possible for college and careers after high school. Participants described their perceptions of alignment of purpose, consistency of aligned instructional practices, and the formation of cluster-wide, PLC-wide goals.

Mere participant membership in a vertical PLC with a leader who has a vision does not necessarily result in an understanding of or a fidelity to the purpose or vision of

a PLC. Although the study participants represented school district role and level

variation, they shared a common school-based and central office leaders' group identity.

Collectively, their perceptions aligned to a shared purpose, which is significant because

researchers have found that participants may impact the effectiveness of a PLC when

they express or demonstrate variances from or commitment to the purpose, alignment of

practices, or collective accountability for all students' achievement in a PLC (Voelkel &

Chrispeels, 2017).

Challenge the Process, Personal and Organizational Learning, Shared Personal

Practice, Collective Learning, and Application

Participant responses primarily from Research Questions 2 and 3 and related

queries determined this theme. Participant responses aligned with the unified framework

and the findings from the literature review, participants described the importance of

providing purposeful staff and student opportunities to learn and grow together within the

PLC's structure (Hord & Summers, 2008). It is well accepted in the research that a PLC

is an avenue to bring forth positive change (Budgen, 2017; Christiansen & Robey, 2015);

however, Campbell and Stohl Lee (2017) found that little is known about how PLC

participation supports growth. In the current study, participant responses are evidenced

growth in personal and professional learning; they described a sense of efficacy

concerning the learning of students and colleagues. Participants described a communal

sense of accountability in aligning consistent, research-based practices in the cluster and

shared a sense of responsibility for all kids, not some in the larger cluster PLC. Even

though research-based evidence reveals differences in practice within and among PLCs,

principals still may select the structure of a PLC in their schools to confront the status quo and to challenge the process and culture that exist in their schools. Abery et al. (1999) suggested that building a collectively responsible culture for results may be evidence of growing individual or collective commitment to a reform effort. One such change was perceived by DML1 who provided the mathematics department's practice for implementing research-based practices to foster teacher and student growth in mathematics used both the "work of NCTM and the school district's equity-based teacher actions that support these practices." DML1 stated that they were able to develop an "Equity-based Mathematics Teaching Practices Look-For Tool" that was used for collaborative math classroom visits across the PLC.

The participants in this study self-described their awareness of the need to raise achievement in mathematics for their schools and cluster. They also felt that the vertical PLC had been created hopefully to positively impact the entire cluster's student achievement levels. Leaders may choose a PLC structure for participants as the context for individual and organizational growth and committing to change efforts and interventions (Cherkowski & Schnellert, 2017; Hord & Summers, 2008; Vescio et al., 2008). Because prior research findings suggested that placing participants in the same meeting or professional learning community together will not necessarily yield a collaborative culture (Ford & Youngs, 2017); combining a shared presence with either a contrived or genuine opportunity to demonstrate collegiality may provide opportunities for participants to perceive shared practices, which is another observable marker of an effective PLC.

Encourage the Heart

Participant responses primarily from Research Questions 1 and 3 and related queries determined this theme. The responses of participants aligned with the unified framework and the findings from the literature review. Participants described the alignment of practices, goals, and efforts as well as detailed a collective sense that "all means all" when committing to the success of students. It may be possible for school leaders to apply Kouzes and Posner's (2017) recommendation of encouraging the heart leadership practices as a way to build empathy for the success of all students and staff members, specifically by praising and recognizing individual teaching excellence in their schools. Furthermore, recommending the lifting of those teachers who are making a positive difference in and across schools for students who are underperforming, and demonstrating care and concern for all.

Since PLCs are not all similar in purpose, Hord and Summers (2008) suggested that principals need to lead collective accountability and responsibility changes to combat any inequities, variances from developmentally appropriate pedagogy, or absences of positive community habits in the PLC. As an example, the district math office collected data on teachers' proficiency demonstrations of the eight math practices over a period of multiple years. These data were shared throughout the school district and with vertical cluster teachers and leaders to identify teachers' performance strengths and needs over time. Increases in math practice demonstration proficiency percentages were cited by DML1 over the past few years of data collection. This PLC and district practice is in alignment with Marsh's (2012) recommendation from a meta-analysis of school

improvement interventions that create a safe climate for educators to examine and analyze quantitative student and organizational growth data rather than knowledge and skills qualitative data.

Participants provided evidence of data collected from the cross-grade band, informal walk throughs in alignment with Marsh's recommendations. Vertical PLC participants visited each other's classrooms to examine instruction and student work and to provide individual and collective team feedback on teacher growth with the agreed-upon math practices. DML2 and MTL1 purported their experiences with joining leaders and teachers for collaborative, across-school visits. Some of the feedback shared may have supported "encouraging the heart" practices because part of the debriefing and feedback structure included (a) what was observed, (b) what was encouraging, and (c) what take-aways can be applied to their classroom practices.

Effective teachers strive for excellence and equity for all students by improving their craft. In a one-school district case study, data from 30 teachers' self-reports indicated that both effective peer modeling and receiving relevant and detailed feedback from a trusted observer influenced a desire to improve instruction (Donahue & Vogel, 2018). Leaders may need to acknowledge that perhaps not all teachers will express the desire to grow individually or collectively with the vertical PLC organization. Effective leaders work to combat resistance to change habits, but the process may not be an easy one; rather, fostering the development of new positive community habits instead may be the answer.

From a study of math teachers' personally-held beliefs and family background experiences, Sawyer (2018) revealed the impact of their beliefs and prior experiences to their acceptance of change efforts as well as their perceptions of others' willingness to change. Sawyer categorized teachers' beliefs as being teacher centered or student centered and suggested that encouraging the heart leadership practices may occur through professional development. The responses of P1, DML2, and P3 were in alignment with Sawyer's findings because they utilized professional learning within the vertical PLC to study cross-school data and trends for the purpose of collectively aligning math practices in order to prioritize and eliminate instructional gaps in mathematics and mathematics instruction.

Specifically, DML2 commented that the PLC participants sought to find common, well-defined needs, challenges, and approaches to solve those challenges for each school and across schools. P3 used the phrase "common ground" to describe the commonness of needs assembled by participants from looking at the data, sharing a "realization they saw that same thing at the different levels." This may be termed collective accountability and responsibility, which may reflect evidence of encouraging the heart practices. What principals and teacher leaders may share in a PLC, however, is the belief that the goal of a PLC may be to raise the performance of all teachers. Effective teachers are needed daily in every classroom to demonstrate a knowledge of their students and content as well as to exhibit a collective responsibility for the success of all students (Robinson & Lewis, 2017).

Additional figurative language responses articulated by one participant suggest

additional support for the presence of "encouraging the heart" leadership practices in the vertical PLC (see Table B1). Namely, the word choice and images depicted through her phrasing painted a picture of effort, steadfastness toward goals, despite barriers and challenges. P1 also illustrated the perceptions of challenging the process and status quo through modeling prioritizing the needs of all of students in the cluster, not just one school. P1 also recalled the processes used to foster shared leadership and working with others for the benefit of all students and setting a positive vision for students' future is described.

Model the Way, Community Habits, Partnership, Conflict, Communication, and Leadership of Planned Change

Responses primarily from Research Questions 1 and 3 and related queries determined this theme. The responses of participants aligned with the unified framework and the findings indicated in the literature review, in which participants described the communication, collaborative partnerships, and leadership behaviors observed within the vertical PLC focused on mathematics. Effective leadership of planned change includes self-reflection in order to examine one's values, biases, world views, and theories of change (Jones & Thessin, 2017; Vinson, 2018). Consistent with this, DML1 described the regular collaborative school classroom visits and P1 characterized the monthly meetings with administrators, district personnel, math coaches, and assessment office personnel as "driven by collaboration" and as "an administrative partnership." MTL1 reported that people were brought together to communicate, collaborate, and learn when a few people took the lead to suggest a meeting schedule, set up a calendar, and share in the work.

Collaboration occurred across grade level bands and levels and between persons with different roles and responsibilities within the PLC.

The SRF (Abery et al., 1999) may be used to understand how persons' values and beliefs may affect their individual and collective commitment to a change effort. School leaders may choose a PLC as the context for intentionally bringing together adults for learning and growth, such as in this vertical PLC case study (Hord & Summers, 2008; McGee et al., 2013). Leaders may navigate many diverse experiences, observe values and attitudes of individuals, and perceive collective habits of the organization. Community habits may be positive or negative, such as conflict and partnership habits (Abery et al., 1999). In the vertical PLC case study, participants likely varied by grade level, role, school type, and certification which may have led to any difficulties of leading diverse educators across school boundaries. Study findings from Birkhead et al. (2017) suggested that teachers can demonstrate difficulty to communicate with each other across grade level bands, including the conversations centered on content, pedagogy, and developmental appropriateness.

In an Irish study of 471 teacher perceptions of transition barriers between primary and secondary mathematics programs in the same district, teachers identified several challenges that appeared to mirror vertical articulation issues, including a lack of teacher knowledge about learning progressions, what is considered to be developmentally-appropriate instruction at the other grade level bands, and effective communication across levels (Prendergast et al., 2019). The Prendergast et al. (2019) study findings are important because the difficulties experienced in that study are ones that the PLC

leadership in the vertical PLC were trying to prevent by utilizing collaboration, effective communication, and shared leadership across the PLC. Effective leadership of change involves creating program coherence, using data, and modeling inquiry, and reflection on teaching and learning. (Jones & Thessin, 2017; Vinson, 2018).

Leading instructional improvement and change and fostering the development of new positive community habits may not be easy for principals. Teachers' resistance to change in a PLC may be a barrier to effective communication, shared instructional practices, evidence of a growth mindset, and shared responsibility for all students' success. One way to foster positive community habits is though professional development. The findings of McGee et al. (2013) suggest that supporting job-embedded professional development is essential but evaluating the effectiveness and efficiency of efforts and results also is important. Participants reported that job-embedded professional learning occurred vertically across the grade bands and was not comprised of just one type of professional learning. Rather, professional learning encompassed the examination of work samples, observations, peer walk throughs, and peer-led discussions about math practices and student and teacher mathematics talk. P1 said, "It was never sit and get, never."

Supportive Conditions, Relationships, and Structures

Participant responses primarily from Research Questions 1 and 3 and related queries determined this theme. The responses of participants aligned with the unified framework and the findings shared in the literature review in which participants described perceptions of community-centered, supportive conditions conducive to shared

accountability for increasing student and participation growth and positive impacts on teachers' practices. According to the research by Hord and Summers (2008), leadership that fostered supportive conditions, such as those described above for change, was just one of the five dimensions that describe effective PLCs. The researchers found that it was possible for PLCs to be named a PLC without meeting the effective PLC criteria. Besides fostering supportive conditions, the remaining four dimensions were: (a) shared beliefs, values, and vision, (b) collective learning and its application, (c) shared personal practice, and (d) shared and supportive leadership.

In addition, collaborative, professional relationships developed within the supportive structure of the vertical PLC, with one participant citing that he talked with teachers at the next grade band, and in his experience, that does not ever happen, stating that "elementary teachers don't talk to middle school teachers and vice versa." The alignment of practices, goals, and agreements perceived by participants support the notion that the vertical PLC embedded supportive conditions. The conditions were aligned in part with a Dutch mixed-methods study of 130 schools, 130 teachers and 3,000 students Lomos et al. (2011) which investigated the relationship between math departments (which they defined as PLCs) and student achievement. Findings included some positive, significant results for the influence of mathematics PLCs on student achievement using questionnaires, linear modeling, and student Trends in International Mathematics and Science Study results. The organizational construct of the department was the focus of the study, a traditional, secondary school typically organized teacher collaboration and instruction in that manner (Lomos et al., 2011).

Similar to the findings of the Dutch study research, DML1 explained that there had been increases over the past two year, as measured by classroom look for tools, in student summer programs involving PLC volunteer participants as well as staff performance during the school year. DML1 celebrated the increase in the percentage of teachers demonstrating math practices more successfully and he encouraged the PLC participants to create their own school-year goals for their own school teams, aligned across the cluster schools. Leaders are needed to fulfill the supportive steps necessary to set up their staff members and students for success.

Bringing changes to instruction through professional learning is dependent upon helping teachers learn to keep doing what works for students and teachers, such as in the case of the perceptions of DML1, and also to learn to change what is not working for the outcome growth of teachers and students (Darling-Hammond et al., 2017). When individual students, or student groups, and schools do not make sufficient progress on local, state, or national standards, lead learners and teachers are needed to implement reform structures to increase performance outcomes, and PLCs may be one choice of reform effort (Binkhorst et al., 2018; Darling-Hammond et al., 2014; Forrester, 2018; Lomos et al., 2011). Effective principals can recognize the need for change and are able to choose a supportive structure to make a positive impact. Within the PLC, leaders chose to implement a lesser-studied PLC as an intervention context, a geographically-connected, feeder-system, vertical PLC. Five elementary schools and two middle schools were a part of this vertical cluster PLC focused on mathematics.

Specifically, within a vertical cluster, a principal may need to develop the capacity for support, shared awareness of responsibility, and distributed leadership (Chikoko, 2007) to bring forth desired changes. Chikoko (2007) studied five primary clustered schools in South Africa and explored cluster participants' perceptions of threats to the effectiveness of the cluster. Findings included perceptions of an inability to sustain a continuous improvement culture because of perceived barriers such as a teacher development focus without a leader development focus. In addition, there was a decline in the amount of resources and professional learning provided, as well as evidence of change resistance. Chikoko also found that the "presence of a cluster structure" is not enough to generate change (p.56). By contrast to the South African cluster study, participants in the vertical PLC expressed their perceptions of a supportive conditions and structures, including effective communication across the grade bands, shared resources, communal responsibility and accountability, effective shared leadership, professional learning, and support from school-based and district leadership. The PLC participants disclosed that the purpose of the vertical PLC was communicated well, that their goal was to improve the mathematics performance for all of the kids in the cluster, K-12.

Enable Others to Act, Roles and Relationships, and Shared and Supportive Leadership

Participant responses primarily from Research Questions 1 and 3 and related queries determined this theme. The responses of participants were in alignment with the unified framework and the findings shared in the literature review in which participants described observing instructional leadership that was shared in the PLC by leaders with

and without formal titles. Leadership of school improvement may vary and is dependent on the leader to set up a structure or to default to no structure to see who emerges as a leader. Specifically, within a vertical cluster, a principal may need to develop the capacity for support, shared awareness of responsibility, and distributed leadership (Chikoko, 2007). Participants described a perceived sense of agency and efficacy for making a positive difference and for leading change efforts through professional learning, classroom visits, and debriefing sessions. The findings in the literature review acknowledged that because principals had challenging, complex jobs that sharing leadership is a way to tap talent and to build collective efficacy (Leithwood et al., 2007; Neumerski, 2012; Ross, Lutfi, & Hope, 2016; Stein et al., 2016; Wallace Foundation, 2013).

The responses of participants aligned to the research findings in the literature review. Specifically, P1 defined the shared leadership of the PLC as a "collaborative approach" and a mechanism for "tapping each other's strengths." P1 perceived the PLC as a brave space for participants to leverage their strengths for the benefit of others, stating, "One of the biggest reasons we had a "successful experience is we had buy-in across the board and we had shared distribution of leadership and ownership of the work." Another leader, DML2 saw the collaborative classroom visits across levels as being pivotal for developing knowledge and skill within the PLC. "I think the most valuable experience was actually seeing instruction and practice in a different building," but specifically "in a different grade band building, so like elementary to middle, middle to elementary."

In addition, DML2 outlined the multitude of math coaching roles, including classroom visits to other grade bands, professional learnings, and demonstrating agency for next steps for students and staff, math classrooms to see the practices and instruction in action, and across different grade band levels." Participants described shared leadership in terms of roles, responsibilities, titles, and actions. Leaders identified were district-level, data department, school-based leaders, teachers, and school-based math teacher leaders (math coaches). Participants also shared perceptions of shared leadership and mathematics-specific leadership.

Because some teachers do not trust administrators, sharing leadership may help to build some trusting relationships throughout the school. Researchers suggest tapping talents of not only the veteran teachers, but to consider sharing leadership with diverse teachers as well as early career teachers (Huggins et al., 2017). Huggins et al.'s (2017) study findings of four early career teachers provided some insights into leadership benefits to the school community, including the roles early career teachers can serve in the schools. They may be viewed as powerful vessels of school information because they may be able to disrupt negative community habits that exist in the culture because they may lack the entrenched relationships and history. Similarly, Kouzes and Posner (2017) found that leadership is not limited to those with specific titles (Abu-Tineh, Khasawneh, & Al-Omari, 2009).

The work of the informal school and classroom leaders within a PLC is essential for effective communication. Research has shown that teacher actions within a classroom have the greatest impact on student achievement (Hallinger & Murphy, 2013; Hattie,

2009; Leithwood et al., 2004) yet most teachers function as solo practitioners and do not collaborate or visit other teachers' classrooms. Principals and teacher leaders cannot do all the work that is needed to influence the instructional practices of teachers and raise student achievement.

Empowering informal leaders and teachers to assist their colleagues is a critical part of enabling others to act (Kouzes & Posner, 2017). Scornavacco et al. (2016) research findings describe the variance among teacher leadership and roles, and around the nature of co-leaders' work. Findings also suggested that principals support shared leaders by defining expectations for roles and responsibilities. Scornavacco's findings align with the perceptions of participants from the vertical PLC. Principals, math coaches, and district-level personnel supported the leadership, direction, professional development, and agency of the shared leaders.

In the findings, MTL1 said that the math coaches made decisions on their own with the principals' support and the PLC depended on them to lead the professional learning. Other participants described the shared leadership process as developing shared, established norms such as conducting across grade level lesson observations and providing debriefing feedback which resulted in expectations, practices, and resources alignment efforts. Leaders without administrative titles were able to drive instructional decisions and professional learning. PLC participants recounted actions of leaders within the PLC and Table 3 shows the actions of the leaders functioning in an effective PLC according to Hord and Summers (2008), and as categorized by Kouzes and Posner (2017).

Table 3

A Sample of Perceived Shared Leadership Functioning in the Vertical PLC Focused on Mathematics

Leadership practice	District math and data leaders	School-based leaders	Teachers	Mathematics coaches
Model the way	X	X	X	X
Inspire a shared vision	X	X		X
Challenge the process	X	X	X	X
Enable others to act	X	X	X	X
Encourage the heart	X	X	X	X

Limitations of the Study

This study included some limitations, including the number of participants. Although desired variation by role was achieved, the study sample contained six participants. An unexpected result was that despite repeated attempts, I was unable to obtain any teacher participants. Because no classroom teachers participated in this study, it is unknown to what degree the classroom teachers perceived safe and supportive conditions within the PLC to assume risks, and to align themselves and their instructional practices to the shared vision. Another limitation was a lack of ability to discern alignment of any teachers' responses to the work of Campbell and Stohl Lee (2017) that suggested that teacher variance exists with demonstrated fidelity to the purpose of a PLC, and with their willingness to share and discuss student work samples.

Another limitation of the study is that I was not able to describe any development of negative community habits. The SRF premise (Abery et al., 1998) is that it is possible

to develop both positive and negative community habits during reform efforts. No participant shared evidence of negative community habit development such as resistance to change habits. It is important to note that no participant shared perceptions of PLC conflicts which is not viewed as a negative community habit, rather conflict is viewed as a necessary, positive part of growth, and disagreements must be surfaced and addressed as part of the community culture.

Another limitation of this study is it takes place in a medium-sized, public school district in a Mid-Atlantic state in the United States, which may or may not be representative of other schools in the United States or elsewhere. This study focused solely on mathematics, and not on other content areas. A limitation is that these findings may not be applicable to other contents. Last, a limitation of this study is that the vertical PLC studied was comprised of seven, geographically close schools whose students either partially or fully "fed" into one of the two middle schools and one high school in the cluster. Other PLCs studied may not have this geographic factor or school community cluster practice in place.

Recommendations

Replication of this study is suggested for researchers who desire to add to the literature on PLCs, effective leadership, vertical organization constructs for shared accountability and responsibility cultures, and planned change. If I were to replicate this study, I would like to have a larger sample size of diverse participants, including administrators, math coaches, school district personnel, and classroom teachers so that their perceptions are represented to gain more perspectives. Further research topics may

include the inclusion of early career or veteran teacher participants' perceptions to provide additional insights into the leadership demonstrated, growth perceived, and usefulness of the vertical structure. A larger sample size would perhaps provide additional perceptions about the nature of what happens when diverse participants engage in a reform effort and what community habits may develop. Another research topic may be the exploration of the vertical structure itself, but for schools that are also not geographically close. It may be interesting to discern the influence of geographic location to perceptions of communal accountability and responsibility. Additional research may be conducted on vertical PLCs that are not focused on mathematics. One of the participants had said that there was a belief that a nonmathematical vertical PLC was attempted in the district but the perception from the participant was that it was not as successful. Additional research exploring the use of figurative language during planned change such as school improvement in PLCs is a possible future area of focus. The connection between expressed language and perceptions within a change effort may be an interesting future study.

Implications

Implications for this vertical PLC study focused on mathematics are the insights into the nature of collective fidelity to the shared purpose of improving student and staff performance outcomes in what was perceived to have been an effective PLC, according to the criteria by Hord and Summers (2008). The uniqueness of the feeder school, geographically close, clustered vertical system was interesting and provided some strong insights into the ability and willingness of participants to engage in a communal effort for

the sake of the kids and the larger community. This research suggests that vertical PLCs with effective, shared leadership, and with a communal, relentless focus on research-based practices, reflection, professional learning is worth replicating. In this case study, it appears that the nature and structure of the shared PLC leadership were able to develop individuals and the organization at the same time. There was a culture, as the participants described, of a learning organization (Wallace Foundation, 2013) in which participants were expected to learn and grow, including the leaders. Participants experienced many of the research-based indicators of effective professional learning within the PLC, namely content learning was provided and sustained over time, and was presented in a manner appropriate for adult learners in supportive conditions (Darling-Hammond et al., 2017; Knowles et al., 2015). Last, the laser focus on reform, as well as the commitment to the process, goals, and efforts was something that the participants shared with me. They described the benefits of working in a community of scholars and practitioners who together were engaged in studying data, used research-based techniques, gave feedback, shared leadership, and displayed ingenuity. The vertical PLC is not common and I believe it should be. The study findings will be shared with the school district to consider for possible replication. Further recommendations are to consider possible replication with older or younger students, possibly to include a high school or pre-school aged students.

Positive social change implications from this case study center on the collective accountability and responsibility perceived by participants, as recalled by them about their words, thoughts, and actions demonstrating care, equity, and excellence for students

involved in the PLC. Phrases such as "our kids" symbolized the collective concern for the well-being of all students across the vertical cluster. The vertical PLC was put in place to address the low performance of students in the cluster in mathematics. The participants in this study stated their care and concern for students, stating that the efforts of teachers and schools would hopefully influence students' performance in high school and beyond. Several participants viewed students in prior and resulting grades as still "their responsibility." Furthermore, they felt that helping all students to reach their potential in mathematics was important, regardless of the level. In society, valuing all neighbors, respecting the worth and dignity of all persons is a core value for many, including me.

Conclusion

P1 disclosed that this vertical structure taught them that "all means all…you know that all of those kids in our cluster were our responsibility." P1 took this idea further to describe a picture of who these kids exactly were. She pointed out that the "kids at the high school were a direct reflection of the work" middle school was doing or would be doing, and the "elementary kids weren't quite" secondary levels' yet, but "our investment of them was going to pay off for them." The sense of efficacy and agency described by P1 is the take-away from this case study, of what leaders could think and do alongside others, as a reflection of their beliefs and values within a vertical PLC focused on mathematics.

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Appendix A: Interview Guide

Date:

Location:

Time:

Interviewee Code:

Parts of the Interview	Interview Questions and Interviewer Notes
Introduction and Welcome	Thank you for consenting to be a part of this in person or Internet telephone interview. I am counting on you to be honest with all your responses. This interview should take about 30 to 40 minutes. The purpose of this interview is to gather your perceptions about your experiences within the vertical PLC focused on mathematics. I will be audio recording this interview and will transcribe the responses later for your review. Do I have your consent for participation and audio recording? Do you have any questions? I will begin.
Research Question 1	**Please describe your perceptions of any demonstrated leadership in the vertical PLC focused on mathematics.** **POSSIBLE PROBES:** How were structures and processes such as the PLC's vertical organization, professional learning agenda or expectations established, developed, and communicated with the PLC participants? How were any experiences in which you or other participants shared personal instructional lessons, pedagogy, or student

	work with another participant of the PLC facilitated by a leader? Tell me about a time that PLC participants without formal leadership titles or positions made suggestions for the PLC that were implemented.
Research Question 2	**Please describe your perceptions of the experiences you had within the vertical PLC focused on mathematics.** 　　　**POSSIBLE PROBES:** 　　　　Thinking back to how the PLC originated, what is your understanding of the purpose? 　　　　How were you and other participants brought together across schools and grade levels to collaborate, communicate, and learn in the PLC? 　　　Which experiences added to your knowledge and skill with teaching mathematics?
Research Question 3	**Please describe your perceptions of the usefulness of the vertical structure of the PLC** 　　　**POSSIBLE PROBES:** 　　　　What is your understanding of the purpose for the vertical structure of the PLC? 　　　　What do you feel was unique with this vertical PLC structure as compared to other PLCs, teams, department groups, or committees you may have been involved with?

Closure and Thank You	When you think back on this experience, is there anything else that you would like to add about the vertical PLC that has not been discussed? A personal take away? I want to thank you very much for your voluntary participation. I will be contacting you soon to provide you with an opportunity for you to review my initial interpretation and your responses from the transcription document. A reminder that your information will be deidentified and will be kept private at my home in a secure location for 5 years as required by the university.

Appendix B: Results

Table B1

Participant P1's Usage of Figurative Language

Leadership practice	Participant P1 response
Encourage the heart	"One of the wisest decisions we made when I was there was to participate in that process… we saw some data movement, and access issues resolved for students as a result of that work. So, I know it was definitely a **lifeline** for me as a new principal. And it really helped me to **grow** as an instructional leader." "This process is being replicated to meet the needs of our neediest learners, because it has proven to be effective, and it has **already garnered a lot of traction** and ideas, even in a very different demographic. So I advocate that it's not just for situations where there are some intense and high needs but when you have the opportunity or see the achievement gap."
Challenge the process	"We were looking at the fact that our schools are very connected. We are **fighting very similar instructional battles.**" "I think that it is a model that every cluster system should be trying, or every feeder system should be trying, because it takes a lot of the pressure off, because like you're not **fighting in isolation.**" "And so the purpose was for us to do cross school data analysis, looking at trends from elementary to middle to high school, and then to collaboratively align our practices to prioritize and **tackle instructional gaps** in mathematics and in mathematics instruction." "And then I think a lot of teacher leadership arose from that as well because when it was, you know, we are **tackling** these issues for our kids and they are all our kids. Together we saw teachers step up and involve themselves in a way both in their classrooms as leaders and then within the cluster. "

Enable others to act	"So, I feel like we took areas that were strengths for each one of us, and kind of took the lead on those, got, you know, cluster and a lot of teacher feedback and **we'll come back to the table."** "You know one of the things that I was able to do well was to **pull it together,** individuals, kind of that networking piece and then really **dig into the data. T**hat was definitely a strength that I had, so I brought that to the table. "I learned so much about the content, about the process, about instructional leadership and math, about **digging into the data and create actionable strategies**."
Model the way and inspire a vision	"Soon, we will start a process of us looking at how to identify capacity and students. And if and **then what bridges, we need to vertically build** for those students who access the higher-level math courses."