THE EFFECTS OF PROFESSIONAL LEARNING COMMUNITIES
ON STUDENT ACHIEVEMENT

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The purpose of this study was to examine data from the Early Childhood Longitudinal Study: Kindergarten Class of 1998-99 (ECLS-K) report, identify questions and statements that correlate to the dimensions of professional learning communities (PLCs), and determine the effect PLCs have on student achievement based on the ECLS-K data. In addition, the rationale for doing this research was to measure growth in student achievement over time.

A multilevel growth model was used for this research. Univariate analysis was conducted in order to reveal frequencies and percentages associated with teacher responses. Bivariate analysis was applied in order to determine the inter-correlations between the fourteen variables. Once the inter-correlations were determined from the bivariate analysis, principal component analysis was applied in order to reveal the theoretical relationship between the variables. Through the use of principal components a set of correlated variables is transformed into a set of structure coefficient: support and collaborative. Finally, a multilevel growth model was used in order to determine the effect that each variable within the support and collaborative structure coefficients had on student achievement over time.

This study revealed a number of variables within the ECLS-K report that correspond to the dimensions of PLCs have a statistically significant effect on student achievement in math and reading over time. This study demonstrated that support and collaborative variables within PLCs have a positive effect on both math and reading IRT achievement from 3rd grade to 5th grade.
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CHAPTER 1
INTRODUCTION

Historical Context

It is often decried by critics of public education that schools are miserably failing (Chubb, J., & Moe, T., 1990; Kozol, J., 1993; Hood, J., 1993; & McGuinness, D., 1997). More intense condemnation of public education was asserted by noted author Samuel Blumenfeld (1995) when he said, “The simple truth is that the American public school system is slowly crippling the country by destroying the brains of its youngest citizens…America is literally losing its brains” (p. 196). Furthermore, the Orton Dyslexia Society (1997) reported, “Reading failure is epidemic” (p. 2). The recent criticism, however, is not new. Possibly the most cited alarm of the crisis of American public education occurred in 1957 after the launch of Sputnik. The alarmist rhetoric continued through the early 1980s when the U.S. government published A Nation at Risk, arguing that the U.S. population was too poorly educated to compete in the global marketplace. While broad accusations of the report have since been challenged in literature such as Berliner and Biddle’s (1995) The Manufactured Crisis: Myths, Fraud, and the Attack on America’s Public Schools, the perceptions of schools in crisis remains. Furthermore, Stevenson and Stigler’s (1992) systemic study of schooling in Chinese, Japanese, and U.S. societies compounds the issue when it stated that Westerners are not convinced that teaching “should be one of our most esteemed professions” (p. 172).

In addition to these complex issues facing the current education system, the external pressures on public schools resulting from Goals 2000: Educate America Act and No Child Left Behind Act (NCLB) have school administrators looking for ways to restructure their responses to these mandates in order to improve student performance. To address these challenges,
administrators have incorporated practices on their campuses such as aligning curriculum with standardized tests (Popham, 1991), training their staff on how to analyze testing data (Calkins, J., Montgomery, K., & Santman, D., 1998), implementing differentiated instruction (Tomlinson, C.A., 1999), introducing programs that promote new literacy (Willinsky, 1990) and thoughtful literacy (Brown, 1992), and employing drill-and-skill methods of instruction (Calkins et al., 1998).

One possible solution to help change this climate of perceived failure within schools is to begin establishing professional learning communities (PLCs). The literature in Chapter 2 of this study pertaining to PLCs reports the many positive effects that a PLC has on the academic achievement of students as well as the climate of the school. Chapter 3 reveals the data analysis which details the positive effects that PLCs had in the research conducted for this study. The results, because they are based on a nationally representative sample, can be used to generalize the positive effects that PLCs would have in other studies.

Purpose

The purpose of this study is to examine data from the Early Childhood Longitudinal Study: ECLS-K Fifth Grade (ECLS-K) report, to identify questions and statements that correspond with the dimensions of PLCs, and to determine the effect PLCs have on student achievement based on the ECLS-K data. As a result, this study will measure the academic growth of individual students over time.

Specifically, this study examines the effect that the five dimensions of PLCs (shared and supportive leadership, shared values and vision, collective learning and application, shared personal practice, and supportive conditions) have on student achievement. The five dimensions
will be evaluated in isolation of the other dimensions as well as in combination with the other
dimensions in order to determine the effect on student achievement.

Theoretical Basis

The problems facing American public schools are not isolated within the actual schools. In fact, the crisis seems to be systemic. Hodgkinson (1991) highlighted further difficulties faced by U.S. schools: “One-third of preschool children are destined for school failure because of poverty, neglect, sickness, handicapping conditions or lack of adult protection and nurturance” (p. 10). In addition, “almost one quarter (23 percent) of children (birth to age 5) live in poverty; more than 80 percent of America’s one million prisoners are high school dropouts” (p. 10).

Schools cannot solve these problems alone, but they must see themselves as a major participant in the solution. One way educators can help to resolve these issues is through the development and implementation of school goals based on identifiable needs. Gardner (1991) provides a comprehensive examination of what the goals of education should be in *The Unschooled Mind*. He identifies the basic goal of education: to reach the broadest number of students in developing education for understanding. In doing so, Gardner would say that educators should have the following:

> A sufficient grasp of concepts, principles, or skills so that one can bring them to bear on new problems and situations, deciding in which ways one’s present competencies can suffice and in which ways one may require new skills or knowledge. (p. 18)

Within the same text, Gardner presented yet another challenge facing educators with the evidence pointing out that the modern school is not very well equipped to facilitate the development of the habits and skills of continuous learning on the part of students. He emphasized that much of the curriculum material presented “strikes many students as alien, if not
pointless” (p.149). He proceeded to explain how the current curriculum in reading and literacy, sciences, social science, humanities and the arts, the whole system in fact, fails to address students’ misunderstandings of subject matter. As a result, the current state of curricula essentially fails to provide comprehension within the programs of study and facilitates achievement gaps between student groups. Students are unable to grasp the fundamental concepts and cannot successfully apply those concepts to new situations.

Evidence of the lack of student achievement has been found in the results from The Nation’s Report Card: Reading 2005 and Mathematics 2007. The Nation’s Report Card is a publication of the National Center for Educational Statistics and its purpose is to inform the public about the academic achievement of elementary and secondary school students in the United States. These report cards detail the findings of the National Assessment of Educational Progress (NAEP), a continuing and nationally representative measure of achievement in various subjects over time. Specifically with the Reading 2005 and Mathematics 2007 Report Cards, there are evident achievement gaps that need to be addressed. For instance, 8th grade white students’ average reading scores from 1998 until 2005 have been 28 points higher than black students’ average reading scores and approximately 25 points higher than Hispanic students’ average reading scores. For the mathematics report card, the achievement gap is also evident. The achievement gap in performance between white students and black students between 1990 and 2007 has only decreased by one point on the average mathematics scores. The achievement gap in performance for average mathematics scores between white students and Hispanic students during this same time period actually increased by two points.

Given the aforementioned difficulties facing U.S. schools, there is a need for administrators to develop complex and dynamic solutions. Fullan (1992) discussed this issue by
suggesting that schools are social institutions under stress that need to evolve. Before a school can evolve, however, the administrators within the school must know how to implement change. Fullan explained that the only hope for the future lies in growing awareness and willingness to experiment from many quarters and many philosophical perspectives. In other words, no one person needs to identify all of the answers. Indeed, this may be exactly what is not needed. A new metaphor, offered by Fullan (1999), explains a possible solution:

But what will cause the diverse innovations needed to lead to a coherent overall pattern of deep change? I believe that the answer lies in a new guiding metaphor. Just as the machine metaphor shaped the thinking that created schools in the industrial age, the emerging understanding of living systems can guide thinking for the future. (p.52)

The implication is that the fundamental nature of reality is relationships, not things. Fullan (2005) asserted that “the foremost intellectual behavior for postindustrial society will be a heightened ability to think in concert with others” (p.204). David Hargreaves (2004) reminded us of Donald Schon’s (1973) observations, more than 30 years ago:

We must…become adept at learning. We must become able not only to transform our institutions, in response to changing situations and requirements; we must invest and develop institutions which are “learning systems,” that is to say, systems capable of bringing about their own continuing transformations. (p. 28)

The challenge, as Tom Bentley (2003) suggested, is the following:

But embedding high expectations and performance permanently in the workings of public service organizations means changing “whole systems,” often radically, and equipping them to adapt to more ongoing change. (p.9)

Fullan (2005) introduced the social aspect of the living system when he noted that if you want to change systems, “you have to increase the amount of purposeful interaction between and among individuals within and across the various levels of the system, and indeed within and across systems” (p.17). He has documented various problems that have occurred at the national level. He believes systems thinking can address many of these problems:
1. Yes, we know that current systems are working in isolation with terrible results, but we have known that for years.

2. Yes, collaboration is key, and you have to get agreement among all the teachers, but how do you do that, not to mention agreement among districts, governments, and the public?

3. Systems thinking is not just a cognitive endeavor in order to discover the whole picture and long-term trends. The goal is to understand the system and change it for the better.

4. Systems thinking means not only that given individuals or organizations can appreciate and take into account the larger system but also that individuals and organizations can be engaged with others outside themselves in order to change the very system that surrounds them.

5. For systems thinking to have its intended effect, it can’t be for a small group of specialists; it must be made practically accessible to the large group of new and emerging leaders. (pp. 42-43)

Because solutions rely, at least in part, on the users themselves and their capacity to take shared responsibility for positive outcomes, the outcomes arise from a combination of personal effort and wider social resources (Bentley & Wildsdon, 2003). Therefore, the focus of this research is to investigate the effects of gaining agreement among educators, getting individuals within the educational system to be engaged with others, and achieving systems thinking by a large group of people.

The key to changing systems is to produce greater numbers of systems thinkers. Systems thinking in a person means: “the ability to understand (and sometimes predict) interactions and relationships in complex, dynamic systems: the kinds of systems we are surrounded by and embedded in” (Senge, Cambron-McCabe, Lucas, Smith, Dutton, Kleiner, 2000, p. 239). If more and more leaders become systems thinkers, they will gravitate toward strategies that alter people’s system-related experiences; that is, they will alter mental awareness of the system as a whole, thereby contributing to altering the system itself.
Systems thinking was first proposed in 1990 by Peter Senge who described it as follows:

Human endeavors are also systems. They…are bound by invisible fabrics of interrelated actions, which often take years to fully play out their effects on each other. Systems thinking is a conceptual framework, a body of knowledge and tools that has been developed over the past fifty years, to make the full patterns clearer, and to help us to see how to change them effectively. (p.7)

Systems thinking, in terms of organizational behavior, is the integration of disciplines, fusing them into what Senge (1990) termed a “coherent body of theory and practice” (p.12). Senge goes on to note that in a learning organization there is a shift of mind from seeing ourselves as separate from the world to connected to the world, from seeing problems as caused by someone or something out there to seeing how our own actions create the problems we experience. Senge maintained a learning organization is a place “where people are continually discovering how they create their reality and how they can change it” (p.13).

Applied to an educational setting, this means involving everyone in the system in expressing their aspirations, building their awareness, and developing their capabilities together. In a school that learns, people who traditionally may have been suspicious of one another—parents and teachers, educators and local businesspeople, administrators and union members, people inside and outside the school walls, students and adults—recognize their common stake in the future of the school system and the things they can learn from one another (Senge, et al., 2000). These systems—the classroom, the school, and the community—interact in ways that are sometimes hard to see but that shape the priorities and needs of people at all levels. Senge went on to pose, “In any effort to foster schools that learn, changes will make a difference only if they take place at all three levels” (p. 11). Accordingly, one of the most promising ways to facilitate any change is to do so through professional learning communities.
At the forefront of current research and literature concerning ways to improve student performance is a large group of researchers who are suggesting that PLCs have a positive effect on student achievement (Senge, 1990; Fullan, 1995; Louis & Krause, 1995; Newman & Wehalge, 1995, Hord, 1997; DuFour & Eaker, 1998; Huffman & Hipp, 2003). The common element that ties all dimensions of PLCs together is purposeful collaboration among the faculty. In addition to being the thread that binds the components of a PLC together, the purposeful collaboration among faculty is the basis for choosing the variables within the culmination of data found in the ECLS-K.

Statement of Problem

How to positively impact student achievement is a problem that educators are struggling with on a daily basis. There have been numerous attempts to address the issue of improving students’ academic performance. From differentiated instruction to teaching students a scripted curriculum, educators have been experimenting with various methods that have had mixed results. Although there are a range of ideas, programs, and strategies that can be brought in to a school, the benefits of a well-established professional learning community within a school may be a practice that has a positive impact on the academic growth of individual students. This study will investigate the type of influence that PLCs have on student achievement.

Research Questions

The questions that guided this dissertation are the following:

1. What is the effect of professional learning communities (PLCs) on student achievement over time in math among United States elementary students?
2. What is the effect of professional learning communities (PLCs) on student achievement over time in reading among United States elementary students?

Definition of Terms

- **Correlation coefficient** – A mathematical expression of the direction and magnitude of the relationship between two measured variables.

- **Design effect** – The ratio, for a given statistic, of the variance estimate under the actual sample design to the variance estimate that would be obtained with a simple random sample size (Raudenbush, S.W. & Bryk, A.S., 2002).

- **Effect size** – An estimate of the magnitude of a difference, a relationship, or other effect in the population represented by a sample (Gall, M., Gall, P., & Borg, W., 2003).

- **Item-response theory (IRT)** – An approach to test construction based on the assumptions that: 1) an individual’s performance on a test item reflects a single ability; 2) individuals with different amounts of that ability will perform differently on the item; and 3) the relationships between the variables of ability and item performance can be represented as a mathematical function (Gall, M., Gall, P., & Borg, W., 2003).

- **Longitudinal study** – Involves collecting data from a sample at different points in time in order to study changes or continuity in the sample’s characteristics (Gall, M., Gall, P., & Borg, W., 2003).

- **Mean** – A measure of central tendency calculated by dividing the sum of the scores in a set by the number of scores (Gall, M., Gall, P., & Borg, W., 2003).

- **Multilevel analysis** – A research technique in which data can be analyzed at more than one level of grouping.

- **Paradigm** – A pattern, an example, or a model of thought or belief.
• Primary sampling unit (PSU) – Counties or groups of counties in the United States that were selected for ECLS-K data collection. From the PSUs, public and private schools were selected.

• Professional learning community (PLC) – A school’s professional staff members who continuously seek to find answers through inquiry and act on their learning to improve student learning (Astuto, Clark, Read, McGree, & Fernandez, 1993). The five characteristics of PLCs are shared and supportive leadership, shared values and vision, collective learning and application, shared personal practice, and supportive conditions (Huffman & Hipp, 2003).

• Standard deviation – A measure of the extent to which the scores in a distribution deviate from their mean (Gall, M., Gall, P., & Borg, W., 2003).

• Systems thinking – The ability to understand (and sometimes predict) interactions and relationships in complex, dynamic systems: the kinds of systems we are surrounded by and embedded in (Senge, Cambron-McCabe, Lucas, Smith, Dutton, and Kleiner, 2000, p. 239).

• Variable – A quantitative expression of a construct (e.g., academic motivation) that can vary in quantity or quality in observed phenomena (Gall, M., Gall, P., & Borg, W., 2003).

Assumptions

The underlying assumption of this study is that the responses to the questions or statements selected from the ECLS-K data that represent the components of a professional learning community, would show growth in the academic achievement of students. It is assumed that the ECLS-K data is both valid and reliable. The statements for each response for each question are dependent upon the teacher’s perception of the question. Therefore, it is assumed that the findings can be generalized nationally.
Delimitations

The results that may prevent the findings from being true for all people in all times and places are the following:

1. The use of self-administered questionnaires completed by teachers regarding the surveyed students they teach may contain bias.

2. The one-to-one assessment of a child’s cognitive skills may be skewed because of a lack of the natural surroundings of the classroom.

3. The use of telephone interviews or computer-assisted personal interviewing of parents regarding their children may contain bias.

4. The respondents of the survey will only be tracked until the completion of their eighth grade year and, therefore, the results may not be generalized to the achievement of secondary students.

5. The fact that the survey was quantitative in nature could be a limitation because the participants were not asked to explain their responses.

Limitations

This section lists limitations important to this study. These limitations represent this particular study and are presented to provide additional understanding.

1. There may be limitations due to the multiple-treatment interfaces that all respondents receive every two years.

2. There may be limitations due to the maturation of respondents.

3. There may be limitations due to experimental mortality of respondents within the sample.

4. The location of each school is not detailed.

Significance

The significance of this research is that it provides data on factors that positively affect the academic growth of students. Specifically, the use of the hierarchical linear modeling (HLM)
detailed in chapter 3 is significant because it will measure growth over time beginning with third grade. This is a much more powerful analysis of data compared with analyses not measuring growth by using data collected at only one point in time. With a beginning sample of 22,000 respondents comprising various stakeholders in schools, the ECLS-K data is voluminous in the amount of rich data it can offer to researchers, and its adaptability to various topics of study is considerable. For this research, questions and statements from the ECLS-K were chosen that directly relate to the five dimensions of PLCs. This data represents the results of research of the original kindergarten cohort group (1999) through their fifth grade year (2004). This research can serve as a springboard for future research for those interested in exploring the effects of professional learning communities. Furthermore, once the ECLS-K data has been fully analyzed and reported, it will provide comprehensive and reliable data that may be used to describe and to better understand children’s development and experiences in the elementary and middle school grades and how their early experiences relate to their later development, learning, and success in school.

Organization of the Study

Chapter 1 of this study gave a brief historical context of the problems that exist within the American education system, the purpose of this study, the theoretical basis for professional learning communities, the statement of the problem, the research questions that will guide this study, the definition of terms, the assumptions of this study, the delimitations of this study, the limitations of this study, and the significance of this study.

Chapter 2 of this study presents the literature review regarding professional learning communities. Chapter 3 of this study details the methodology and procedures of the study. In
addition, it explains the data collection procedures and data analysis. Chapter 4 of this study reports the findings of the data analysis. Chapter 5 of this study provides conclusions, implications, summary, and areas for future research.
CHAPTER 2

REVIEW OF LITERATURE

Introduction

The external pressures on public schools resulting from Goals 2000 and No Child Left Behind Act (NCLB) have school administrators looking for ways to restructure their responses to these anxiety-producing forces in order to improve student performance. In 1989, President George Bush convened the nation’s governors for a summit meeting on education. The result of this summit was the identification of Goals 2000 – six national goals for education, which stipulated by year 2000:

1. All children in America will start school ready to learn;
2. The high school graduation rate will increase to at least 90%;
3. American students will leave grades four, eight, and twelve having demonstrated competency in challenging subject matter, including English, mathematics, science, history, geography, and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our modern economy;
4. U.S. students will be first in the world in mathematics and science achievement;
5. Every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship; and
6. Every school in America will be free of drugs and violence and will offer a disciplined environment that is conducive to learning. (United States Department of Education, 1994)

For educators to accomplish these objectives in a ten-year span is idealistic. If these goals did not put enough pressure on the public education community, then they were certainly supplemented by the passage of NCLB and the lofty mandates found within this legislation.

The adequate yearly progress (AYP) provision of NCLB states that all schools must have 100% of all students performing at proficiency levels by the 2013-2014 school year. Within this
timeframe, if a school does not meet AYP in two-year increments, the school could lose federal funding and it will be taken over by a state education agency in order to provide help. This certainly sent school officials scrambling to find solutions to the lack of academic progress of their students. Although there has been progress in the academic growth of students, the mandate of all students performing at proficiency levels by the 2013-2014 school year is quite ominous.

One of the inhibiting factors that has kept schools from becoming successful is a lack of focus. John Hood (1993) stated, “Many American critics believe that the major problem with public education today is a lack of focus…” (69). This lack of focus may be due to the absence of purposeful collaboration in public schools. According to Hughes and Kritsonis (2006) teaching in isolation has become the norm for schools, especially at the secondary level. Far too often, teachers have kept what worked in the classroom secretive without contributing to the professional knowledge base of the learning community of the school. Hughes and Kritsonis proposed a solution in which teachers and schools need to see a sharing of ideas as a valuable practice. Homer-Dixon (2000) argued the following:

The complexity, unpredictability, and pace of the events of our world . . . are soaring. If our societies are to manage their affairs and improve well-being they will need more ingenuity, that is, more ideas for solving their technical and social problems. We face an ingenuity gap—a shortfall between [the] rapidly rising need for ingenuity and [its] inadequate supply. (p.2)

A way to solve this ingenuity gap is to foster focused collaboration within professional learning communities (PLCs) in order to cultivate and amass the wisdom of the group. However, collaborative efforts in schools have generally been unsuccessful in providing the leadership, understanding, and motivation needed to empower staff members to create the collective vision based on shared values that align curriculum, instruction, assessment, and supporting programs.
for schools (Fullan, 1995; Guskey & Peterson, 1993; Lindle, 1995/1996; Newman & Wehlage, 1995). Evidence of this literature can be found in the data of the School and Staffing Survey (SASS) of 1999-2000 conducted by the National Center for Educational Statistics (NCES). The SASS is a study that emphasizes teacher demand and shortage, teacher and administrator characteristics, school programs, and general conditions in schools.

The SASS data indicate that only 34% of teachers feel that cooperative efforts among staff are high within public schools. Also in the data report, merely 33% of public schools teachers feel that there are any types of collaborative efforts in schools. In addition, there are 67% of teachers who do not feel that their colleagues share the mission of the school. Finally, the data shows that 38% of public school teachers reported that they consciously coordinate with other teachers. What this research reveals is that there is a perceived lack of collaboration among American public school teachers.

Some research suggests that developing professional learning communities might be the organizational strategy that could improve student achievement (DuFour & Eaker, 1998; Louis & Kruse, 1995). School reform, according to Cuban (1988), can be categorized as either first- or second-order changes. First-order changes are those administrative changes that improve current practices by more efficient and effective strategies. Second-order changes are systemic transformations that attempt to alter the basic components of organizations, including structures, goals, and roles. According to Huffman (2003), the professional learning community model represents second-order change as reflected by the substantial and profound changes that occur in relationships, culture, roles, norms, communication patterns, and practices. Newman and Wehlage (1995) posed that as a result of a strong professional community, students learn:

they are expected to work hard to master academic material, staff and peers have confidence that, in the long run, students will be successful if they work hard on
academic tasks; and staff will give them help and support, both through individual teaching/tutoring and by establishing classroom norms where learning is taken seriously, where peers are expected to help one another, and where student have the opportunity to make mistakes and try again without being judged “stupid.” (p.39)

According to DuFour and Eaker (1998), this collaboration within a professional learning community is “the most promising strategy for sustained, substantive school improvement” (p. xi). Furthermore, Darling-Hammond (1996) added that shared decision making, a PLC dimension, is a factor related to curriculum reform and the transformation of teaching roles in some schools. In addition, Hord (1997a) argued: “As an organizational arrangement, the professional learning community is seen as a powerful staff development approach and a potent strategy for school change and improvement” (p. 2).

According to the School Restructuring Study (SRS) found in Newmann and Wehlage (1995), the level of professional community in a school had significant effects on student achievement whether achievement was measured as authentic performance or tested in more conventional ways. The effects of professional community on authentic performance in mathematics and social studies are evident in two main results from the SRS of 24 elementary, middle, and high schools. Overall, if two average students, one in a school with low teacher professional community, and the other in a school with high professional community, the students in a high community school would score about 27% higher on the SRS measure. This difference would represent a gain of 31 percentile points.

History of School Organizations

Increasingly, school administrators and teachers are encountering internal and external pressures relating to improved student achievement that are causing them to challenge traditional ways of thinking about schools as organizations. Historically, schools have been allegorized as
knowledge-producing factories of individual efficiency, with teachers being the producers and students being the product. According to Leonard and Leonard (2001), “consequently, schools have been fashioned to reflect and perpetuate cultures of individualism, competitiveness, and isolation” (p. 321). This organizational division obstructs the creation of new school cultures that replicate a more communal dimension of schools as ethical societies. Schools modeled on the qualities of community values supplant contractually based precepts, and foster cultures of collaboration grounded in strong moral ties. The increased interest in collaboration (Friend & Cook, 2000; Jordan, 1999) is rooted in changes in thinking about what makes an organization effective and what constitutes leadership. Table 1 summarizes the three major developments in administrative thought and practice.

The genesis of current shared practice may be examined in applying paradigms of organization and leadership theories. Traditionally, organization theory rooted in business and industry attributed the power of leadership to those assuming formal roles legitimated by hierarchical structures. For example, classical theorists, representing Taylor’s principles of scientific management, Weber’s characteristics of the ideal bureaucracy, and Fayol’s general principles of management, relied heavily upon hierarchy, one-way command structure, top-down decision making, compartmentalization of units, and specialization of responsibilities and tasks (Leonard & Leonard, 2001). These classical theorists believed that applying the bureaucratic structure and processes of organizational control would promote rational, efficient, and disciplined behavior and make possible the achievement of well-defined goals. In his book, *Educational Organization and Organizational Behavior*, Hansen (2003) writes the following:

Efficiency, then, is achieved by arranging positions within an organization according to hierarchy and jurisdiction. Scientific procedures are used to determine the best way of performing a task, and then rules are written that require workers to perform in a prescribed manner. Experts are hired for defined roles and are grouped according to task
### Table 1

**Overview of the Three Major Developments of Administrative Thought and Practice**

<table>
<thead>
<tr>
<th>Period</th>
<th>Management Elements</th>
<th>Procedures</th>
<th>Contributors and Basic Concepts</th>
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<td>Management Elements</td>
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<td>Contributors and Basic Concepts supervisor</td>
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<td>Machine</td>
<td>Fayol-five basic functions, fourteen principles of management</td>
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<td></td>
<td>Production</td>
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<td>Process</td>
<td>Anticipated Consequences</td>
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<td>Rules, coercive</td>
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<td>Process</td>
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<td>Management Elements</td>
<td>Procedures</td>
<td>Contributors and Basic Concepts</td>
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<tr>
<td>Behavioral Science Approach</td>
<td>Consideration of all major elements with heavy emphasis on contingency leadership, culture, transformational leadership, and systems theory</td>
<td>McGregor; Follett; Greenleaf; Pollard Burns; Covey Goleman; Senge, Handy</td>
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specialization. Within the classical theory framework, the individual worker was conceived of as an object, a part of the bureaucratic machine. (p. 5)

In response to the changing and complex needs of contemporary society, recognition of the value of moving from a “cult of efficiency” (Friend & Cook, 2000, p.15) to collaboration for achieving organizational goals grew. Skepticism emerged surrounding organizational and leadership practices perceived to deny the importance of human resources, community building and collaboration. For example, some students of organizational behavior began to turn their attention to the importance of participative decision making (Follet, 1926/1996) and of tapping into workers’ expertise and potential (McGregor 1957/1996). Early in the 1930s, the Hawthorne studies demonstrated workers have strong social needs, and they value cooperation, creative relationships, and feelings of belonging. According to Miles (1965), creating opportunities for workers to share their creativity and expertise would improve decision making and increase their participation and satisfaction. These ideas retain their prevalence in recent systems organization literature. Senge (1994), for example, wrote of learning organizations where members are encouraged to channel, cultivate, and learn from each others’ ideas and expertise. Leonard and Leonard (2001) stated: “leaders, therefore, have been encouraged to jettison traditional management practices for non-hierarchical ones whereby all workers would contribute, share in the decision making, and achieve their potential” (p. 385). This type of intentional group effort is discussed in the next section and it seems to be rapidly growing as a form of leadership within school organizations.

Shared and Collaborative Leadership

Shared and collaborative leadership styles are described and labeled in various ways. Alternative and more inclusive views of what constitutes a leader are given full consideration in
contemporary treatises on leadership in public, private and non-profit organizations (Drucker, 1996). Reconceptualizations include, among others, notions of servant leaders (Greenleaf 1977/1995; Pollard, 1996), transformational leaders (Burns 1978/1995; Senge, 1990), principle-centered leaders (Covey, 1991), emotionally intelligent leaders (Goleman, 1998), and distributed leaders (Handy, 1996). These leadership concepts have their educational counterparts (Greenfield, 1980; Sarason, 1990; Sergiovanni, 1990 and 1996; Hodgkinson, 1991 and 1996; Leithwood, 1992; Starratt, 1993 and 1999; Blackbourn, 1999/2000), particularly in the reconceptualization of leadership which emphasize “its connection with moral dimensions” (Telford, 1996, p.8). This was intimated by Benjamin Gruenberg (1912) when he noted in *American Teacher* that education should measure its efficiency in terms of increased humanism, increased power to do so, and increased capacity to appreciate.

Non-educational organizations adopted notions of collaboration primarily because a shift to shared leadership and participative decision making increases their productivity (Leithwood, 1992). Friend and Cook (2000) determined that as collaboration is increasingly recognized in “business, industry, and general society, we are also learning to do it [in] schools” (p. 15). In school organizations, Sergiovanni (1996) asserted, the role of the principal would remain important, but would take on an investment character aimed at purposing and capacity-building. In this manner, Sergiovanni (1996) also stated that new teachers, students, parents, and other stakeholders become bound by a set of “obligations result[ing] from common commitments to shared values and beliefs” (p. 34). Increasingly, in the context of education, shared governance and democratic decision making have emerged from various studies as constituting a condition that promotes the development of a professional learning community (Hord, 1997). Consequently, hierarchical, top-down management, and control have given way to considering
other ways of viewing schools as organizations that include the practice of facilitative or transformational leadership, teacher empowerment, and shared decision making—the so-called moral community (Leonard & Leonard, 2001). According to Kruse and Louis (1997), community is seen as: “the antidote to bureaucracy, which may be efficient but depersonalizes the important development processes and ethical or moral dimensions of organizational life” (p. 261).

Collaboration may be the response to neutralizing internal and external pressures placed on educators as well as being the cause of reconceptualizing schools as moral communities. DiPardo (1997) suggested collaboration “may promote the creation of school communities ... places that celebrate risk-taking, that encourage teachers to assume the habits of interdependence and shared leadership” (p. 100). Reconceptualizing schools as democratic, professional, collaborative learning communities has significant implications for both the leader and the led in the school community (Hord, 1997). While there is general acknowledgement that there is no one best way to lead (Blackbourn, 1999/2000), advocates of the school-as-community metaphor assert that professional learning communities are more likely to flourish when administrators have an affinity for a non-hierarchical leadership style (Hord, 1997; Leonard & Leonard, 1999; Blackbourn 1999-2000).

Professional Learning Communities

According to Huffman (2003), the term “professional learning communities” (PLCs) has emerged from organizational theory and human relations literature. PLCs are linked to Senge’s (1990) description of a learning organization in which “people continually expand their capacity to create desired results, where new and expansive patterns of thinking are nurtured, where
collective aspiration is set free” (p. 3). According to Fullan (2004), the crux of the learning organization is a shift of mind from that of seeing ourselves as separate from the world to connected to the world, from seeing problems as caused by something external to seeing how our own actions create the problems we experience. The learning organization that Senge (1990) proposed has five disciplines: personal mastery, mental models, shared vision, team learning, and systems thinking. Fullan (2004) suggests systems thinkers in action actually create the intellectual ideas and moral purpose and social commitment conditions that increase motivation without sapping energy. While learning organizations were created for the business sector, they easily transfer to the world of education (Hughes & Kritsonis, 2006). This is evidenced in the aforementioned attributes of Hord’s (1997a) PLCs. As Senge’s concept was shared with educators, the learning organization name was changed to learning communities (Hughes & Kritsonis, 2006). In an interview with Schultz (1999), Senge said the following:

To meet today’s challenges of globalization, changing work forces, evolving competition, and new technologies, the only hope for building and sustaining momentum in a learning organization requires a fundamental shift in thinking and actions. (p.1)

Hughes and Kritsonis (2006) assert that creating an organization with an emphasis on developing the attributes of a learning organization will have the potential of allowing organizations or schools to be more welcoming and creative.

Lieberman, in an interview with Sparks (1999), described PLCs as “places in which teachers pursue clear, shared purposes, engage in collaborative activities to achieve their purposes, and take collective responsibility for students’ learning” (p.53). DuFour (2004) noted powerful collaboration that is typical of PLCs is a logical process in which teachers become more engaged and pool resources to evaluate and improve their classroom practice. As a result, Sergiovanni (1996) purported that this helps create a school culture where people are morally
bound to collective goals. Furthermore, Sergiovanni noted, this community will be a “collection of individuals who are bonded together by natural will and who are together bound to a set of shared ideas and ideals” (p. 48). Fullan (2004) suggested that without engagement you don’t get the ingenuity and creativity of practitioners that is necessary for developing new and better solutions. In simplistic terms, Fullan stated any approach to reform, “must make the extraordinary do-able” (p.4). Senge (1990) said that learning organizations will be the only truly successful institution of the future. Sparks (as cited in DuFour et al., 2004) asserted: “successful professional learning communities clearly demonstrate what is possible when teachers learn and collaborate within their schools as part of their daily work” (p. 156). Darling-Hammond noted this participation in PLCs through school and teacher networks also “deepens teachers’ understanding” (p.753) of how to improve student achievement. Watkins and Marsick (1999) affirmed: “A centerpiece of reform recommendations is that parents, teachers, administrators, staff members, and students join together to learn their way through change as communities of inquiry and experimentation” (p. 78). The common thread of educators working together collaboratively to improve both instructional practices and student performance can be accomplished through professional learning communities (Hughes & Kritsonis, 2006). As good as the literature says PLCs are to educational settings, the establishment of one is not a simplistic undertaking.

Huffman (2003) cautioned that establishing mature PLCs is no easy task: “Developing the capacity of individuals and staff members to engage in meaningful reform and restructuring to benefit students continues to be the challenge for school leaders” (p.21). In addition, Lezotte (as cited in DuFour et al., 2004) concluded that school restructuring could be “neither successful nor sustainable unless it was embraced by the teachers, administrators, and support staff that
define the professional learning community” (p. 48). In summarizing Fullan (2004), any solution for improvement must do two things: it must mobilize the ingenuity and creative resources of a critical mass of the whole system, and it must foster a we-we or collective commitment. Furthermore, Boyd (1992a, p.7) brought to light what needs to happen before change takes place in an educational setting. Figure 1 details the indicators of an educational context that would be conducive to change.

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**REDUCING ISOLATION**
- Schedules and structures that reduce isolation
- Policies that foster collaboration
- Policies that provide effective communication
- Collegial relationships among teachers
- A sense of community in the school

**INCREASING STAFF CAPACITY**
- Policies that provide greater autonomy
- Policies that provide staff development
- Availability of resources
- Norm of involvement in decision making

**PROVIDING A CARING, PRODUCTIVE ENVIRONMENT**
- Positive teacher attitudes toward schooling, students, and change
- Students’ heightened interest and engagement with learning
- Positive, caring student-teacher-administrator relationships
- Supportive community attitudes
- Parents and community members as partners and allies

**PROMOTING INCREASED QUALITY**
- Norm of continuous critical inquiry
- Norm of continuous improvement
- Widely shared vision or sense of purpose

*Figure 1.* Indicators of a context conducive to change (Boyd, 1992a).

Depending on the research, there are usually five or six distinguishing dimensions of professional learning communities. The transition from Senge’s (1990) disciplines (personal mastery, mental models, shared vision, team learning, and systems thinking) of learning organizations to the dimensions of professional learning communities has been evidenced in the
work of Hord (1997), DuFour and Eaker (1998), and Huffman and Hipp (2003). Hord’s (1997a) attributes include the following: 1) supportive and shared leadership, 2) collective creativity, 3) shared values and visions, 4) supportive conditions, 5) and shared personal practice. DuFour and Eaker (1998) identify the characteristics as 1) shared value mission, vision and values, 2) collective inquiry, 3) collaborative teams, 4) action orientation and experimentation, 5) continuous improvement, and 6) results orientation. According to Huffman and Hipp (2003) these dimensions include 1) shared and supportive leadership, 2) shared values and vision, 3) collective learning and application, 4) shared personal practice, 5) supportive conditions-relationships, and 6) supportive conditions-structures. A close reading within and among the dimensions of each definition of professional learning communities reveals that collaboration of some sort is the unifying force that under-girds each of these frameworks.

**Shared and Supportive Leadership**

Sergiovanni (2001) stated that schools should be *nested communities*, in which collections of people are tied together by common foundational values. Prior to this, Sergiovanni (1994) noted: “The sources of authority for leadership are embedded in shared ideas” (p.34). These values result in “commitment to both individual and shared responsibilities” (p. 34). Furthermore, Darling-Hammond (1996) suggested shared decision making is a factor related to curriculum reform and the transformation of teaching roles in some schools. Therefore, according to Hall and Hord (1987), systems can change as long as individuals within those systems are included within the decision making process. In addition, Prestine (1993) stated this reconceptualization of the role of principals as primary decision makers within professional learning communities facilitates the work of staff. Klein-Kracht (1993) posed the traditional
pattern that teachers teach, students learn, and administrators manage is altered such that
everyone contributes in the quest for effective solutions to school problems. This was shown in
the work of Senge (1990), Block (1993), and Galagan (1994), which emphasized the importance
of celebrating the work of the individual staff person and of supporting the collective
engagement of staff in such activities as shared vision development, problem identification, and
problem resolution (Hord, 1997a). It is the task of school leaders to both develop and lead
leaders. Johnson (1996) emphasized this when she wrote:

Today’s school leaders must understand both the limits and the potential of their
positions, carefully balancing their use of positional authority with their reliance on
others, gradually building both a capacity and widespread support for shared leadership.
(p. 65)

According to Fullan (2004), the best system produces a culture in which it becomes easier to
accomplish more by moving beyond dependence on the heroic or martyr-like efforts of a few to
fostering leadership in others. Glickman (2002) stated this earlier when he suggested that if a
school leader understands that the “use of multiple structures with multiple leaders for assisting,
focusing, and improving classroom teaching and learning, then continuous improvement can
become an ongoing reality” (p. 9). This was corroborated by Mintzberg (2004) when he observed
“successful management is not about one’s own success but about fostering success in others”
(p.11) Fullan (1992) earlier asserted, “Rather than impose their individual visions, principals
would do well to develop collaborative work cultures” (p. 38). James Surowiecki (2004) termed
this “accessing the wisdom of the crowds” and he suggested four conditions for collective
wisdom to function well:

1) the members need to feel independent of one another – where people’s opinions
are not determined by those around them; 2) the members need to be diverse enough
to represent the range of backgrounds, needs, and interests of the group; 3) they need
to be sufficiently decentralized, whereby people are able to specialize and draw on
local knowledge; and 4) there has to be some means, either formal or informal, of
aggregation or turning independent judgments or information into collective decisions. (p. 47)

In other words, the answer is a mixture of disciplined collaborative networks on one hand and intelligent accountability on the other (Milliband in Fullan, 2000). Networks do build in a strong, but not complete, measure of accountability. As such communities interact around given problems, Fullan (2004) asserted, they generate better practice, shared commitment and accountability to peers and other constituencies. As evidenced in the 1999-2000 SASS, teachers do not feel that they have enough control of school policy linked closely with teaching. Only 44% of public school teachers felt that they had some sort of influence in establishing the curriculum at their school. The percentage dropped to 37.6% when teachers were surveyed on their perceived influence over setting student performance standards. In regards to inservice training in public schools, only 32% of teachers felt that they exhibited influence over what type of training is selected and implemented. In SASS, it is reported only 41.8% of teachers strongly agreed administration is helpful and supportive. In essence, this means teachers do not feel that their administrators have a philosophy of shared and supportive leadership.

**Shared Values and Vision**

The SASS also indicates that less than half (48%) of public school teachers feel that their school goals are communicated clearly. In addition, only 49.7% of public school teachers agreed that their principal expressed his or her expectations for the staff. Clearly, with fewer than half of all public school teachers knowing the goals of the school as well as not knowing the expectations of the principal, public schools are not havens of shared values and vision. According to Huffman (2003): “It is crucial . . . to understand that the emergence of a strong, shared vision, based on collective values provides the foundation for informed leadership, staff
commitment, student success, and sustained school growth” (p. 32). Newman and Wehlage (1995) emphasized clear shared goals maximize teacher success through collective reinforcement and improvement of teacher efficacy. Furthermore, Scribner, Cockrell, Cockrell, and Valentine (1999) asserted that organizational learning is a process that can lead to change and is the result of the critical evaluation of underlying values and assumptions that guide behavior. Kotter’s (1990) research led him to conclude the following:

The principal’s most significant effect on student learning comes through his or her efforts to establish a vision of the school and develop goals related to the accomplishment of the vision. Shared leadership and aligning people to a vision is crucial and leads to a “leadership-centered culture.” (p.11)

Huffman (2003) suggested that the task of the educational leader is to share and combine the personal visions of the faculty members into a single collective vision to be embraced by all. Fullan (2004) noted that when best ideas are freely available and cultivated, when collective identity prospers, there is a change in the very context of the local system. The context of system will change in a way that benefits all schools. Hord (1997a) advised sharing a vision creates a mental image of what is important to an individual and to the organization. Hord (1997a) suggested transforming the school organization into a learning community can only be done with the leaders’ sanction and active nurturing of the entire staff’s inclusion in developing vision for the school. In addition, staff sharing fuels school improvement that has an undeviating focus on student learning. Because the ideas are better and because people are committed to each other, more can get done with less effort when vision and values are shared (Fullan, 2004).

Hallinger and Heck (1996) also noted the most significant effect on student learning comes through the principal’s efforts to establish a vision of the school and to develop goals related to the accomplishment of that vision. Furthermore, Hallinger and Heck (1996) also maintained that visionary leadership combined with shared and collaborative strategies provide
support for faculty to invest the time and effort needed to create the school vision. There is widespread recognition that, when teachers have common educational goals and hold similar beliefs and values about education, there are greater tendencies to move towards collaborative practices (Odden & Wohlstetter, 1995; O’Neill, 1995; Hord, 1997b). In their identification of important leadership tasks and functions as part of a collaborative community of practice, Spillane, Halverson, and Diamond (2004) pointed out that developing a vision for the school and building norms of trust and collaboration as essential functions of leaders of schools. DuFour and Eaker (1998) examined the co-creation of shared vision:

The lack of a compelling vision for public schools continues to be a major obstacle in any effort to improve schools. Until educators can describe the school they are trying to create, it is impossible to develop policies, procedures, or programs that will make that ideal a reality . . . . Building a shared vision is the ongoing, never-ending, daily challenge confronting all who hope to create learning communities. (p.64)

They went on to add that what separates a learning community from an ordinary school is its “collective commitment to guiding principles that articulate what the people in the school believe and what they seek to create” (p. 25). Additionally, Hord’s (1997a) research described the adhesive effects of co-creating vision. She defined vision as a concept in a learning community that leads to “binding norms of behavior that have a primary focus on student learning and are supported by the staff members” (p. 3) in a climate made possible by mutual trust and respect. Above all, it means greater connectivity within and among levels of the system because cohesion involves bringing diverse elements together amid common principles and habits. It is less a matter of alignment, and more a matter of permeable connectivity (Fullan, 2004) within the school community. MacMullen (1996), in a review and analysis of factors influencing Coalition of Essential Schools reform, also concluded that a significant requirement for impact is the inclusion of the whole faculty in developing the vision, understanding of the mission and
purpose for which they are engaging, and deciding how to carry out their reform plans.

Collective Learning and Application

Fullan (2004) stated: “It is not so much that we have to put blind trust in the wisdom of crowds, but rather we have to create the conditions under which local wisdom can be amassed and mined” (p. 7). One way to do this is through direct observation of teachers. According to Larsen (1987) principal’s instructional leadership can include observing teachers in the classroom and providing constructive evaluations, requiring teachers to do work collaboratively, providing substantive training in teaching methods, and working directly with teachers to develop new curricula or teaching techniques. In Larsen’s (1987) study, high-achieving schools had principals who visited classrooms and talked to teachers frequently about instructional methods and content. However, only 11% of public school teachers surveyed in the SASS said that their principals often discussed instructional practices with them. As Hargreaves (2004) noted, the focus must be on disciplining innovation - the continuing identification of high-leverage best practices and in-depth interaction conducive to transferring the cultivation of collective identity (similar to the aforementioned we-we concept, p. 28).

Peterson, McCarthy, and Elmore (1996) found that successful school restructuring involved teachers meeting together as a whole staff or in teams. DuFour and Eaker (1998) emphasized that the “basic structure of the professional learning community is a group of collaborative teams that share a common purpose” (p.26). Senge (2000) said: “A strong professional community encourages collective endeavors rather than isolated individual efforts” (p. 327). Lambert (2000) endorsed this view by stating: “leadership needs to be embedded in the school community as a whole [because] leadership is about learning together, and constructing
meaning and knowledge collectively and collaboratively” (p. 3). Haberman (2004) proposed that an attribute of a learning community is collaboration where star teachers become involved in team teaching and other collaborative efforts in program development, writing, and research in order to transfer best practices among teachers. Achinstein (2002) suggested a renewed interest in fostering teacher community or collaboration as an avenue to foster collective learning and application that results in decreased isolation, improved teacher practice, and improved student learning. The 2001 report of the National Association of Secondary School Principals on the high school of the 21st century titled, *Breaking Ranks: Changing an American Institution*, echoed this by stating:

The success of a high school depends on its being more than a collection of unconnected individuals. The word “community” implies a commonality of interests and so it should be in any high school. The building of a community very much involves the members of the staff. And, on a practical level, the synergy of cooperation ought to end up enabling the educators in a high school to accomplish more for the students than they could by acting on their own. School improvement more readily succeeds in situations in which teachers work in a collegial manner. (p. 90)

Ross, Smith, and Roberts (1994) refer to the collective inquiry process as “the team learning wheel” and identify four steps in the process:

1. Public reflection – members of the team talk about their assumptions and beliefs and challenge each other gently but relentlessly.
2. Shared meaning – the team arrives at common ground, shared insights.
3. Joint planning – the team designs action steps, an initiative to test their shared thoughts.
4. Coordinated action – the team carries out the action plan. This action need not be joint in action but can be carried out independently by the members of the team. (p. 59-64)

By analogy, one toothpick is a very useful tool and can withstand various pressures. However, a collection of toothpicks bound together is much stronger and can withstand exponentially more pressure than a single toothpick.
McLaughlin and Talbert (1993) suggested that when experienced teachers had opportunities for collaborative inquiry and its related learning, the result was a body of wisdom about authentic instruction that could be widely shared with individuals. On the other hand, Lee, Smith, and Croninger (1995) posed that authentic instruction presents complex challenges to teachers in that there is no magic formula for getting teachers to collaborate about their pedagogical practices. They went on to state that authentic instruction seems to demand a communal or organic social organization. Furthermore, Newman and Wehalge (1995) asserted the following:

When teachers collaborate productively, they participate in reflective dialogue to learn more about professional issues; they observe and react to one another’s teaching, curriculum, and assessment practices; and they engage in joint planning and curriculum development. By enriching teachers’ technical and social resources, collaboration can make teaching more effective. (p.38)

According to Fullan (2004), it is clear that deep pedagogy and deep learning cultures feed on each other. As evidenced in Louis and Kruse (1995), a review of teacher’s behavior by colleagues is the norm in the professional learning community. In addition, Pugach and Johnson (1995) proposed that collaborative schools are more likely to become communities of learners in which all participants would contribute to their own and each other’s growth. Consistent with Hord’s (1997a) findings, this practice is not evaluative but is part of a peers-helping-peers process based on the desire for individual and community improvement and is enabled by the mutual respect and trustworthiness of staff members. Hargreaves (2004) termed this lateral capacity and he laid out the conditions in which it flourishes: sufficient learning for ongoing purposeful exchange; a limited focus which can be pursued in depth in order to identify specific, high yield best practices; and mechanisms for transferring and implementing best ideas. Thus,
shared ideas and commitment are simultaneously being cultivated (Fullan, 2004). Pfeffer and Sutton (2000) made a similar point when they proposed embedding “more of the process of acquiring new knowledge in the actual doing of [teaching] and less in formal training programmes that are frequently ineffective” (p. 32). According to these authors, nothing surpasses learning in context for the development of improved and focused instructional strategies.

**Supportive Conditions**

The first area of supportive conditions is the educational facility. John Lyons (2001) reported there have been numerous studies that have shown higher test scores for students learning in better buildings. In addition, Lyons mentioned a report evaluating school facilities in Milwaukee in which it was shown that facility conditions may have a stronger effect on student performance than the combined influences of family background, socio-economic status, school attendance, and behavior. This was evidenced in the work of Lee, Bryk, and Smith (1993) when they noted that student achievement gains and other benefits are influenced by organizational characteristics beyond the skills of individual teachers. Louis and Kruse (1995) identified the following physical factors that support learning communities: time to meet and talk, small size of the school and physical proximity of the staff to one another, teaching roles that are interdependent, communication structures, school autonomy, and teacher empowerment. These characteristics gave credit to Boyd’s (1992) list of physical factors that are conducive to school change and improvement. In summary, these physical factors include the following: the availability of resources; schedules and structures that reduce isolation; policies that provide greater autonomy, foster collaboration, provide effective communication, and provide for staff
development. Despite the research showing the benefits of good, quality resources, the SASS survey reveals that most public school teachers (62.8%) do not feel that materials necessary for student success are readily available.

Of these factors, Watts and Castle (1993) stated that time is a resource and “time, or more properly lack of it, is one of the most difficult problems faced by school districts” (p. 306). Donahoe (1993) also maintained that formally rearranging the use of time in school so that staff are supported in their interactions is a prime issue to be resolved by restructuring schools.

According to Newmann and Wehlage (1995):

> When teachers work in groups that require coordination, this, by definition, involves collaboration. When groups, rather than individuals, are seen as the main units of implementing curriculum, instruction, and assessment, they facilitate development of shared purposes for student learning and collective responsibility to achieve it. (p. 38)

The manner in which organizations structure the time and space of the work environment can provide useful clues regarding underlying organizational assumptions (Schein, 1992). Thus, schools that reorganize the schedule to provide more time for collegial planning provide more opportunities for shared values and visions, collective learning and application, and shared personal practice.

The second area of supportive conditions is supportive, or collegial, relationships. According to Huffman and Hipp (2003), “collegial relationships include respect, trust, norms of critical inquiry and improvement, and positive, caring relationships among students, teachers, and administrators” (p. 57). The importance of collegial relationships cannot be underestimated due to the human component of the aforementioned PLC dimensions. In order for there to be a reconceptualization of the role and actions of educational leaders, there must first be a readiness to do so. Huffman and Hipp (2003) note that “creating a readiness for change is critical and often does not occur without focusing on the people in the organization and the interaction among all
stakeholders” (p. 57). By focusing on the humanistic side of the organization, educational leaders facilitate deep-seated relationships among the faculty. According to Hord (1998), relationships are significantly enhanced by a culture of respect and trust among colleagues, appropriate skill and knowledge and teaching and learning, support from administrators, and intensive socialization processes. In fact, Walker and Sackney (1999) reported: “dynamic locations of extraordinary, but natural human excellence where elements of social cohesion, including trust, hope, and reciprocity, are ever present” (p. 24) are keen evidence of a well-developed PLC. Davis (2002) upholds this by describing the reciprocity of collegial relationships as being “personal, interactive and immediate” (p. 2). In their comparison of healthy families and healthy organizations, Skynner and Cleese (1993) observed that it is the “degree of emotional support” (p. 32) that family or organization members can draw on “which mainly accounts for the ease with which they deal with change” (p. 32). Fullan (1999) sums it up well:

vitality springs from experiencing conflict and tension in systems which also incorporate anxiety-containing supportive relationships. Collaborative cultures are innovative not just because they provide support, but also because they recognize the value of dissonance inside and outside of the organization. (p. 27)

Therefore, schools that are able to facilitate the creation of an emotional support system might be better suited to handle both the internal and external factors that influence the school.

Summary

In this chapter, a literature review of the history of leadership and collaboration within school organizations was given as was the background and the dimensions of professional learning communities were given. This chapter’s descriptive focus was on foundational and practitioner oriented literature. There is not an abundance of empirical literature available on the
effect that PLCs have on student achievement. However, the research results from this paper will address this gap in the literature on PLCs. Furthermore, in light of this literature, there is a need to add more literature on PLCs in elementary grades. In the next chapter, the methodology of the study will be detailed.
CHAPTER 3

METHODOLOGY

Introduction

In this chapter, the methods and procedures of the study as well as background information on the Early Childhood Longitudinal Study: Kindergarten Class of 1998-99 (ECLS-K) are described. It begins with a restatement of the purpose and the research questions. Next, a brief description of the ECLS-K data, procedures, measures, and participants is given. Then the research design of this study followed by a description of the data analyses procedures that were applied to the data is provided. Finally, a summary concludes the chapter.

Purpose

The purpose of this study was to examine data from the ECLS-K report, identify questions and statements that correlate to the dimensions of PLCs, and determine the effect professional learning communities (PLCs) have on student achievement based on the ECLS-K data. As a result, this research will measure individual growth over time.

Specifically, this study examines the effect of the five dimensions of PLCs (shared and supportive leadership, shared values and vision, collective learning and application, shared personal practice, and supportive conditions) have on student achievement. The five dimensions will be evaluated in isolation of the other dimensions as well as in combination with the other dimensions in order to determine the effect on student achievement.

Research Questions

The questions that guide this dissertation are the following:
1. What is the effect of professional learning communities (PLCs) on student achievement over time in math among United States elementary students?

2. What is the effect of professional learning communities (PLCs) on student achievement over time in reading among United States elementary students?

Description of the ECLS-K Data

The Early Childhood Longitudinal Study: ECLS-K Fifth Grade report (ECLS-K) captures information about children’s development in different domains such as physical health and growth, social development, and emotional well-being. It contains information about the family background along with the educational quality of the home environment.

The ECLS-K aims are as follows:

(1) a study of the achievement on item response theory (IRT) measures in the in kindergarten through fifth grade; (2) an assessment of the developmental status of children in the United States at the start of their formal schooling and at key points during the elementary school years; (3) a cross-sectional study of the nature and quality of kindergarten programs in the United States; and (4) a study of the relationship of family, preschool, and school experiences to children’s developmental status at school entry and their progress during the kindergarten and early elementary school years. (NCES, 2001, p. 16)

An advantage of ECLS-K is that it allows researchers to examine children’s growth trajectories in different domains (e.g., social, physical, and cognitive) beginning with kindergarten through early elementary grades. One advantage of the longitudinal nature of the ECLS-K is that the researcher can predict children’s development in different domains, utilizing the large components of the family school, class and home environment and child care experiences measures in kindergarten and the early grades (NCES, 2001; 2002; 2004a).

The cognitive component of ECLS-K consists of mathematics, reading, and science achievement of children in kindergarten following them through the completion of their fifth grade year. Some of the child, school, and class variables that ECLS-K captures are gender, race,
child care attendance, socioeconomic status, age of the children, and kindergarten entrance age. Therefore, ECLS-K allows studying the relationship between children’s cognitive development and child and classroom characteristics. Moreover, since the ECLS-K involves repeated measures, it permits an investigation of children’s growth across elementary grades (NCES, 2001; 2002; 2004a).

**Sampling Design**

The ECLS-K used a nationwide representative sample of 22,260 children beginning with their kindergarten year through fifth grade. The ECLS-K sample includes substantial numbers of children from various minority groups (NCES, 2001). Among those children, 11,723 were white, 3,204 were African-American, 3,732 were Hispanic, 1,355 were Asian, 220 were Pacific Islander, 51, were American Indian and Alaskan, and 1,921 were others including Native American, multirace and unknown (NCES, 2001).

The ECLS-K sample consisted of children who attended kindergarten in the 1998-1999 school year. The sampling procedure consisted of three stages. The first stage was sampling counties (primary sampling units [PSUs]). Originally, 1,404 PSUs where at least 15,000 people lived were determined. Then, the minimum number of five year old children in each PSU was decided. The criterion was that each PSU should have at least 320 five-year-old children from the estimation of U.S. Census Bureau in 1994. If the PSU does not have 320 five-year-old children, it was combined with another PSU.

The measure of size used for selecting PSUs took into account the amount of oversampling of [Asian and Pacific Islanders] APIs required to meet the ECLS-K precision goals. The weighted measure of size (MOS) was calculated as follows:

\[
MOS = 2.5 \times n_{api} + n_{other}
\]
where 2.5 is the oversampling rate for APIs and \( n_{api} + n_{other} \) are the counts of five-year-old APIs and all others, respectively (p. 69). A total of 100 PSUs were determined (NCES, 2001).

The second stage involved sampling public and private schools offering kindergarten programs based on 1995-96 Common Core of Data (CCD) and the 1995-96 Private School University Survey3 (PSS). To be sampled, schools had to have at least 24 kindergartners in public schools and 12 kindergartners in private schools. If the schools had less than the minimum number of kindergartners, they were clustered for the purpose of weighting. In total, 1,277 schools were included in the study. Of these, 914 were public schools and 363 were private schools. The final stage included sampling children, teachers, and parents (NCES, 2001).

In this stage, an effort was made to sample students to obtain an approximately self-weighting sample of students and achieve minimum required sample size for APIs who were the only subgroup that needed to be oversampled (NCES, 2001).

**Sampling Weights**

As explained above, the sampling design of the study was not simple random sampling. The ECLS-K sample was from a multistage stratified sampling frame with a complex design, including equal probability systematic sampling for students other than APIs and higher rate of probability sampling for APIs. These procedures would produce over or underestimation of the population. Consequently, such complex designs require an adjustment called *weighting* to balance the demographic profile of the sample. Application of weighting procedures provides representation of the sample to the population (NCES, 2001; 2002; 2004a). Therefore, “[t]he ECLS-K data were weighted to compensate for differential probabilities of selection at each sampling stage and to adjust for the effects of nonresponse” (NCES, 2001, p. 77).
Different types of weights for longitudinal and cross-sectional study designs were created for the ECLS-K data analysis, such as weights to be used with parent data; weights to be used with a combination of child direct assessment data and parent; child weights to be used with direct child assessment data; weights to be used with a combination of child direct assessment data and parent interview data and teacher data; weights to be used with a combination of child direct assessment data and parent interview data, teacher data, and school data. In the current study the following weighting variable will be used:

C56CWO: is the child panel weight full sample.

Research Design

A multilevel growth model was used for this research. First, univariate analysis was done in order to detail the percentage for each possible response for each PLC question. In addition, univariate analysis was performed in order to report the mean and standard deviation for 3rd and 5th grade math and reading item-response theory (IRT) achievement for the total sample of students who had taken at least one test ($N = 17,565$). Next, bivariate analysis was done in order to establish what correlations existed between the variables. Bivariate analysis is appropriate to investigate how specific independent variables affect the dependent variable of interest (Leedy & Ormrod, 2001). Once the inter-correlations were determined, principal component analysis was applied to those variables that have a $\geq .40$ inter-correlation. Principal component analysis is a variable reduction procedure. It is useful when data on a number of variables is obtained and there is a likelihood of some redundancy in those variables. In this case, redundancy means that some of the variables are correlated to one another, possibly because they are measuring the same construct. Because of this redundancy, it should be possible to reduce the observed
variables into a smaller number of principal components (artificial variables) that will account for most of the variance in the observed variables. Finally, a multilevel growth model was used in order to determine the effect that each PLC dimension had on student achievement over time. The multilevel growth model was used both with and without the child panel design weighting and the results were the same.

Measures

For this study, children’s performance on cognitive assessments was described using an IRT score scale. For the purpose of this study, 3 PL IRT scale scores were used to obtain cognitive skills. IRT scale scores for reading ranged between 0 and 154 and mathematics IRT scale scores ranged between 0 and 123 (NCES, 2001; 2002; 2004a).

The number of correct item scores is the raw numbers of the items that the child answered correctly. It is useful when all children take the same test. However, in the ECLS-K study, children were given different test items depending on their ability level. This means that the ECLS-K measures do not take into account the fact that the same child would get a different number of correct responses if she or he were given a lower or higher level of the item sets, than she or he had been given. The $t$ scores are the standardized norm referenced scores that help to estimate the children’s level of achievement relative to the population. In other words, it provides information on how well children perform compared to their peers. In such cases, there are several advantages of using IRT rather than raw scores or $t$ scores (NCES, 2001; 2002; 2004a).

First, in IRT, trait score estimates and the corresponding standard error do not depend on the population distribution. Trait scores are estimated separately for each score or response, controlling for the item characteristics. Therefore, it is not only the person’s trait or score to the
item that determines his trait level, but also item characteristics, such as item discrimination and
item difficulty, are determinants on the trait scores estimates (Embretson & Reise, 2000).

A second advantage is that IRT does not assume normal distribution of trait levels in a
targeted population. Rather, interval scale is obtained by justification of the measurement model
(i.e., Rash model). Consequently, change scores on IRT trait levels would have a more constant
meaning (Embretson & Reise, 2000).

Third, IRT could easily handle combining items with different numbers of categories and
different formats by setting the item parameters to relate responses to the latent trait. Finally, IRT
uses all the information in the data, and yields more accurate information. In 3-PL models, in
addition to item difficulty and item discrimination parameters, pseudo-guessing parameter,
which refers to the probability of responding correctly to an item by chance by the examinee, is
taken into account (Embretson & Reise, 2000). This has the effect of establishing reliability of
the instrument.

The reliability of the overall reading and mathematics IRT scores were estimated “based
on the variance of repeated estimates of theta” (NCES, 2001, p. 58).

Participants

For each of the indicators chosen from the ECLS-K data that correlate to PLCs, the
sample size is 10,622. This is a smaller sample than the original because this research is only
analyzing the growth in IRT achievement for those students who took all of the IRT tests for
each data collection period. The sample includes a representative sample from various minority
groups including African-American, Hispanic, Asian, Pacific Islander, American Indian,
Alaskan, Native American, and those of multi-race background.
Design Effect (DEFF)

As previously explained, the ECLS-K sampling design included stratified clustered design.

In a stratified clustered design like the ECLS-K, stratification generally leads to a gain in the efficiency over simple random sampling (SRS), but clustering has the opposite effect because the positive intracluster correlation of the units in the cluster. The basic measure of the relative efficiency of the sample is called the design effect (DEFF), defined as the ratio, for a given statistic, of the variance estimate under the actual sample design to the variance estimate that would be obtained with an SRS of the same sample size:

\[
\text{DEFF} = \frac{\text{Var}_{\text{DESIGN}}}{\text{Var}_{\text{SRS}}}.
\]

The root design effect is

\[
\text{DEFF} = \sqrt{\text{DEFF}} = \frac{\text{SE}_{\text{DESIGN}}}{\text{SE}_{\text{SRS}}}
\]

Where SE is the standard error of the estimate.

If a statistical analysis software package such as SPSS is used the standard errors should be corrected using DEFT, since these programs calculate standard errors, assuming the data were collected with a simple random sample. (NCES, 2001, p.98-99)

In this study, R will be used for the statistical analyses. R is a language and environment for statistical computing and graphics. To overcome possible overestimation of the variances resulting from sampling, two stages are necessary before conducting any analysis. The first stage is the normalization of the weights and using DEFF (e.g., adjustment of the weight) using the normalized weight and adjusted weight formulas:

\[
\text{NORM} = \text{Weight} \times \frac{\text{Sample n}}{\text{population N}}
\]

\[
\text{ADJWGHT} = \text{NORM}/\text{DEFF}. \text{ (NCES, 2003)}
\]

Variables

- Time variable – The time variable includes the moment of the first assessment and
collection of data through the final assessment and collection of data. The information was
collected in the fall and spring of kindergarten (1998-1999), the fall and the spring of 1st grade
(1999-2000), the spring of 3rd grade (2002), and 5th grade (2004).

- Student variable – This variable is the ability of the student, based on performance of IRT
  measures, at the time of each assessment.
- PLC variables – These variables were measured at each data collection point and are
  based on the indicators from ECLS-K that correlate to the following dimensions of PLCs: shared
  and supportive leadership; shared values and vision; collective learning and application; shared
  personal practice; and supportive conditions.
- Outcome variables – The outcome variables were reading and mathematics achievement
  (on IRT scores) in spring-kindergarten, spring first grade, spring third grade, and spring fifth
  grade. IRT scale scores are chosen for the scale features, such as compensation for the possibility
  of a low ability student guessing several hard items correctly, and use the pattern of responses to
  estimate the probability of correct responses for all test questions. Finally, it is especially
  appropriate since it enables possible longitudinal measurement of gain in achievement over time,
  even though the tests administered are not identical at each point.

Procedures

ECLS-K is an ongoing study, collecting data in kindergarten, first-, third-, and fifth-grade
beginning in 1998-1999 school year. During the data collection period, several sources and
methods were applied. Specifically, child direct assessments, interviews with parents, self
administered questionnaires completed by school or district business administrators, principals,
and teachers, student records abstracts, school facility checklist, school records obtained by the
field staff were used to acquire substantial information about the schools, children and teachers. Interviews with parents were conducted through computer-assisted telephone/personal interviewing (CATI/CAPI). Child assessment was conducted through computer-assisted personal interviewing (CAPI). Teachers, principals, and administrators filled out self-administered questionnaires (NCES, 2001; 2002; 2004a).

For this study, the data collected in ECLS was used in order to determine the effect of PLCs on student achievement. In order to determine this effect, fourteen questions or statements were chosen from the ECLS-K report that specifically correlated to the aforementioned dimensions of PLCs. Each question and/or statement was examined both individually and collectively with other questions and/or statements in order to determine its effect on the growth in student performance from kindergarten to fifth grade.

An application for this research project was submitted to the University of North Texas Institutional Review Board (IRB). The IRB number of the application is 08213. This research did not fall under the purview of IRB because it was not considered to have involved human subjects because it involved no contact or interaction with human subjects and no identifiable private information was used.

Data Analysis

Descriptive statistics and multilevel growth modeling procedures were utilized in this study. Pearson Product-moment Correlations and growth modeling was conducted using $R$. All reported $p$ values are two-tailed with an $a$ priori established alpha of .05. Given the debate on prior research the researcher has purposefully chosen two-tail reported $p$ values. $R$ was employed to account for the clustered structure of the data where students were nested within schools.
Although many researchers rely upon traditional approaches such as repeated measures ANOVA, due to the hierarchical nature of the data as well as the goal of this study to measure change over time, growth modeling is a better statistical method to utilize (Llabre, Spitzer, Siegel, Saab, & Schneiderman, 2004). In this model, growth over time is measured as a latent, or unobserved, variable. Utilizing a multilevel growth model is practical when examining longitudinal data, allowing each individual in the sample to have distinct patterns of change over time (Llabre et al., 2004; Muthen & Muthen, 2005).

Additionally, these patterns of change are summarized in parameters, which in turn are modeled as functions of other variables. Unlike repeated measures ANOVA which examines only means, growth model analysis examines the correlations, variances, as well as the means. Furthermore, associated to traditional methods, multilevel models do not rely on assumptions of independence of observations which is violated with hierarchically structured data (van Montfort, Oud, & Satorra, 2006). Data in this study are not independent of each other. As students are in clusters, they are more alike than they are different. Llabre et al.(2004), and van Montfort et al.(2007), provided another advantage to multilevel models is that variables measured on different levels can be analyzed simultaneously, and cross level interactions can be estimated. In other words, any variance or covariance can be incorporated and tested.

A multilevel model was calculated to explain the amount of variation at both the individual and the school level. Initially, a random intercept model, which is statistically identical to a random effects analysis of variance (ANOVA) model, was calculated to provide information regarding the percentage of variation in outcomes at the two levels. According to Bryk and Raudenbush (1992), hierarchical linear modeling (HLM) is preferable to conventional
regression analysis for research of school effects because it clearly provides a distinction between student and school level variables.

The growth model diagram in Figure 2 shows four years of student achievement, with two latent variables, intercept and slope. Intercept is the starting point, or kindergarten achievement. Slope measures the growth over time from that initial starting point, examining the average amount of decrease or increase for each subject. Variables in boxes are observed variables, while variables in circles are unobserved variables. Years 1, 2, and 3 IRT, which represents student achievement, are measured as observable variables in the within level, examining individual student achievement differences. However, those outcome variables become latent variables in the between level measuring differences between schools over time. In both the within and between levels, covariance is also examined. All variables in the between level of growth model are latent variables.

For the purposes of this study, only the results beginning in 3rd grade were reported because this is the year in which schools must begin to meet adequate yearly progress in accordance with the No Child Left Behind Act.

A model in which Level 3 (organizational-level) contextual predictors are included to explain variation in the Level 2 (student-level) means and slopes over time (Level 1) is referred to as the random effects model (Bryk & Raudenbusch, 1992). First, an unconditional random effects model was constructed to test for the existence of student-level variation in the dependent variable, reading and math achievement. Next, individual-level predictors were added and random effects models in order to reveal whether the individual-level predictor effects on the dependent variable varied across schools. Level 3 predictors were included with the goal to reduce the amount of random, or unexplained, variation. The residual error terms for the
Figure 2. Multilevel growth model-Level 2 (student) and Level 3 (organizational).
individual-level predictors were restricted when the unconditional random effects tests reveal no significant variation. The fully specified HLM that was utilized is reported below. First, the null model for math IRT is given. This will be followed by the math IRT models using the supportive variable and then the collaborative variable. Then, the null model for reading IRT is given followed by the reading IRT model using the support variables and collaborative variables. The supportive and collaborative variables were derived from the principal component analysis of the fourteen indicators of PLCs from the ECLS-K data.

Principal Component Analysis

Due to the large number of statistically significant correlations between the PLC variables, principal component analysis (PCA) was conducted in order to determine the underlying structure of the correlations and to determine which variables accounted for the most variability regarding the effect on student achievement.

The results of conducting PCA are detailed in Table 2. The first two structure coefficients explained the underlying structure of the variables and most of the variability among the variables. The variables that were maintained within each of these components had a theoretical concept that clustered them within the component. The concepts of support and collaboration were determined to explain the underlying structure of each of the maintained structure coefficients, respectively. The following is a detailed explanation of each variable maintained within the support and collaborative coefficients and how they are related theoretically.
Table 2

*Principal Component Analysis of Factors With \( \geq .40 \) Loading*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Component 1</th>
<th>Component 2</th>
<th>Component 3</th>
<th>Component 4</th>
<th>Component 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTEGRATE TWO CURRICULUM AREAS</td>
<td></td>
<td>-.693</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIMES MEET FOR LESSON PLANNING</td>
<td>.994</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIMES MEET TO DISCUSS CURRICULUM</td>
<td>.878</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIMES MEET TO DISCUSS A CHILD</td>
<td></td>
<td></td>
<td>.674</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIMES MEET W/ SPEC ED TEACHER</td>
<td>.649</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STAFF ACCEPT ME AS COLLEAGUE</td>
<td>.834</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STAFF LEARN/SEEK NEW IDEAS</td>
<td>.382</td>
<td>-.525</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PARENTS SUPPORT SCHOOL STAFF</td>
<td>.994</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOW MUCH TEACHERS IMPACT POLICY</td>
<td>.861</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HOW MUCH TCHRS CONTRL CURRICULUM</td>
<td></td>
<td>-.577</td>
<td>.506</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FACULTY ON MISSION</td>
<td>.998</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCH ADMIN COMMUNICATES VISION</td>
<td>.900</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SCH ADMIN HANDLES OUTSD PRESSUR</td>
<td></td>
<td></td>
<td></td>
<td>.759</td>
<td></td>
</tr>
<tr>
<td>ADMIN ENCOURAGES STAFF</td>
<td>.998</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 2 reveals that Component 1 maintained the following factors that share the same conceptual meaning of support: Times Meet for Lesson Planning, Parents Support School Staff, Faculty Agrees on the Mission of the School, and Administration Supports and Encourages Staff. According to Huffman and Hipp (2003), supportive conditions “include respect, trust, norms of critical inquiry and improvement, and positive, caring relationships” (p. 57). When teachers meet to plan lessons and when they agree on the mission of the school, they are establishing norms of critical inquiry and improvement. In addition, when teachers feel supported by parents and administrators, there is an establishment of positive, caring relationships. Both of these help to establish supportive structural and collegial conditions within the school. Therefore, this component was named support.

Table 2 reveals that Component 2 maintained the following factors that share the same
conceptual meaning of collaboration: Times Meet to Discuss Curriculum, Staff Support Me as a Colleague, How Much Teachers Impact Policy Decisions, and School Administration Communicates Vision. McLaughlin and Talbert (1993) suggested that when experienced teachers had opportunities for collaborative inquiry and its related learning, the result was a body of wisdom about authentic instruction that could be widely shared with individuals. In addition, DuFour and Eaker (1998) emphasized that the “basic structure of the professional learning community is a group of collaborative teams that share a common purpose” (p. 26). When school administrators communicate the vision that they have for the school, this establishes the common purpose for the school. When teachers meet to discuss curriculum or policy decisions in order to carry out the vision of the school, this establishes an environment of collaborative inquiry. Feeling accepted as a colleague within these meetings further establishes a collaborative culture. Therefore, this component was named collaborative.

By virtue of Component 1 (support) and Component 2 (collaborative) having different conceptual meanings, they also measured different constructs. Therefore, both of these components had substantive meaning independent of each other and were retained in order to cluster the factors. As a result, clustering the factors helped to explain the same information that would have been obtained from the larger number of original factors. Once again, although the factors were subset into components, they were analyzed independently through the conceptual lens of support or collaborative, respectively, in order to determine the effect that each had on student achievement over time. The following is an explanation of the question or statement posed by the factors within the support and collaborative components and the types of responses available for each factor.

The supportive component is composed of the following factors: Times Teachers Meet
for Lesson Planning (Lesson Planning); Parents Support School Staff (Parent Support); There is Broad Agreement among the Entire School Faculty about the Central Mission of the School (Mission of School); and the School Administration’s Behavior toward the Staff is Supportive and Encouraging (Support and Encourage).

The support factor Lesson Planning asked how many times teachers meet with other teachers in order to discuss lesson planning. The possible responses and the code that is used to correspond to these responses in the R program are the following: Never = 0; Once a month or less = 1; Two or three times a month = 2; Once or twice a week = 3; Three or four times a week = 4; and Daily = 5.

The support factor Parent Support asked to what extent teachers agree with the following statement: Parents are supportive of school staff. The possible responses and the code used to correspond to these responses in the R program are the following: Strongly disagree = -2; Disagree = -1; Neither agree nor disagree = 0; Agree = 1; and Strongly agree = 2.

The support factor Mission of School asked to what extent teachers agree with the following statement: There is broad agreement among the entire school faculty about the central mission of the school. The possible responses and the code used to correspond to these responses in the R program are the following: Strongly disagree = -2; Disagree = -1; Neither agree nor disagree = 0; Agree = 1; and Strongly agree = 2.

The support factor Support and Encourage asked to what extent teachers agree with the following statement: The school administration’s behavior toward the staff is supportive and encouraging. The possible responses and the code used to correspond to these responses in the R program are the following: Strongly disagree = -2; Disagree = -1; Neither agree nor disagree = 0; Agree = 1; and Strongly agree = 2.
The collaborative component is composed of the following factors: Times Meeting with Other Teachers to Discuss Curriculum Development (Discuss Curriculum); I Feel Accepted and Respected as a Colleague by Most Staff Members (Colleague); How Much Teachers Impact Policy (Impact Policy); and the School Administration Communicates the Vision for the School (Vision).

The collaborative factor Discuss Curriculum asked teachers how many times they meet with other teachers to discuss curriculum development. The possible responses and the code that is used to correspond to these responses in the R program are the following: Never = 0; Once a month or less = 1; Two or three times a month = 2; Once or twice a week = 3; Three or four times a week = 4; and Daily = 5.

The collaborative factor Colleague asked to what extent teachers agree with the following statement: I feel accepted and respected as a colleague by most staff members. The possible responses and the code used to correspond to these responses in the R program are the following: Strongly disagree = -2; Disagree = -1; Neither agree nor disagree = 0; Agree = 1; and Strongly agree = 2.

The collaborative factor Impact Policy asked teachers how much they influence policy decisions for the school. The possible responses and the code used to correspond to these responses in the R program are the following: No influence = 0; Slight influence = 1; Some influence = 2; Moderate influence = 3; and A great deal of influence = 4.

The collaborative factor Vision asked teachers to what extent they agree with the following statement: The school administrator knows what kind of school he/she wants and has communicated it to the staff. The possible responses and the code used to correspond to these responses in the R program are the following: Strongly disagree = -2; Disagree = -1; Neither
agree nor disagree = 0; Agree = 1; and Strongly agree = 2.

After principal component analysis was conducted, each of the factors maintained within Component 1 and Component 2 were independently analyzed through multilevel analysis in order to determine the effect each had on student achievement in math and reading. The following are the models used to analyze each predictor factor beginning with the null model. The models are labeled as either support or collaborative depending on the conceptual lens through which the variable was analyzed.

**Null Model with Just Time**

\[
irt_{it} = \beta_{00} + \beta_{10} * time + \mu_{0i} + \mu_{1i} + e_{iti}
\]

(1)

**Level 1**

\[
irt_{it} = \pi_{0i} + \pi_{1i} * time + e_{iti}
\]

(1a)

**Level 2**

\[
\pi_{0i} = \beta_{00} + \mu_{0i}
\]

\[
\pi_{1i} = \beta_{10} * time + \mu_{0i}
\]

(1b)

The null model for this procedure for both math and reading was defined as:

\[
irt_{it} = \beta_{00} + \beta_{10} * time + \mu_{0i} + \mu_{1i} + e_{iti}
\]

(1c)

where \(irt_{it}\) represents the distribution of student \(i\) math or reading IRT scores over time \(t\), \(\beta_{00}\) is the grand intercept, \(\beta_{10}\) is the grand slope for time across all four years of student data, \(\mu_{0i}\) is the random effect for the slope coefficients for each student, \(\mu_{1i}\) is the random effect for the slope coefficients for time for each student, and \(e_{iti}\) is the level-1 residual effect.
**Full Model for Math Support**

\[ mathirt_{it} = \beta_{00} + \beta_{10} \times time + \beta_{01} \times supportvariable + \beta_{11} \times time \times supportvariable + \mu_{0i} + \mu_{1i} + e_{it} \] (2)

**Level 1**

\[ mathirt_{it} = \pi_{0i} + \pi_{1i} \times time + e_{it} \] (2a)

**Level 2**

\[ \pi_{0i} = \beta_{00} + \beta_{01} \times supportvariable + \mu_{0i} \]
\[ \pi_{1i} = \beta_{10} \times time + \beta_{11} \times time \times supportvariable + \mu_{1i} \] (2b)

where \( mathirt_{it} \) represents the distribution of student \( i \) math IRT scores over time \( t \), \( \beta_{00} \) is the grand intercept representing the predicted math IRT score for students at time point zero in classrooms with the lowest level of support, \( \beta_{10} \) represents the predicted change across time for students in classrooms with the lowest level of support, \( \beta_{01} \) represents the predicted change in student math IRT scores as the level of support increases, \( \beta_{11} \) represents the interaction effect between time and the increase in the level of support on student math IRT, \( \mu_{0i} \) is the random effect for the slope coefficients for each student, \( \mu_{1i} \) is the random effect for the slope coefficients for time for each student, and \( e_{it} \) is the level-1 residual effect.

**Full Model for Collaborative**

\[ mathirt_{it} = \beta_{00} + \beta_{10} \times time + \beta_{01} \times collaborativevariable + \beta_{11} \times time \times collaborativevariable + \mu_{0i} + \mu_{1i} + e_{it} \] (3)

**Level 1**

\[ mathirt_{it} = \pi_{0i} + \pi_{1i} \times time + e_{it} \] (3a)

**Level 2**

\[ \pi_{0i} = \beta_{00} + \beta_{01} \times collaborativevariable + \mu_{0i} \]
\( \pi_{it} = \beta_{00} \times \text{time} + \beta_{10} \times \text{time} \times \text{collaborativevariable} + \mu_{0i} \)  \hspace{1cm} (3b) 

where \( mathirt_{it} \) represents the distribution of student \( i \) math IRT scores over time \( t \), \( \beta_{00} \) is the grand intercept representing the predicted math IRT score for students at time point zero in classrooms with the lowest level of collaboration, \( \beta_{10} \) represents the predicted change across time for students in classrooms with the lowest level of collaboration, \( \beta_{01} \) represents the predicted change in student math IRT scores as the level of collaboration increases, \( \beta_{11} \) represents the interaction effect between time and the level of collaboration on student math IRT, \( \mu_{0i} \) is the random effect for the slope coefficients for each student, \( \mu_{ii} \) is the random effect for the slope coefficients for time for each student, and \( e_{ui} \) is the level-1 residual effect.

**Full Model for Reading Support**

\( readingirt_{it} = \beta_{00} + \beta_{10} \times \text{time} + \beta_{01} \times \text{supportvariable} + \beta_{11} \times \text{time} \times \text{supportvariable} + \mu_{0i} + \mu_{ii} + e_{ui} \)  \hspace{1cm} (4) 

**Level 1**

\( readingirt_{it} = \pi_{0i} + \pi_{ii} \times \text{time} + e_{ui} \)  \hspace{1cm} (4a) 

**Level 2**

\( \pi_{0i} = \beta_{00} + \beta_{01} \times \text{supportvariable} + \mu_{0i} \)

\( \pi_{ii} = \beta_{10} \times \text{time} + \beta_{11} \times \text{time} \times \text{supportvariable} + \mu_{0ii} \)  \hspace{1cm} (4b) 

where \( readingirt_{it} \) represents the distribution of student \( i \) reading IRT scores over time \( t \), \( \beta_{00} \) is the grand intercept representing the predicted reading IRT score for students at time point zero in classrooms with the lowest level of support, \( \beta_{10} \) represents the predicted change across time for students in classrooms with the lowest level of support, \( \beta_{01} \) represents the predicted change in student reading IRT scores as the level of support increases, \( \beta_{11} \) represents the interaction effect
between time and the increase in the level of support on student math IRT, \( \mu_{0i} \) is the random effect for the slope coefficients for each student, \( \mu_{ti} \) is the random effect for the slope coefficients for time for each student, and \( e_{it} \) is the level-1 residual effect.

Full Model for Collaborative

\[
\text{readingIRT}_{it} = \beta_{00} + \beta_{10} \times \text{time} + \beta_{01} \times \text{collaborativevariable} + \beta_{11} \times \text{time} \times \text{collaborativevariable} + \mu_{0i} + \mu_{ti} + e_{it} \tag{5}
\]

Level 1

\[
\text{readingIRT}_{it} = \pi_{0i} + \pi_{1i} \times \text{time} + e_{it} \tag{5a}
\]

Level 2

\[
\pi_{0i} = \beta_{00} + \beta_{01} \times \text{collaborativevariable} + \mu_{0i}
\]

\[
\pi_{1i} = \beta_{10} \times \text{time} + \beta_{11} \times \text{time} \times \text{collaborativevariable} + \mu_{0i} \tag{5b}
\]

where \( \text{readingIRT}_{it} \) represents the distribution of student \( i \) reading IRT scores over time \( t \), \( \beta_{00} \) is the grand intercept representing the predicted reading IRT score for students at time point zero in classrooms with the lowest level of collaboration, \( \beta_{10} \) represents the predicted change across time for students in classrooms with the lowest level of collaboration, \( \beta_{01} \) represents the predicted change in student reading IRT scores as the level of collaboration increases, \( \beta_{11} \) represents the interaction effect between time and the increase in the level of collaboration on student reading IRT, \( \mu_{0i} \) is the random effect for the slope coefficients for each student, \( \mu_{ti} \) is the random effect for the slope coefficients for time for each student, and \( e_{it} \) is the level-1 residual effect.
Summary

In this chapter, the methodology used in this study was detailed. Student achievement was examined using a longitudinal measure, examining student math and reading achievement over a four year period at four different points. $R$ was used to complete a parallel growth model to determine what effect professional learning communities have on student achievement.
CHAPTER 4

ANALYSIS

The purpose of this study was to examine data from the Early Childhood Longitudinal Study: ECLS-K Fifth Grade report (ECLS-K), identify questions and statements that correlate to the dimensions of professional learning communities (PLCs), and determine the effect PLCs have on student achievement based on the ECLS-K data. This study analyzed the effect of PLC variables on student achievement as measured by math and reading item-response theory (IRT) scores for 3rd and 5th grade elementary students in the United States. As a result, this research was able to measure growth in student achievement over time.

Specifically, this study employed a multilevel growth model in order to determine the effect of the five dimensions of PLCs on student achievement as measured by the following teacher-level predictor factors: shared and supportive leadership, shared values and vision, collective learning and application, shared personal practice, and supportive conditions. The five dimensions were initially evaluated through univariate and bivariate analysis and then the effect of the five dimensions on student achievement over time was calculated through multilevel analysis.

Initially, univariate analysis was conducted in order to detail the percentage for each possible response for each question. The questions were grouped according to the type of responses for each question. In addition, univariate analysis was performed in order to report the mean and standard deviation for 3rd grade and 5th grade math and reading IRT achievement for the total sample of students who had taken at least one test (\(N = 17,565\)). Next, bivariate analysis was applied in order to determine the inter-correlations between the fourteen PLC factors. The bivariate analysis is appropriate to investigate how specific independent variables affect the
dependent variable of interest (Leedy & Ormrod, 2001). Once the inter-correlations were
determined from the bivariate analysis, principal component analysis was applied in order to
cluster the factors according to the structure relationship between the factors and to reduce the
number of factors. As Stevens (2002) stated, “The hope is that a much smaller number of these
components will account for most of the variance in the original set of variables” (p. 387).
Furthermore, principal component analysis is useful when data on a number of factors is
obtained and there is a likelihood of some redundancy in those factors. In this case, redundancy
means that some of the factors are correlated to one another, possibly because they are measuring
the same construct. Because of this redundancy, it should be possible to reduce the observed
factors into a smaller number of principal components (artificial factors) that will account for
most of the variance in the observed factors. Through the use of principal components a set of
correlated factors is transformed into a set of uncorrelated factors (structure coefficients).
Finally, a multilevel growth model was used in order to determine the effect that each principal
component which represent PLCs had on student achievement over time. The final sample for
multilevel analysis was 10,622 students. This is a smaller sample than that used in univariate
analysis because multilevel analysis was conducted only on students who had taken all tests at
each data collection point.

Descriptive Statistics

Univariate Descriptive Statistics

The percentages of each possible response for each question from the ECLS-K report are
reported in Table 3 through Table 6. The sample for each question includes responses from 880
teachers. The purpose of reporting these frequencies percentages is to detail the frequency
percentage of each type of response chosen by teachers in this sample. The responses of “Don’t know” and “Not ascertained” were omitted from univariate analysis. Therefore, the total number of responses and the percentages for each question did not total 880 and 100%, respectively.

Table 3 indicates that the majority of teachers who responded (59.4%) integrate two or more curriculum areas. In addition, only 1.5% of teachers in this study never integrate two or more curriculum areas.

Table 3

<table>
<thead>
<tr>
<th>Integrate Two or More Curriculum Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
</tr>
<tr>
<td>Never</td>
</tr>
<tr>
<td>Occasionally</td>
</tr>
<tr>
<td>Usually</td>
</tr>
<tr>
<td>All the time</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Note. Frequency and percentages don’t add to 880 and 100%, respectively, due to omission of Don’t Know and Not Ascertained responses.

Table 4 indicates that the majority of teachers have some impact or control over the policies (56.0%) and curriculum (60.7%). On the other hand, Table 3 indicates that only 5.3 percent of teachers don’t feel that they have any impact over the policies of their school and 0.6% of teachers in this study do not feel that they have any control over the curriculum in their schools.
Table 4

*Univariate Analysis of Frequency and Percentage for each Question*

<table>
<thead>
<tr>
<th>Response</th>
<th>HOW MUCH TEACHERS IMPACT POLICY</th>
<th>HOW MUCH TCHRS CTRL CURRICULUM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$f$</td>
<td>$P(%)$</td>
</tr>
<tr>
<td>No impact or control</td>
<td>47</td>
<td>5.3</td>
</tr>
<tr>
<td>Slight impact or control</td>
<td>107</td>
<td>12.1</td>
</tr>
<tr>
<td>Some impact or control</td>
<td>162</td>
<td>18.4</td>
</tr>
<tr>
<td>Moderate impact or control</td>
<td>134</td>
<td>15.2</td>
</tr>
<tr>
<td>Great deal of impact or control</td>
<td>91</td>
<td>10.3</td>
</tr>
<tr>
<td>Total</td>
<td>541</td>
<td>61.30%</td>
</tr>
</tbody>
</table>

Note. Frequency and percentages don’t add to 880 and 100%, respectively due to omission of *Don’t Know* and *Not Ascertained* responses

Table 5 indicates that a majority of teachers who responded to the ECLS-K survey meet to discuss lesson planning (57.3%), meet to discuss curriculum (57.0%), meet to discuss a child (61.0%), and meet with special education teachers (60.1%). From these responses teachers spend more of their time meeting to discuss lesson planning (32.9%) and meeting to discuss a child (29.0%) rather than meeting to discuss curriculum (16.3%) and meeting with a special education teacher (19.7%). This points out that teachers are more concerned with what is going on in their specific classroom with their instructional practices and their students rather than what impacts the whole school through curriculum discussions and meeting with special education teachers.
Table 5

Univariate Analysis for Frequency and Percentage of each Question

<table>
<thead>
<tr>
<th>Response</th>
<th>TIMES MEET FOR LESSON PLANNING</th>
<th>TIMES MEET TO DISCUSS CURRICULUM</th>
<th>TIMES MEET TO DISCUSS A CHILD</th>
<th>TIMES MEET W/ SPEC ED TEACHER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( f )</td>
<td>( P(%) )</td>
<td>( f )</td>
<td>( P(%) )</td>
</tr>
<tr>
<td>Never</td>
<td>33</td>
<td>3.8</td>
<td>35</td>
<td>4.0</td>
</tr>
<tr>
<td>Once a month or less</td>
<td>107</td>
<td>12.1</td>
<td>202</td>
<td>22.9</td>
</tr>
<tr>
<td>Two or three times a month</td>
<td>108</td>
<td>12.3</td>
<td>157</td>
<td>17.8</td>
</tr>
<tr>
<td>Once or twice a week</td>
<td>193</td>
<td>21.9</td>
<td>110</td>
<td>12.5</td>
</tr>
<tr>
<td>Three or four times a week</td>
<td>50</td>
<td>5.7</td>
<td>21</td>
<td>2.4</td>
</tr>
<tr>
<td>Daily</td>
<td>47</td>
<td>5.3</td>
<td>12</td>
<td>1.4</td>
</tr>
<tr>
<td>Total</td>
<td>538</td>
<td>61.10%</td>
<td>537</td>
<td>61.00%</td>
</tr>
</tbody>
</table>

Note. Frequency and percentages don’t add to 880 and 100%, respectively, due to omission of Don’t Know and Not Ascertained responses
Table 6 can be broken down into three categories: teacher relationships, teacher-parent relationships, and teacher-administrator relationships. When removing the responses for Neither agree nor disagree, there is an interesting dynamic between the three categories. The teacher relationship questions, being accepted as a colleague (57.4%) and learning-seeking new ideas as a staff (51.8%), rated 1st and 3rd highest, respectively, for positive responses to each question. This indicates that teachers who responded to this survey do have positive relationships with the teachers with whom they work. The teacher-parent relationship question in which teachers agreed or disagreed that parents support school staff (55.2%) scored 2nd highest of these questions. This indicates a healthy relationship between the majority of teachers in this survey and the parents of students at their schools. Finally, the teacher-administrator relationship questions scored lowest of the three groupings with less than half of the teachers having a positive response to the following statement: faculty agrees on the mission of the school (43.2%), the school administration communicates the vision for the school (48.7%), the school administration handles outside pressure (44.5%), and the school administration encourages the staff (48.1%). This indicates to administrators a need for relationship building with teachers.

Table 7 details the mean and standard deviation for 3rd grade and 5th grade math and reading IRT achievement for the total sample of students who had taken at least one of the tests (N = 17,565). This sample is larger than the sample (N = 10,622) used for this study because this study only analyzed those students who had taken all math and reading IRT achievement tests.
Table 6

Univariate Analysis of Frequency and Percentage for each Question

<table>
<thead>
<tr>
<th>Response</th>
<th>STAFF ACCEPT ME AS COLLEAGUE</th>
<th>STAFF LEARN/SEEK NEW IDEAS</th>
<th>PARENTS SUPPORT SCHOOL STAFF</th>
<th>FACULTY ON MISSION</th>
<th>SCH ADMIN COMMUNICATES VISION</th>
<th>SCH ADMIN HANDLES OUTSIDE PRESSURE</th>
<th>SCH ADMIN ENCOURAGES STAFF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( f )</td>
<td>( P(%) )</td>
<td>( f )</td>
<td>( P(%) )</td>
<td>( f )</td>
<td>( P(%) )</td>
<td>( f )</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>4</td>
<td>0.5</td>
<td>3</td>
<td>0.4</td>
<td>10</td>
<td>1.1</td>
<td>8</td>
</tr>
<tr>
<td>Disagree</td>
<td>7</td>
<td>0.8</td>
<td>18</td>
<td>2.0</td>
<td>43</td>
<td>4.9</td>
<td>38</td>
</tr>
<tr>
<td>Neither agree nor disagree</td>
<td>24</td>
<td>2.7</td>
<td>62</td>
<td>7.0</td>
<td>106</td>
<td>12.0</td>
<td>88</td>
</tr>
<tr>
<td>Agree</td>
<td>234</td>
<td>27.0</td>
<td>275</td>
<td>31.3</td>
<td>300</td>
<td>34.1</td>
<td>273</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>268</td>
<td>30.4</td>
<td>180</td>
<td>20.5</td>
<td>80</td>
<td>9.1</td>
<td>134</td>
</tr>
<tr>
<td>Total</td>
<td>537</td>
<td>59.40%</td>
<td>538</td>
<td>61.20%</td>
<td>539</td>
<td>61.20%</td>
<td>541</td>
</tr>
</tbody>
</table>

Note. Frequency and percentages don’t add to 880 and 100%, respectively, due to omission of Don’t Know and Not Ascertained responses.
Table 7

_Univariate Descriptive Statistics_

<table>
<thead>
<tr>
<th>Subject</th>
<th>3rd Grade</th>
<th>5th Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td>Deviation</td>
<td>Deviation</td>
</tr>
<tr>
<td>Math</td>
<td>92.55</td>
<td>21.65</td>
</tr>
<tr>
<td>Reading</td>
<td>116.91</td>
<td>27.81</td>
</tr>
</tbody>
</table>

N = 17,565

_Bivariate Descriptive Statistics_

Spearman’s rho correlation analysis was conducted on each of the fourteen variables to determine levels of statistically significant correlation between variables. Table 8 contains the Spearman rho bivariate correlations for the PLC variables. There were numerous statistically significant correlations between the PLC variables ($p < .01$) ranging from .364 to .998 with the strongest correlation noted between Faculty agree about the Central Mission of the School (11) and School Administration encourages Staff (14).

The following are the results for the main effects of the composite factors (support and collaborative) on mathematics and reading IRT achievement. The first tables for mathematics and for reading will list the main, fixed, and random effects for each of the supportive or collaborative factors that are affecting the IRT achievement for each student beginning in the spring of their kindergarten year. The intercept for the Null Model in each of these tables established the starting intercept for either math or reading IRT for all students (N=10,622) in this study. In addition, the main effect of time was the growth in either math or reading IRT achievement that students experienced for each unit of time (Kindergarten, 1st grade, 3rd grade,
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrate two curriculum areas</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Times meet for lesson planning</td>
<td>0.009</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Times meet to discuss curriculum</td>
<td>0.451**</td>
<td>0.006</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time meet to discuss a child</td>
<td>0.405**</td>
<td>0.025</td>
<td>0.459**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Time meet with special education teachers</td>
<td>0.376**</td>
<td>-0.033</td>
<td>0.442**</td>
<td>0.408**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Staff accept me as a colleague</td>
<td>0.423**</td>
<td>0.072</td>
<td>0.823**</td>
<td>0.430**</td>
<td>0.421**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Staff learn/seek new ideas</td>
<td>0.364**</td>
<td>0.047</td>
<td>0.410**</td>
<td>0.375**</td>
<td>0.395**</td>
<td>0.397**</td>
<td>1</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Parents support school staff</td>
<td>0.023</td>
<td>0.983**</td>
<td>0.021</td>
<td>0.021</td>
<td>-0.034</td>
<td>0.07</td>
<td>0.029</td>
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<td></td>
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</tr>
<tr>
<td>How much teachers impact school policy</td>
<td>0.443**</td>
<td>0.001</td>
<td>0.810**</td>
<td>0.442**</td>
<td>0.420**</td>
<td>0.780**</td>
<td>0.392**</td>
<td>-0.03</td>
<td>1</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>How much teachers control curriculum</td>
<td>0.370**</td>
<td>0.01</td>
<td>0.402**</td>
<td>0.410**</td>
<td>0.389**</td>
<td>0.385**</td>
<td>0.411**</td>
<td>-0.01</td>
<td>0.442**</td>
<td>1</td>
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<tr>
<td>Faculty agree about the central mission of school</td>
<td>0.018</td>
<td>0.991**</td>
<td>0</td>
<td>0.014</td>
<td>-0.035</td>
<td>0.057</td>
<td>0.033</td>
<td>0.992**</td>
<td>-0.01</td>
<td>-0.01</td>
<td>1</td>
<td></td>
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<tr>
<td>School administration communicates vision</td>
<td>0.448**</td>
<td>0.074</td>
<td>0.844**</td>
<td>0.447**</td>
<td>0.417**</td>
<td>0.807**</td>
<td>0.410**</td>
<td>0.095</td>
<td>0.832**</td>
<td>0.393**</td>
<td>0.072</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>School administration handles outside pressures</td>
<td>0.443**</td>
<td>0.007</td>
<td>0.445**</td>
<td>0.431**</td>
<td>0.416**</td>
<td>0.452**</td>
<td>0.385**</td>
<td>0.005</td>
<td>0.404**</td>
<td>0.405**</td>
<td>-0.015</td>
<td>0.455**</td>
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<td></td>
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<tr>
<td>School administration encourages staff</td>
<td>0.015</td>
<td>0.990**</td>
<td>0</td>
<td>0.015</td>
<td>-0.039</td>
<td>0.066</td>
<td>0.034</td>
<td>0.991**</td>
<td>-0</td>
<td>0</td>
<td>0.998**</td>
<td>0.081</td>
<td>0.001</td>
<td>1</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed).
5th grade). From the models, a growth table for each support or collaborative factor detailed the IRT achievement of students in 3rd grade and 5th grade. This study will only begin with the results from 3rd grade because this is the year in which schools must begin to meet adequate yearly progress in accordance with the No Child Left Behind Act.

The growth table for each variable detailed the growth in IRT achievement students experienced from 3rd through 5th grade. The growth tables are based on the model given for each particular variable detailed in chapter 3. The intercept, the main effect of time, the effect of the increase in the level of support or collaboration, and the effect of the interaction between time and support or collaboration are used to establish the growth tables. Formula 2 through Formula 5 in Chapter 3 detail how each prediction growth table was created. In order to establish a growth pattern, the models established the initial intercept of IRT achievement during the spring of kindergarten for the students in this study. However, the growth tables will report the 3rd grade and 5th grade results of applying the main effect of time, the effect of the increase in the level of support or collaboration, and the interaction effect of time and the level of support or collaboration.

Mathematics IRT Achievement

Table 9 details the main, fixed, and random effects and the standard error for each of the math support variables. The Null Model column contains the fixed and random effects for the null model. In reading the Null Model, the estimate at time point 0 (kindergarten) for the intercept of the null model is 35.43 (which is also the grand mean of math IRT), and that the variability of the entire individual group means \( \sigma^2_{u0} \) around this grand mean is 152.33. The intraclass correlation (ICC) \( \frac{\sigma^2_{u0}}{\sigma^2_v + \sigma^2_{u0}} \) is .386 and is consistent with the meta-analysis.
conducted by Hughes and Hedberg (2007) who found ICCs ranging from .07 to .31 in mathematics achievement. Intraclass correlation is the proportion of total variance that is between the groups [teachers] of the regression equation. In other words, it “is the degree to which individuals share common experiences due to closeness in space and/or time” (Kreft & de Leeuw, 1998, p. 9). Hox (2002) explained the ICC as a “population estimate of the variance explained by the grouping structure” (p.14). For this study, the grouping structure is teachers. According to Roberts (2004), the more powerful ICCs are ones that are larger (>.20) and derived from samples where the average cluster size is large. The ICC for math support is considered significant and, therefore, the traditional linear model must be abandoned because the
assumption of independent observations has been violated (Kreft & de Leeuw, 1998). Next, the
goodness of fit is detailed for the math support variable models.

The null model includes the chi-square, the Akaike information criterion (AIC), and the
Bayesian information criterion (BIC). One of the inherent weaknesses in conducting a growth
model outside of the SEM framework is that you cannot obtain fit indices such as RMSEA, GFI,
and NNFI. However, according to Roberts (2004), the best fit of a model to the data can be
evaluated based on parsimony considerations through the Akaike information criterion AIC
(Akaike, 1987) or the Bayesian information criterion BIC (Schwarz, 1978). Both of these
statistics estimate the goodness of fit of a model based on previous model estimates, but they
include a “punishment factor” (p.33) based on the number of parameters estimated. When
comparing competing models, “you simply need to consult these statistics to see if the values for
each went down from the previous model’s estimate. If the values go down, then the new model
is considered to be a better model of the data than the previous model” (p. 33). For each of the
math support factor models, the values go down when compared to the null model. Therefore,
each of the math support factor models is a better model of the data than the null model.

The fixed effect of the support predictor factor Lesson Planning model indicates that at
time point 0 (kindergarten) the estimate for the intercept (or average intercept) has now changed
to 34.43 with a decrease to 12.67 in the variance of the intercepts (σ²w0) around the grand
intercept. In other words, by adding this factor (i.e., the teacher-level β’s), more of the
variability of the math IRT achievement intercepts for students is explained. Per each time data
collection point for this study (kindergarten, 1st grade, 3rd grade, and 5th grade), the average rate
of growth for a student across time is 25.94 points in math IRT achievement. For every increase
in the level of support that teachers reported in reference to the number of times they meet in
order to plan lessons, the slope estimate for the predictor factor Lesson Plan will result in a .27 point increase in a student’s score on math IRT achievement. The estimate for the interaction effect of time and the support factor Lesson Planning on math IRT achievement is .17. Because the interaction effect is positive and it is warranted by our model, this means that across time, it matters whether or not a teacher reports having a classroom with a high level of support. In other words, over time, the effect of having a teacher who reports a high level of support in Lesson Planning will increase math IRT achievement of an average student in that class. In addition, the variability between the group slopes of time ($\sigma^2_{ui}$) is 3.50 and the covariance between the intercept and time ($\sigma_{u01}$) is 28.82. This means that the error terms for $\gamma_{00}$ and $\gamma_{10}$ are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept ($\mu_{0j}$) and the error terms for the slope of time ($\mu_{1j}$). Another way to say this is that the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Lesson Planning on math IRT was statistically significant ($p < .05$).

The fixed effect of the support predictor factor Parent Support model indicates that the estimate for the intercept (or average intercept) has now changed to 27.29 with a decrease to 12.49 in the variance of the intercepts ($\sigma^2_{u0}$) around the grand intercept and the slope estimate for the Parent Support predictor factor is 2.19. Therefore, by adding this teacher-level predictor factor, more of the variability of the math IRT achievement intercepts for students is explained. Over time (kindergarten, 1st grade, 3rd grade, 5th grade), the average rate of growth for a student is 24.73 points in math IRT achievement. The estimate for the interaction effect of time and the support factor Parent Support on math IRT achievement is .50. This interaction effect is also positive and because this model is a better fit, the interaction effect is warranted by this model. Therefore, across time, if you are a student whose teacher feels fully supported by parents, your
math IRT achievement will increase at a rate of half a point higher per assessment than a student whose teacher does not feel fully supported by parents. In addition, the variability between the group slopes of time ($\sigma_{u1}^2$) is 3.49 and the covariance between the intercept and time ($\sigma_{u01}$) is 27.03. This means that the error terms for $\gamma_{00}$ and $\gamma_{10}$ are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept ($\mu_{0j}$) and the error terms for the slope of time ($\mu_{1j}$). Therefore, the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Parent Support on math IRT achievement was statistically significant ($p < .01$)

The fixed effect of the Mission of School model indicates that the estimate for the intercept (or average intercept) has now changed to 30.68 and also has a decrease to 12.62 in the variance of the intercepts ($\sigma_{u0}^2$) around the grand intercept. By adding this teacher-level predictor factor ($\beta$), more of the variability is explained regarding the intercepts of students on math IRT achievement. Per each time data collection point (kindergarten, 1st grade, 3rd grade, 5th grade), the average rate of growth for a student across time is 25.68 points in math IRT achievement. For every increase in the level of support (teachers agreeing with the rest of the faculty on the mission of the school), the score on math IRT achievement will increase 1.21 points on math IRT achievement for students. The estimate for the interaction effect of time and the support factor Mission of School on math IRT achievement is .23. Because this model is a better fit and because the interaction effect is positive, across time (kindergarten through fifth grade), it matters whether or not a teacher reports being a part of a faculty that agrees on the mission of the school. As a result of a teacher reporting being a part of a supportive faculty, the average student in that teacher’s class will increase their math IRT achievement over time. In
addition, the variability between the group slopes of time ($\sigma_{u1}^2$) is 3.52 and the covariance between the intercept and time ($\sigma_{u01}$) is 27.99. This means that the error terms for $\gamma_{00}$ and $\gamma_{10}$ are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept ($\mu_{0j}$) and the error terms for the slope of time ($\mu_{1j}$). Another way to say this is that the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Mission of School on math IRT achievement was statistically significant ($p < .01$).

The fixed effect of the Support and Encourage model indicates that at time point 0 (kindergarten) the estimate for the intercept (or average intercept) has now changed to 31.38 with a decrease to 31.38 in the variance of the intercepts ($\sigma_{u0}^2$) around the grand intercept. In the same way, by adding this factor (i.e., the teacher-level $\beta$'s), more of the variability of the math IRT achievement intercepts for students is explained. Per each time data collection point for this study (kindergarten, 1st grade, 3rd grade, and 5th grade), the average rate of growth for a student across time is 25.66 points in math IRT achievement. For every increase in the level of support that teachers felt supported and encouraged by the administration of their school, the score on math IRT achievement for students will increase by .98 points. The estimate for the interaction effect of time and the support factor Support and Encourage on math IRT achievement is .22. Therefore, the effect of this variable over time per assessment results in an increase in math IRT achievement for an average student in a class whose teacher reports being fully supported and encouraged by the administration of their school compared to an student in a class whose teacher does not report being fully supported and encouraged by the administration of their school. In addition, the variability between the group slopes of time ($\sigma_{u1}^2$) is 3.52 and the covariance between the intercept and time ($\sigma_{u01}$) is 28.08. This means that the error terms for $\gamma_{00}$ and $\gamma_{10}$
are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept \( \mu_{0j} \) and the error terms for the slope of time \( \mu_{1j} \). In other words, the error terms of the intercept are dependent on the error terms of the slope of time. The effect of Support and Encourage on math IRT achievement was statistically significant \( (p < .05) \).

Figure 3 details the growth in student math IRT achievement based on Model 2 in chapter 3. Figure 3 reports the starting intercept for math IRT in kindergarten and the growth that occurred due to the main effect of each math support variable, the fixed effect of time, the interaction effect between time and each support factor, and the error terms associated with these fixed effects on math IRT achievement from 3rd grade through 5th grade. In addition, the difference in math IRT achievement between an average student whose teacher reported the highest levels of support and an average student whose teacher reported the lowest levels of support is reported for both 3rd grade and 5th grade.

When the fixed effects and error terms for Lesson Planning are substituted into Model 2, the math IRT growth from kindergarten to 3rd grade and kindergarten to 5th grade experienced by an average student in a class whose teacher reported the lowest level of support was 50.88 points and 76.82 points, respectively. However, the average student in a class whose teacher reported the highest level of support through daily meetings in order to discuss lesson planning had an increase of 3.05 points on math IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of support because of never meeting to discuss lesson planning. In 5th grade, for teachers who reported the highest level of support, the average student in their class had an increase of 3.90 points on math IRT achievement compared to an average student in classes whose teacher reported the lowest level of support. The effect size \( \kappa \) for Lesson Planning was .06; according to Cohen (1998), this is a small effect size.
Figure 3. Growth in math IRT due to support factors.
When the fixed effects and error terms for Parent Support are substituted into Model 2, the math IRT growth from kindergarten to 3rd grade and kindergarten to 5th grade experienced by an average student in a class whose teacher reported the lowest level of support was 34.94 points and 58.67 points, respectively. However, the average student in a class whose teacher reported the highest level of support from parents had an increase of 12.76 points on math IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of support from parents. In 5th grade, for teachers who reported the highest level of support, the average student in their class had an increase of 14.76 points on math IRT achievement compared to students in classes whose teacher reported the lowest level of support. The effect size ($\kappa$) for Parent Support was .45; according to Cohen (1998), this is a medium effect size.

When the fixed effects and error terms for Mission of School are substituted into Model 2, the math IRT growth from kindergarten to 3rd grade and kindergarten to 5th grade experienced by an average student in a class whose teacher reported the lowest level of support was 43.27 points and 68.49 points, respectively. However, in a class whose teacher strongly agreed that there was broad agreement among the entire school faculty about the central mission of the school, the average student in this teacher’s class had an increase of 6.68 points on math IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of support because of a lack of agreement among the faculty about the central mission of the school. In 5th grade, for teachers who reported the highest level of support, the average student in their class had an increase of 7.60 points on math IRT achievement compared to students in classes whose teacher reported the lowest level of support. The effect size ($\kappa$) for Mission of School was .25; according to Cohen (1998), this is a small effect size.
When the fixed effects and error terms for Support and Encourage are substituted into Model 2, the math IRT growth from kindergarten to 3rd grade and kindergarten to 5th grade experienced by an average student in a class whose teacher reported the lowest level of support was 44.43 points and 69.65 points, respectively. However, the average student in a class whose teacher reported the highest level of support regarding feeling fully supported and encouraged by the administration at the school, scored 5.68 points higher on math IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of support because of not feeling supported and encouraged by the administration at the school. In 5th grade, for teachers who reported the highest level of support, the average student in their class had an increase of 6.56 points on math IRT achievement compared to students in classes whose teacher reported the lowest level of support. The effect size ($\kappa$) for Support and Encourage was .20; according to Cohen (1998), this is a small effect size.

Table 10 details the main, fixed, and random effects and the standard error for each of the math collaborative factors. The Null Model column contains the fixed and random effects for the null model. In reading the Null Model, the estimate for the intercept of the null model is 35.43 (which is also the grand mean of math IRT), and that the variability of the entire individual group means ($\sigma^2_{\mu_0}$) around this grand mean is 12.79. Also from the null model, the estimate of the intraclass correlation (ICC) $\sigma^2_{\mu_0} / (\sigma^2_e + \sigma^2_{\mu_0})$ is .428 is determined to be a large and appreciable amount (Roberts, 2004). The ICC for the current study is consistent with the meta-analysis conducted by Hughes and Hedberg (2007) who found ICCs ranging from .07 to .31 in mathematics achievement. This finding supports the need for multilevel modeling with this dataset (Kreft & de Leeuw, 1998). Next, the goodness of fit is detailed for the math collaborative variable models.
Table 10

Models for Mathematics Collaborative Factors

<table>
<thead>
<tr>
<th></th>
<th>Null Model</th>
<th>Discuss Curriculum</th>
<th>Colleague</th>
<th>Impact Policy</th>
<th>Vision</th>
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<td>35.51</td>
<td>.47</td>
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<td>1.26**</td>
<td>.23</td>
<td>.59**</td>
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<td>.06</td>
<td>.58**</td>
<td>.09</td>
<td>.21**</td>
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<tr>
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<td>12.67</td>
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<td>12.67</td>
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<td>$\sigma_{u1}^2$</td>
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<td>28.10</td>
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<td>$\chi^2$</td>
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</tbody>
</table>

$N=10,622$; **$p<.01$ (2-tailed); *$p<.05$ (2-tailed).

The null model includes the chi-square, the Akaike information criterion (AIC), and the Bayesian information criterion (BIC). These parameters are another method of computing model fit, but take into account that simpler models are better (parsimony). When the values of these go down when compared to the null model, the conclusion can be made that the parameter (predictor variable) added to the model produces a better model fit than the null model and is therefore warranted (Roberts, 2004). For each of the math collaborative variable models, the values go down when compared to the null model. Therefore, each of the math support factor models is a better model of the data than the null model.

The fixed effect of the Discuss Curriculum model indicates that at time point 0 (kindergarten) the estimate for the intercept (or average intercept) has now changed to 35.51 with
a decrease to 12.66 in the variance of the intercepts ($\sigma_{u_0}^2$) around the grand intercept. In other words, by adding this factor (i.e., the teacher-level $\beta$'s), more of the variability of the math IRT achievement intercepts for students is explained. Per each time data collection point for this study (kindergarten, 1st grade, 3rd grade, and 5th grade), the average rate of growth for a student across time is 26.47 points in math IRT achievement. For every increase in the level of collaboration that teachers reported in regards to the number of times they meet to discuss curriculum, the score on math IRT will increase by -.05 points. The estimate for the interaction effect of time and the support factor Discuss Curriculum on math IRT achievement is .03. Because the interaction effect is positive and it is a better model than the null model, this means that across time (kindergarten through 5th grade) it matters whether or not a teacher reports being a part of a collaborative faculty that discusses curriculum on a regular basis. In other words, over time, the effect of having a teacher who reports a high level of collaboration in Discuss Curriculum will increase the math IRT achievement of an average student in that class. In addition, the variability between the group slopes of time ($\sigma_{u_1}^2$) is 3.51 and the covariance between the intercept and time ($\sigma_{u01}$) is 28.88. This means that the error terms for $\gamma_{00}$ and $\gamma_{10}$ are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept ($\mu_{0j}$) and the error terms for the slope of time ($\mu_{1j}$). The effect of Discuss Curriculum on math IRT achievement was not statistically significant ($p < .05$).

The fixed effect of the Colleague model indicates that the estimate for the intercept (or average intercept) has now changed to 29.67 with a decrease in the variance to 12.67 of the intercepts ($\sigma_{u_0}^2$) around the grand intercept and the slope estimate for the predictor factor Colleague is 1.26. Therefore, by adding this teacher-level predictor factor, more of the
variability of the math IRT achievement intercepts for students is explained. Over time (kindergarten, 1st grade, 3rd grade, 5th grade), the average rate of growth for a student is 24.00 points in math IRT achievement. The estimate for the interaction effect of time and the support factor Colleague on math IRT achievement is .58. This interaction effect is also positive and because this model is a better fit, the interaction effect is warranted by this model. Therefore, across time, it matters if you are a student whose teacher feels fully accepted as a colleague because your math IRT achievement will increase. In addition, the variability between the group slopes of time ($\sigma_{ul}^2$) is 3.51 and the covariance between the intercept and time ($\sigma_{u01}$) is 28.02. This means that the error terms for $\gamma_{00}$ and $\gamma_{10}$ are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept ($\mu_{0j}$) and the error terms for the slope of time ($\mu_{1j}$). Another way to say this is that the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Colleague on math IRT achievement was statistically significant ($p < .01$).

The fixed effect of the Impact Policy model indicates that the estimate for the intercept (or average intercept) has now changed to 33.42 with a decrease to 12.67 in the variance of the intercepts ($\sigma_{u0}^2$) around the grand intercept. By adding this teacher-level predictor factor ($\beta$), more of the variability is explained regarding the intercepts of students on math IRT achievement. Per each time data collection point (kindergarten through 5th grade), the average rate of growth for a student across time is 25.87 points in math IRT achievement. For every increase in the level of collaboration that teachers reported by being involved in impacting the policies of their school, the score on math IRT for an average student in their class will increase .59 points. The estimate for the interaction effect of time and the support factor Impact Policy on
math IRT achievement is .21. So, over time a student in a class whose teacher reports collaborating to impact policy will score higher on math IRT achievement compared to a student whose teacher reports not collaborating to impact policy. In addition, the variability between the group slopes of time ($\sigma_{u1}^2$) is 3.53 and the covariance between the intercept and time ($\sigma_{u01}$) is 28.18. This means that the error terms for $\gamma_{00}$ and $\gamma_{10}$ are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept ($\mu_{0j}$) and the error terms for the slope of time ($\mu_{1j}$). In other words, the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Impact Policy on math IRT achievement was statistically significant ($p < .01$).

The fixed effect of the Vision model indicates that the estimate for the intercept (or average intercept) has now changed to 32.65 with a decrease to 12.67 in the variance of the intercepts ($\sigma_{u0}^2$) around the grand intercept. By adding this teacher-level predictor factor, more of the variability of the math IRT achievement intercepts for students is explained. Over time (kindergarten through 5th grade), the average rate of growth for a student is 26.17. For every increase in the level of collaboration that teachers reported regarding their agreement on whether or not the administration communicates the vision of the school, the score on math IRT will increase by .67 points. The estimate for the interaction effect of time and the collaborative factor Vision on math IRT achievement is .10. Because the interaction between time and the factor Vision is positive and this model is a better fit of the data, an average student in a class whose teacher reports full collaboration in reference to Vision will score higher in math IRT achievement over time compared to a student whose teacher reports no collaboration in reference to the factor Vision. In addition, the variability between the group slopes of time ($\sigma_{u1}^2$) is 3.52
and the covariance between the intercept and time ($\sigma_{\alpha 1}$) is 28.10. This means that the error terms for $\gamma_{00}$ and $\gamma_{10}$ are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept ($\mu_{0j}$) and the error terms for the slope of time ($\mu_{1j}$). Another way to say this is that the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Vision on math IRT achievement was statistically significant ($p < .05$).

Figure 4 details the growth in student math IRT achievement based on Model 3 in Chapter 3. Figure 4 reports the starting intercept for math IRT in kindergarten and the growth that occurred due to the main effect of each math collaborative factor, the fixed effect of time, the interaction effect between time and each collaborative factor, and the error terms associated with these fixed effects on math IRT achievement from 3rd grade through 5th grade. In addition, the difference in math IRT achievement between an average student in a class whose teacher reported the highest level of collaboration and an average student in a class whose teacher reported the lowest level of collaboration is reported for both 3rd grade and 5th grade.

When the fixed effects and error terms for Discuss Curriculum are substituted into Model 3, the math IRT growth from kindergarten to 3rd grade and from kindergarten to 5th grade experienced by an average student in a class whose teacher reported the lowest level of collaboration was 53.02 points and 79.49 points, respectively. However, an average student in a class whose teacher reported the highest level of collaboration through daily meetings in order to discuss curriculum had an increase of .05 points on math IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of collaboration because of never meeting to discuss curriculum. In 5th grade, for teachers who reported the highest level of collaboration, the average student in their class had an increase of .20 points on
Figure 4. Growth in math IRT due to collaborative factors.
math IRT achievement compared to students in classes whose teacher reported the lowest level of collaboration. The effect size ($\kappa$) for Discuss Curriculum was -.03; according to Cohen (1998), this was a small effect size.

When these fixed effects and error terms for Colleague are substituted into Model 3, the math IRT growth from kindergarten to 3rd grade and from kindergarten to 5th grade experienced by an average student in a class whose teacher reported the lowest level of collaboration was 37.49 points and 60.33 points, respectively. However, the average student in a class whose teacher reported the highest level of collaboration by feeling accepted as a colleague had an increase of 9.68 points on math IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of support because of not feeling accepted as a colleague. In 5th grade, for teachers who reported the highest level of collaboration, the average student in their class had an increase of 12.00 points on math IRT achievement compared to students in classes whose teacher reported the lowest level of collaboration. The effect size ($\kappa$) for Colleague was .82; according to Cohen (1998), this was a large effect size.

When these fixed effects and error terms for Impact Policy are substituted into Model 3, the math IRT growth from kindergarten to 3rd grade and from kindergarten to 5th grade experienced by an average student in a class whose teacher reported the lowest level of collaboration was 47.71 points and 73.16 points, respectively. However, the average student in a class whose teacher reported the highest level of collaboration by being fully involved in impacting policy decisions at their schools had an increase of 4.04 points on math IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of collaboration because of not being involved in impacting policy decisions. In 5th grade, for teachers who reported the highest level of collaboration, the average student in their
class had an increase of 4.88 points on math IRT achievement compared to students in classes whose teacher reported the lowest level of collaboration. The effect size ($\kappa$) for Impact Policy was .38; according to Cohen (1998), this was a small effect size.

When the fixed effects and error terms for Vision are substituted into Model 3, the math IRT growth from kindergarten to 3rd grade and from kindergarten to 5th grade experienced by an average student in a class whose teacher reported the lowest level of collaboration was 47.82 points and 73.79 points, respectively. However, the average student in a class whose teacher reported the highest level of collaboration by strongly agreeing that the school administration has communicated the vision for the school had an increase of 3.48 points on math IRT achievement in 3rd grade compared to an average student in a classroom whose teacher strongly disagreed that the administration had communicated the vision for the school. In 5th grade, for teachers who reported the highest level of collaboration, the average student in their class had an increase of 3.88 points on math IRT achievement compared to students in classes whose teacher reported the lowest level of collaboration. The effect size ($\kappa$) for Vision was .43; according to Cohen (1998), this was a medium effect size.

Reading IRT Achievement

Table 11 details the main, fixed, and random effects and the standard error for each of the reading support factors. The Null Model column contains the fixed and random effects for the null model. In reading the Null Model, the estimate for the intercept of the null model is 42.84 (which is also the grand mean of reading IRT), and that the variability of the entire individual group means ($\sigma^2_{u0}$) around this grand mean is 16.80. From the null model, the estimate for the intraclass correlation $\sigma^2_{u0} / (\sigma^2_e + \sigma^2_{u0})$ is .44. The ICC for the reading support factors is
consistent with the range of ICCs (.05 to .74) found in the meta-analysis conducted by Hedges and Hedberg (2007). Because this ICC is larger than .20, Roberts (2004) asserted that it is powerful and multilevel modeling must be used for the predictor level factors because the assumption of independent observations has been violated (Kreft & de Leeuw, 1998). Next, the simplicity of fit is determined for the reading support factor models.

Table 11

Models for Readings Support Factors

<table>
<thead>
<tr>
<th></th>
<th>Null Model</th>
<th>Lesson Planning</th>
<th>Parent Support</th>
<th>Mission of School</th>
<th>Support and Encourage</th>
</tr>
</thead>
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<tr>
<td></td>
<td>estimate</td>
<td>s.e.</td>
<td>estimate</td>
<td>s.e.</td>
<td>estimate</td>
</tr>
<tr>
<td>Intercept</td>
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<td>.18</td>
<td>43.71</td>
<td>.64</td>
<td>33.97**</td>
</tr>
<tr>
<td>Time</td>
<td>33.21</td>
<td>.07</td>
<td>32.54</td>
<td>.23</td>
<td>30.90**</td>
</tr>
<tr>
<td>Support</td>
<td>.20</td>
<td>.17</td>
<td>2.83**</td>
<td>.22</td>
<td>1.74**</td>
</tr>
<tr>
<td>T x S</td>
<td>.10</td>
<td>.06</td>
<td>.54**</td>
<td>.08</td>
<td>.19**</td>
</tr>
</tbody>
</table>

Fixed Effects

\( \sigma_e^2 \) | 13.28 | 13.22 | 13.21 | 13.21 | 13.21
\( \sigma_{u0}^2 \) | 16.80 | 16.71 | 16.44 | 16.61 | 16.63
\( \sigma_{u1}^2 \) | 2.40  | 2.33  | 2.26  | 2.33  | 2.34
\( \sigma_{u01} \) | 29.03 | 24.92 | 23.41 | 24.38 | 24.91

Random Effects

\( \chi^2 \) | 407804 | 297811.8 | 297575.8 | 298308.4 | 297602.2
AIC | 407816 | 297827.9 | 297592.8 | 298324.4 | 297618.1
BIC | 407868.5 | 297895.4 | 297659.4 | 298392.0 | 297685.7

N=10,622; **p<.01 (2-tailed); *p<.05 (2-tailed).

The null model includes the chi-square, the Akaike information criterion (AIC), and the Bayesian information criterion (BIC). Because the null model and the predictor level models are not nested models, the principle that models should be parsimonious indicates that the simpler model should be used for data analysis. General fit indices to compare the fit and simplicity of
statistical models are the AIC and the BIC (Hox, 2002). Each of these estimates the goodness of
fit of a model. “The AIC and BIC are typically used to compare a range of competing models,
and the model(s) with the lowest AIC or BIC value are considered the most attractive” (p. 46).
For each of the reading support predictor factor models, the values go down when compared to
the null model. Therefore, each of the reading support factor models is a better model of the data
than the null model.

The fixed effect of the lesson planning model indicates that the estimate for the intercept
(or average intercept) has now changed to 43.71 with a decrease to 16.71 in the variance ($\sigma^2_{u0}$)
around the grand intercept. Because of the addition of this predictor factor (i.e., the teacher-level
$\beta$'s), more of the variability of the reading IRT achievement intercepts for students is explained.
Per each time data collection point for this study (kindergarten, 1st grade, 3rd grade, and 5th
grade), the average rate of growth for a student across time is 32.54 points in reading IRT
achievement. For every increase in the level of support as noted by teachers regarding the
number of times they meet with other teachers to plan lessons, the score on reading IRT will
increase .20 points. The estimate for the interaction effect of time and the support factor Lesson
Planning on reading IRT achievement is .10. Because this model is a better fit of the data and
because the interaction effect is positive, it matters whether or not a teacher reports having a high
level of support. In other words, over time, the effect of having a teacher who reports a high
level of support by planning lessons more frequently with other teachers will increase the reading
IRT achievement score of an average student in that teacher’s class. In addition, the variance to
time ($\sigma^2_{u1}$) is 2.33 and the covariance of the intercept and time ($\sigma_{u01}$) is 24.92. This means that
the error terms for $\gamma_{00}$ and $\gamma_{10}$ are positively related, indicating that there is a relationship
(correlation) between the error terms for the intercept ($\mu_{0j}$) and the error terms for the slope of
time ($\mu_{ij}$). Another way to say this is that the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Lesson Planning on reading IRT achievement was not statistically significant ($p < .05$).

The fixed effect of the parent support model indicates that the estimate for the intercept (or average intercept) has now changed to 33.97 with a decrease to 16.44 in the variance of the intercepts ($\sigma_{u_0}$) around the grand intercept and the effect this predictor variable on the slope estimate is 2.83. Therefore, by adding this teacher-level predictor factor, more of the variability of the reading IRT achievement intercepts for students is explained. Over time (kindergarten, 1st grade, 3rd grade, 5th grade), the average rate of growth for a student is 30.90 points in reading IRT achievement. The estimate for the interaction effect of time and the support factor Parent Support on reading IRT achievement is .54. Because the interaction effect between time and the factor Parent Support is positive, and because it is warranted by the model, this translates to a student in a class whose teacher reports full support from parents will higher on reading IRT achievement over time compared to a student whose teacher reports not being supported by parents. In addition, the variability between the group slopes of time ($\sigma_{u_1}$) is 2.66 and the covariance between the intercept and time ($\sigma_{u_01}$) is 23.41. This means that the error terms for $\gamma_{00}$ and $\gamma_{10}$ are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept ($\mu_{0j}$) and the error terms for the slope of time ($\mu_{1j}$). In other words, the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Parent Support on reading IRT achievement was statistically significant ($p < .01$).

The fixed effect of the Mission of School model indicates that the estimate for the intercept (or average intercept) has now changed to 37.69 with a decrease to 16.61 in the
variance of the intercepts ($\sigma_{\mu_0}^2$) around the grand intercept. By adding this teacher-level predictor factor, more of the variability of the reading IRT achievement intercepts for the students is explained. Per each time data collection point (kindergarten through 5th grade) for this study, the average rate of growth for a student across time is 32.15 in reading IRT achievement. For every increase in the level of support that teachers feel in regards to agreeing with their colleagues on the mission of the school, the score on reading IRT achievement will increase 1.74 points. The estimate for the interaction effect of time and the support factor Mission of School on reading IRT achievement is .19. Because the interaction effect is positive, and because this model is a better fit for the data, this means that across time it matters whether or not a teacher reports agreeing with his or her colleagues on the mission of the school. In addition, the variability between the group slopes of time ($\sigma_{\mu_1}^2$) is 2.33 and the covariance between the intercept and time ($\sigma_{\mu_0\mu_1}$) is 24.38. This means that the error terms for $\gamma_{00}$ and $\gamma_{10}$ are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept ($\mu_{0j}$) and the error terms for the slope of time ($\mu_{1j}$). Therefore, the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Mission of School on reading IRT achievement was statistically significant ($p < .01$).

The fixed effect of the support and encourage model indicates that the estimate for the intercept (or average intercept) has now changed to 38.10 with a decrease to 16.63 for the variance of the intercepts ($\sigma_{\mu_0}^2$) around the grand intercept. Because of the addition of this predictor factor (i.e., the teacher-level $\beta$'s), more of the variability of the reading IRT achievement intercepts for students is explained. For each increase in time, the average rate of growth for a student is 32.50 points in reading IRT achievement. For every increase in the level
of support that teachers reported in regards to whether or not they feel supported and encouraged by their administrators, the score on reading IRT will increase 1.57 points. The estimate for the interaction effect of time and the Support and Encourage factor on reading IRT achievement is .10. This being a positive interaction effect and this model being a better fit of the data translates to an average student in a class whose teacher reported being fully supported by the administration of the school will score higher on reading IRT achievement over time compared to an average student whose teacher reported the lowest level of support. In addition, the variability between the group slopes of time ($\sigma^2_{a_1}$) is 2.34 and the covariance between the intercept and time ($\sigma_{a_01}$) is 24.91. This means that the error terms for $\gamma_{00}$ and $\gamma_{10}$ are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept ($\mu_{0j}$) and the error terms for the slope of time ($\mu_{1j}$). Another way to say this is that the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Support and Encourage on reading IRT achievement was statistically significant ($p < .01$).

Figure 5 details the growth in student reading IRT achievement based on Model 4 in Chapter 3. Figure 5 reports the starting intercept for reading IRT achievement in kindergarten and the growth that occurred due to the main effect of each reading support factor, the fixed effect of time, the interaction effect between time and each support factor, and the effect of the error terms of these fixed effects on reading IRT achievement from 3rd grade through 5th grade. Also, the difference in reading IRT achievement between an average student in a class whose teacher reported the highest level of support and an average student in a class whose teacher reported the lowest level of support is reported for both 3rd grade and 5th grade.
Figure 5. Growth in reading IRT due to support factors.
When the fixed effects and error terms for Lesson Planning are substituted into Model 4, the reading IRT growth from kindergarten to 3rd grade and from kindergarten to 5th grade for an average student in a class whose teacher reported the lowest levels of support was 65.95 points and 98.49 points, respectively. However, the average student in a class whose teacher reported the highest level of support through daily meetings in order to discuss lesson planning had an increase of 2.00 points on reading IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of support because of never meeting to discuss lesson planning. In 5th grade, for teachers who reported the highest level of support, the average student in their class had an increase of 2.50 points on reading IRT achievement compared to students in classes whose teacher reported the lowest level of support. The effect size ($\kappa$) for Lesson Planning was .11; according to Cohen (1998), this was a small effect size.

When the fixed effects and error terms for Parent Support are substituted into Model 4, the reading IRT growth from kindergarten to 3rd grade and from kindergarten to 5th grade for an average student in a class whose teacher reported the lowest levels of support was 45.11 points and 74.93 points, respectively. However, the average student in a class whose teacher reported the highest level of support through feeling fully supported by parents had an increase of 15.64 points on reading IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of support because of not feeling supported by parents. In 5th grade, for teachers who reported the highest level of support, the average student in their class had an increase of 17.80 points on reading IRT achievement compared to students in classes whose teacher reported the lowest level of support. The effect size ($\kappa$) for Parent Support was 1.55; according to Cohen (1998), this was a large effect size.

When the fixed effects and error terms for Mission of School are substituted into Model
4, the reading IRT growth from kindergarten to 3rd grade and from kindergarten to 5th grade for an average student in a class whose teacher reported the lowest levels of support was 54.91 points and 86.68 points, respectively. However, the average student in a class whose teacher reported the highest level of support by strongly agreeing that there was broad agreement among the entire school faculty about the mission of the school had an increase of 8.48 points on reading IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of support because of never strong disagreement to the aforementioned statement. In 5th grade, for teachers who reported the highest level of support, the average student in their class had an increase of 9.24 points on reading IRT achievement compared to students in classes whose teacher reported the lowest level of support. The effect size ($\kappa$) for Mission of School was .96; according to Cohen (1998), this was a large effect size.

When the fixed effects and error terms for Support and Encourage are substituted into Model 4, the reading IRT growth from kindergarten to 3rd grade and from kindergarten to 5th grade for an average student in a class whose teacher reported the lowest levels of support was 56.72 points and 89.02 points, respectively. However, the average student in a class whose teacher reported the highest level of support through feeling fully supported and encouraged by the school’s administration had an increase of 7.08 points on reading IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of support because not feeling supported and encouraged by the school’s administration. In 5th grade, for teachers who reported the highest level of support, the average student in their class had an increase of 7.48 points on reading IRT achievement compared to students in classes whose teacher reported the lowest level of support. The effect size ($\kappa$) for Mission of School was .86; according to Cohen (1998), this was a large effect size. Table 12 details the main,
fixed, and random effects and the standard error for each of the math collaborative factors.

Table 12

*Models for Reading Collaborative Factors*

<table>
<thead>
<tr>
<th></th>
<th>Null Model</th>
<th>Discuss Curriculum</th>
<th>Colleague</th>
<th>Impact Policy</th>
<th>Vision</th>
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<td>estimate</td>
<td>s.e.</td>
<td>estimate</td>
</tr>
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<td>.64</td>
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<td>33.29</td>
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<td>30.84</td>
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<td>Collaborative</td>
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<td>.21</td>
<td>2.26**</td>
<td>.31</td>
<td>.73**</td>
</tr>
<tr>
<td>T x C</td>
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<td>.07</td>
<td>.47**</td>
<td>.11</td>
<td>.22**</td>
</tr>
<tr>
<td>( \sigma^2_e )</td>
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<td>13.22</td>
<td>13.21</td>
<td>13.21</td>
<td>13.21</td>
</tr>
<tr>
<td>( \sigma^2_{u0} )</td>
<td>16.80</td>
<td>16.70</td>
<td>16.62</td>
<td>16.67</td>
<td>16.63</td>
</tr>
<tr>
<td>( \sigma^2_{u1} )</td>
<td>2.40</td>
<td>2.33</td>
<td>2.32</td>
<td>2.30</td>
<td>2.34</td>
</tr>
<tr>
<td>( \sigma_{u01} )</td>
<td>29.03</td>
<td>24.90</td>
<td>24.29</td>
<td>24.92</td>
<td>25.29</td>
</tr>
</tbody>
</table>

| \( \chi^2 \)        | 407804.0   | 297523.0           | 298393.4  | 297759.2      | 298734.8 |
| AIC                 | 407816.0   | 297538.9           | 298409.4  | 297775.3      | 298750.9 |
| BIC                 | 407868.5   | 297606.5           | 298477.0  | 297842.8      | 298818.4 |

N=10,622; **p<.01 (2-tailed); *p<.05 (2-tailed).

The Null Model column contains the fixed and random effects for the null model. In reading the Null Model, the estimate for the intercept of the null model is 42.84 (which is also the grand mean of reading IRT), and that the variability of the entire individual group means (\( \sigma^2_{u0} \)) around this grand mean is 16.80. The intraclass correlation \( \sigma^2_{u0} / (\sigma^2_e + \sigma^2_{u0}) \) is .44. The ICC for the collaborative factors is consistent with the range of ICCs (.05 to .74) found in the meta-analysis.
conducted by Hedges and Hedberg (2007). Because this ICC is larger than .20, Roberts (2004) asserted that it is powerful and, according to Kreft and de Leeuw (1998), multilevel modeling must be used for the predictor level factors because the assumption of independent observations has been violated. Next, the simplicity of fit is determined for the reading collaborative predictor factor models.

The null model includes the chi-square, the Akaike information criterion (AIC), and the Bayesian information criterion (BIC). Because the null model and the predictor level models are not nested models, the principle that models should be parsimonious indicates that the simpler model should be used for data analysis. General fit indices to compare the fit and simplicity of statistical models are the AIC and the BIC (Hox, 2002). Each of these estimates the goodness of fit of a model. “The AIC and BIC are typically used to compare a range of competing models, and the model(s) with the lowest AIC or BIC value are considered the most attractive” (p. 46). In other words, when comparing competing models, Roberts (2004) states, “you simply need to consult these statistics [AIC and BIC] to see if the values go down from the previous model’s estimate. If the values go down, then the new model is considered to be a better model of the data than the previous model” (p.33). For each of the reading collaborative predictor factor models, the values go down when compared to the null model. Therefore, each of the reading collaborative predictor factor models is a better model of the data than the null model.

The fixed effect of the discuss curriculum model indicates that the estimate for the intercept (or average intercept) has now changed to 44.61 with a decrease to 16.70 in the variance of the intercepts ($\sigma^2_{u0}$) around the grand intercept. Therefore, the addition of the teacher-level predictor factor Discuss Curriculum explained more of the variability of the reading IRT achievement intercepts for students. For each data collection point in this study
(kindergarten, 1st grade, 3rd grade, and 5th grade), the average rate of growth for a student across time (kindergarten through 5th grade) is 33.29 points. For every increase in the level of collaboration that teachers reported by how often they met with other teachers to discuss curriculum, the score on reading IRT will decrease by -.06 points. The estimate for the interaction effect of time and the collaborative factor Discuss Curriculum on reading IRT achievement is -.14. Because the interaction effect is negative and our model is a better fit of the data, this translates to a student scoring lower on reading IRT achievement over time whose teacher reported full collaboration compared to a student whose teacher reported no collaboration in discussing curriculum. In addition, the variability between the group slopes of time (\( \sigma_{u1}^2 \)) is 2.33 and the covariance between the intercept and time (\( \sigma_{u01} \)) is 24.90. This means that the error terms for \( \gamma_{00} \) and \( \gamma_{10} \) are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept (\( \mu_{0j} \)) and the error terms for the slope of time (\( \mu_{1j} \)). Another way to say this is that the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Discuss Curriculum on reading IRT achievement was statistically significant (\( p < .01 \)).

The fixed effect of the colleague model indicates that the estimate for the intercept (or average intercept) has now changed to 34.43 with a decrease to 16.62 for the variance of the intercepts (\( \sigma_{u0}^2 \)) around the grand intercept. In other words, by adding this factor (i.e., the teacher-level \( \beta \)'s), more of the variability of the reading IRT achievement intercepts for students is explained. For each increase in time, the average rate of growth for a student is 30.84 points in reading IRT achievement. For every increase in the level of collaboration as reported by teachers in regards to being accepted as a colleague, the score on reading IRT will increase by
2.26 points. The estimate for the interaction effect of time and the collaborative factor Colleague on reading IRT achievement is .47. Because the interaction effect is positive and is warranted by the model, over time, an average student in a class whose teacher reported being fully accepted as a colleague will score higher on reading IRT achievement compared to an average student in a class whose teacher reports not being accepted as a colleague. In addition, the variability between the group slopes of time (σ²_u) is 2.32 and the covariance between the intercept and time (σ_u0) is 24.29. This means that the error terms for γ₀₀ and γ₁₀ are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept (µ₀j) and the error terms for the slope of time (µ₁j). In other words, the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Colleague on reading IRT achievement was statistically significant (p < .01).

The fixed effect of the impact policy model indicates that the estimate for the intercept (or average intercept) has now changed to 42.00 with a decrease of 16.67 in the variance of the intercepts (σ²_u) around the grand slope. By adding the teacher-level predictor factor Impact Policy, more of the variability of the reading IRT achievement intercepts for students is explained. For each data collection points for this study, the average rate of growth for a student across time is 32.18 points in reading IRT achievement. For every increase in the level of collaboration as reported by teachers regarding the amount of influence they have over policy decisions at their school, the score for reading IRT will increase .73 points. The estimate for the interaction effect of time and the collaborative factor Impact Policy on reading IRT achievement is .22. Because this model is a better fit of the data and because this interaction effect is positive, over time it matters whether or not a teacher reported having an impact on policy decisions. In
other words, for an average student in a class whose teacher reported having the greatest amount of influence on policy decision would score higher on reading IRT achievement over time compared to an average student in a class whose teacher reported having no influence over policy decisions. In addition, the variability between the group slopes of time ($\sigma_{u1}^2$) is 2.30 and the covariance between the intercept and time ($\sigma_{u01}$) is 24.92. This means that the error terms for $\gamma_{00}$ and $\gamma_{10}$ are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept ($\mu_{0j}$) and the error terms for the slope of time ($\mu_{1j}$). Another way to say this is that the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Impact Policy on reading IRT achievement was statistically significant ($p < .01$).

The fixed effect of the vision model indicates that the estimate for the intercept (or average intercept) has now changed to 38.85 with a decrease to 16.63 for the variance of the intercepts ($\sigma_{u0}^2$) around the grand intercept. In other words, by adding this factor (i.e., the teacher-level $\beta$'s), more of the variability of the reading IRT achievement intercepts for students is explained. For each increase in time (kindergarten, 1st grade, 3rd grade, and 5th grade), the average rate of growth for a student is 33.24 points in reading IRT achievement. For every increase in the level of collaboration as reported by teachers regarding whether or not the teacher felt that administrators communicated the vision for the school, the score for reading IRT will increase 1.37 points. The estimate for the interaction effect of time and the support factor Vision on reading IRT achievement is -.09. Because the interaction is negative and this model is a better fit of the data, over time, an average student in a class whose teacher fully agreed that administrators communicated the vision of the school will score lower on reading IRT
achievement compared to an average student in a class whose teacher did not fully agree that the administrators communicated the vision of the school. In addition, the variability between the group slopes of time \( \sigma_{u1}^2 \) is 2.34 and the covariance between the intercept and time \( \sigma_{u01} \) is 25.29. This means that the error terms for \( \gamma_{00} \) and \( \gamma_{10} \) are positively related, indicating that there is a relationship (correlation) between the error terms for the intercept \( \mu_{0j} \) and the error terms for the slope of time \( \mu_{1j} \). Therefore, the error terms for the intercept are dependent on the error terms of the slope of time. The effect of Vision on reading IRT achievement was statistically significant \( p < .01 \).

Figure 6 details the growth in student reading IRT achievement based on Model 5 in Chapter 3. Figure 6 reports the starting intercept for reading IRT in kindergarten and the growth that occurred due to the main effect of each reading collaborative variable, the fixed effect of time, the interaction effect between time and the each collaborative variable, and the effect of the error terms of these fixed effects on reading IRT achievement from 3rd grade through 5th grade. Moreover, the differences in student reading IRT achievement between students in classes whose teacher reports a specific level of collaboration is specified in each bar graph for each grade level.
Figure 6. Growth in reading IRT due to collaborative factors.
When the fixed effects and error terms for Discuss Curriculum are substituted into Model 5, the reading IRT growth from kindergarten to 3rd grade and kindergarten to 5th grade experienced by an average student in a class whose teacher reported the lowest level of collaboration was 68.35 points and 101.64 points, respectively. However, the average student in a class whose teacher reported the highest level of collaboration through daily meetings in order to discuss curriculum had a decrease of 1.70 points on reading IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of collaboration because of never meeting to discuss curriculum. In 5th grade, for teachers who reported the highest level of collaboration, the average student in their class had a decrease of 2.80 points on reading IRT achievement compared to students in classes whose teacher reported the lowest level of collaboration. The effect size (κ) for Discuss Curriculum was -.03; according to Cohen (1998), this was a small effect size.

When the fixed effects and error terms for Colleague are substituted into Model 5, the reading IRT growth from kindergarten to 3rd grade and kindergarten to 5th grade experienced by an average student in a class whose teacher reported the lowest level of collaboration was 46.87 points and 76.77 points, respectively. However, the average student in a class whose teacher reported the highest level of collaboration through feeling accepted as a colleague had an increase of 12.80 points on reading IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of collaboration because of not feeling accepted as a colleague. In 5th grade, for teachers who reported the highest level of collaboration, the average student in their class had a decrease of 14.68 points on reading IRT achievement compared to students in classes whose teacher reported the lowest level of collaboration.
collaboration. The effect size ($\kappa$) for Colleague was 1.24; according to Cohen (1998), this was a large effect size.

When these fixed effects and error terms for Impact Policy are substituted into Model 5, the reading IRT growth from kindergarten to 3rd grade and kindergarten to 5th grade experienced by an average student in a class whose teacher reported the lowest level of collaboration was 61.18 points and 92.92 points, respectively. However, the average student in a class whose teacher reported the highest level of collaboration by being fully involved in impacting policy decisions at their school had an increase of 3.51 points on reading IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of collaboration because of not being involved in impacting policy decisions. In 5th grade, for teachers who reported the highest level of collaboration, the average student in their class had a decrease of 4.17 points on reading IRT achievement compared to students in classes whose teacher reported the lowest level of collaboration. The effect size ($\kappa$) for Impact Policy was .40; according to Cohen (1998), this was a medium effect size.

When the fixed effects and error terms for Vision are substituted into Model 5, the reading IRT growth from kindergarten to 3rd grade and kindergarten to 5th grade experienced by an average student in a class whose teacher reported the lowest level of collaboration was 60.11 points and 93.53 points, respectively. However, the average student in a class whose teacher reported the highest level of collaboration by strongly agreeing that administrators communicate the vision of the school had an increase of 4.76 points on reading IRT achievement in 3rd grade compared to an average student in a classroom whose teacher reported the lowest level of collaboration by strongly disagreeing that administrators do not communicate the vision of the school. In 5th grade, for teachers who reported the highest level of collaboration, the average
student in their class had a decrease of 4.40 points on reading IRT achievement compared to students in classes whose teacher reported the lowest level of collaboration. The effect size ($\kappa$) for Vision was .75; according to Cohen (1998), this was a large effect size.

Summary

This study examined the effects of PLCs have on student math and reading achievement based on ECLS-K data. Variables within the ECLS-K database that corresponded with the dimensions of PLCs were identified and were analyzed using a multilevel growth model. All factors except math and reading collaborative factor Discuss Curriculum and reading support factor Lesson Planning were statistically significant in the effect that each had on in student IRT achievement from 3rd grade to 5th grade. In addition, all statistically significant factors showed growth in student IRT achievement in math and reading from 3rd grade to 5th grade.
CHAPTER 5

SUMMARY

The purpose of this study was to examine data from the Early Childhood Longitudinal Study: ECLS-K Fifth Grade report (ECLS-K), identify questions and statements that correlate to the dimensions of professional learning communities (PLCs), and determine if PLCs impact student achievement. This study analyzed the effect of PLC factors on student achievement in math and reading IRT scores for the same 3rd grade and 5th grade elementary students in the United States. As a result, this research was able to measure growth in student achievement over time. This study revealed that selected dimensions of PLCs have a statistically significant effect ($p < .05$) on student achievement in math and reading over time.

Specifically, the following PLC dimensions had a statistically significant effect on math and reading achievement for this study. The information in parenthesis that follow each PLC dimension is the variables from the ECLS-K data that correlated to each PLC dimension and were the variables analyzed for this study. Shared and Supportive Leadership (Impact Policy and Discuss Curriculum), Shared Values and Vision (Mission and Vision), Shared Personal Practice (Lesson Planning), and Supportive Conditions (Colleague, Parent Support, Support and Encourage) are the four PLC dimensions analyzed in this study. This chapter will summarize and discuss the results based on the research questions from Chapter 1. Recommendations for educators and suggestions for additional research based on these results are also included.

Summary of Results

Research Question 1: What is the effect of professional learning communities (PLCs) on student achievement over time in math among United States elementary students?

This study demonstrated that seven of the eight factors from the ECLS-K data that
correspond to the dimensions of PLCs showed statistically significant growth ($p < .05$) on math item-response theory (IRT) achievement from kindergarten to 3rd grade and kindergarten to 5th grade for elementary school students in the United States during the timeframe of this study. In addition, when teachers reported the highest levels of support and collaboration stemming from the factors that correspond to PLCs, the same students from 3rd grade and 5th grade in this study experienced higher scores in math IRT achievement. Except for the collaborative factor, Discuss Curriculum, which did not have a statistically significant effect ($p > .05$) on math IRT achievement, all other PLC factors had a statistically significant ($p < .05$) impact on growth for math IRT achievement in 3rd grade and 5th grade. Therefore, administrators should note how the factors in this study that improved student achievement in math indicate the need for the creation and nurturing of supportive conditions for teachers and parents. In addition, the factors indicated the necessity for administrators to involve teachers in more managerial tasks that have been historically the duty of the principal. Finally, because the current study utilized a nationally representative sample of elementary students in the United States, the results for math IRT achievement can be generalized to the entire population of elementary students who were enrolled in grades K-5 during the timeframe of this study.

A summary of the growth experienced by students in this study is provided in order to aide the reader in understanding the growth in math IRT achievement that occurred from kindergarten to 3rd grade and from kindergarten to 5th grade. Table 13 details the growth from kindergarten to 3rd grade and from kindergarten to 5th grade in math IRT achievement for an average student whose teacher reported the lowest level of support or collaboration. When the fixed effects and error terms for the support and collaborative factors are analyzed, the following
growth resulted. Each of the reported growths in math IRT achievement represented statistically significant growth ($p < .05$).

Table 13

*Growth in Math IRT Achievement from Kindergarten to 3rd Grade and from Kindergarten to 5th Grade*

<table>
<thead>
<tr>
<th>PLC Factor</th>
<th>3rd Grade</th>
<th>5th Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson Planning</td>
<td>50.88</td>
<td>76.82</td>
</tr>
<tr>
<td>Parent Support</td>
<td>34.94</td>
<td>58.67</td>
</tr>
<tr>
<td>Mission of School</td>
<td>43.27</td>
<td>68.49</td>
</tr>
<tr>
<td>Support and Encourage</td>
<td>44.43</td>
<td>69.95</td>
</tr>
<tr>
<td>Colleague</td>
<td>37.49</td>
<td>60.33</td>
</tr>
<tr>
<td>Vision</td>
<td>47.82</td>
<td>73.79</td>
</tr>
<tr>
<td>Impact Policy</td>
<td>47.71</td>
<td>73.16</td>
</tr>
</tbody>
</table>

A summary of the achievement gains is provided in order to aide the reader in understanding the range of gains that occurred in student math IRT achievement for 3rd grade and 5th grade as a result of the support and collaborative factors listed in Table 13. Each of the reported range of gains and individual results from each predictor factor represented statistically significant ($p < .05$) increases in math IRT achievement.

When comparing 3rd grade students in classes whose teacher reported the highest levels of support and collaboration to students in classes whose teacher reported the lowest levels of support and collaboration, the increase in gain experienced by students in 3rd grade as a result of the Support and Collaborative factors ranged from as little as 3.05 points in math IRT achievement to as much as 12.76 points in math IRT achievement. Specifically, the following gain in math IRT achievement occurred due to each support or collaborative predictor factor.
The smallest amount of gain in 3rd grade was 3.05 points in math IRT achievement that resulted from the support factor Lesson Planning. Collaborative factor Vision showed a gain in math achievement of 3.48 points; collaborative factor Impact Policy increased achievement by 4.04 points; support factor Support and Encourage exhibited a gain of 5.68 points; support factor Mission of School resulted in 6.68 points of gain in achievement; collaborative factor Colleague evidenced 9.68 points of gain in math IRT achievement; and support factor Parent Support demonstrated 12.76 of gain on math IRT achievement. The amount of gain in student math IRT achievement produced by the support and collaborative factors is encouraging to administrators looking for solutions to student academic growth concerns. Similar findings with these predictor factors resulted in 5th grade.

When comparing 5th grade students in classes whose teacher reported the highest levels of support and collaboration to students in classes whose teacher reported the lowest levels of support and collaboration, the increase in math IRT achievement experienced by students in 5th grade as a result of the support and collaborative factors ranged from as little as 3.88 points in math IRT achievement to as much as 14.76 points in math IRT achievement. For 5th grade math IRT achievement, the smallest amount of gain was 3.88 points due to the effect of collaborative factor Vision. Support factor Lesson Planning had an impact on gain in math achievement of 3.90 points; collaborative factor Impact Policy resulted in 4.88 points of gain; support factor Support and Encourage resulted in a gain of 6.56 points in math achievement; support factor Mission of School produced 7.60 points of improved achievement; support factor Parent Support generated 14.76 points of gain; and collaborative factor Colleague resulted in 17.80 points of gain in math IRT achievement. As a result of the support and collaborative predictor factors, there was gain in math IRT achievement in 5th grade. The gain as a result of these factors proved
that for the students in this study, PLCs did have a significant amount of positive impact on their academic progress in math.

When teachers reported the highest levels of support or collaboration, the results of each of the supportive and collaborative gain from 3rd grade added to the corresponding support or collaborative gain from 5th grade resulted in combined improvement on math IRT achievement that ranged from as little as 6.95 points in math IRT achievement to as much as 27.52 points in math IRT achievement. Support factor Lesson Planning had combined gain in math IRT achievement of 6.95 points; collaborative factor Vision had combined improvement of 7.36 points; collaborative factor Impact Policy resulted in 8.92 points of combined gain from 3rd grade to 5th grade; support factor Support and Encourage had a combined gain in math IRT achievement of 12.24 points; support factor Mission of School resulted in 14.28 points in combined gain; collaborative factor Colleague resulted in combined gain of 27.48 points; and support factor Parent Support had combined improvement of 27.52 points in math IRT achievement. Within these results is profound evidence of what administrators should do to have the biggest impact on K-5 student achievement in math. The amount of substantial, cumulative academic gain resulting from the predictor factors Colleague and Parent Support indicates the need for administrators to focus on the social needs of teachers in order to have the most positive impact on student achievement. When compared to the 49.75 points of academic gain in math IRT achievement of the other five factors, the effect of these two factors resulted in combined improvement of 55.00 points in math IRT achievement. Such a large amount of gain reveals the substantial benefits of positive relationships among stakeholders in schools in this study.

The statistically significant impact of PLCs on growth and gain in math IRT evidenced in this study supports findings from other studies which report the positive influence of PLCs on
student achievement (Newmann & Wehlage, 1995). In their study, Newmann and Wehlage (1995) found that if two average students, one in a school with low teacher professional community (lowest levels of support and collaboration) and the other in a school with high professional community (highest levels of support and collaboration), the students in a high community school would score approximately 27 percent higher on the school restructuring survey (SRS) math and social studies measure. This difference would represent a gain of 31 percentile points. In addition, the current research supports the tenets of systems theory and the principles of PLCs which stress increasing the amount of purposeful interaction between and among individuals within and across the various levels of the school system in order to improve student academic success (Senge, 1990; Fullan, 1995; Huffman & Hipp, 2003; DuFour, DuFour, & Eaker, 2005; and Eaker & Gonzalez, 2007). For the purpose of this study, the results of the positive interactions between and among teachers, parents, and administrators as evidenced in the growth in student math IRT achievement are the relationships current research indicates will increase student achievement.

Research Question 2: What is the effect of professional learning communities (PLCs) on student achievement over time in reading among United States elementary students?

This study demonstrated that six of the eight factors from the ECLS-K data that correspond to the dimensions of PLCs showed statistically significant growth ($p < .05$) on reading IRT achievement from 3rd grade to 5th grade for elementary school students in the United States. Students in the current study experienced higher scores in reading IRT achievement when teachers reported the highest levels of support and collaboration stemming from the factors that correspond to PLCs. Except for support factor Lesson Planning and collaborative factor Discuss Curriculum, which did not have a statistically significant effect ($p > .05$) on reading IRT
achievement, all other PLC factors had a statistically significant impact on growth for reading IRT achievement in 3rd grade and 5th grade. Once again, because this study utilized a nationally representative sample of elementary students in the United States, the results for reading IRT achievement can be generalized to the entire population of students who were enrolled in grades K-5 during the timeframe of this study.

A summary of the growth in reading IRT achievement experienced by students in this study is provided in order to aide the reader in understanding increase in achievement that occurred from kindergarten to 3rd grade and from kindergarten to 5th grade. Table 14 details the growth from kindergarten to 3rd grade and from kindergarten to 5th grade in reading IRT achievement for an average student whose teacher reported the lowest level of support or collaboration. When the fixed effects and error terms for the support and collaborative factors are analyzed, the following growth resulted. Each of the reported growths in reading IRT achievement represented statistically significant growth ($p < .05$).

Table 14

*Growth in Reading IRT Achievement from Kindergarten to 3rd Grade and from Kindergarten to 5th Grade*

<table>
<thead>
<tr>
<th>PLC Factor</th>
<th>3rd Grade</th>
<th>5th Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent Support</td>
<td>45.11</td>
<td>74.93</td>
</tr>
<tr>
<td>Mission of School</td>
<td>54.91</td>
<td>86.68</td>
</tr>
<tr>
<td>Support and Encourage</td>
<td>56.72</td>
<td>89.02</td>
</tr>
<tr>
<td>Colleague</td>
<td>46.87</td>
<td>76.77</td>
</tr>
<tr>
<td>Vision</td>
<td>60.11</td>
<td>93.53</td>
</tr>
<tr>
<td>Impact Policy</td>
<td>61.18</td>
<td>92.92</td>
</tr>
</tbody>
</table>
A summary of the achievement gains is provided in order to aide the reader in understanding the range of gains that occurred in student math IRT achievement for 3rd grade and 5th grade as a result of the support and collaborative factors listed in Table 13. Each of the reported range of gains and individual results from each predictor factor represented statistically significant \((p < .05)\) increases in math IRT achievement.

When comparing 3rd grade students in classes whose teacher reported the highest levels of support and collaboration to students in classes whose teacher reported the lowest levels of support and collaboration, the increase in achievement experienced by students in 3rd grade as a result of the support and collaborative factors ranged from as little as 3.51 points in reading IRT achievement to as much as 15.64 points in reading IRT achievement. The minimum amount of gain in reading IRT achievement experienced by students in this study was 3.51 due to the collaborative predictor factor Impact Policy. Subsequently, students in this study experienced the following gain in reading IRT achievement: 4.76 points resulted from the collaborative factor Vision; there was a 7.08 point increase in achievement that resulted from support factor Support and Encourage; an 8.48 point improvement resulted from support factor Mission of School; an increase of 12.80 points occurred due to the collaborative factor Colleague; and there was an increase of 15.64 points in reading IRT achievement due to the support factor Parent Support. These results are similar to the results from the 3rd grade math IRT achievement in that the predictor factors that had the most impact on student growth were Colleague and Parent Support. This further substantiates the need for administrators in K-5 schools to focus on the social aspects of the school in order to have the most impact on improving student achievement.

When comparing 5th grade students in classes whose teacher reported the highest levels of support and collaboration to students in classes whose teacher reported the lowest levels of
support and collaboration, the increase in achievement experienced by students in 5th grade as a result of the support and collaborative factors ranged from as little as 4.17 points in reading IRT achievement to as much as 17.80 points in reading IRT achievement. The minimal amount of gain in reading IRT achievement experienced by students was 4.17 points due to the impact of the collaborative factor Impact Policy. The effect of the collaborative factor Vision resulted in 4.40 points of gain; the support factor Support and Encourage resulted in 7.48 points of gain; the support factor Mission of School increased reading IRT achievement by 9.24 points; collaborative factor Colleague showed an increase of 14.68 points in gain; and support factor Parent Support had an effect of increasing student reading IRT achievement by 17.80 points. The effect of these predictor factors on 5th grade reading IRT achievement paralleled those in 3rd grade reading IRT achievement as well as the results in 3rd grade and 5th grade math IRT achievement in that they pointed out the need for strong relationships between the adult stakeholders of a school. Specifically, administrators in schools who serve K-5 students need to facilitate collegial relationships between teachers and they need to encourage positive parent-school relationships. Further proof of the benefits resulting from positive relationships among teachers and parents was evidenced in the cumulative results of reading IRT achievement from 3rd grade to 5th grade.

When teachers reported the highest levels of support or collaboration, the results of each of the supportive and collaborative gains from 3rd grade added to the corresponding support or collaborative gains from 5th grade resulted in combined increase in achievement that ranged from as little as 7.68 points in reading IRT achievement to as much as 33.44 points in reading IRT achievement. The effect of collaborative factor Impact Policy from 3rd grade combined with the effect from 5th grade resulted in cumulative gain of 7.68 points in reading IRT achievement. The
collaborative factor Vision combined to produce 9.16 points of increase in reading IRT achievement; support factor Support and Encourage had a cumulative effect of 14.56 points in reading IRT achievement; support factor Mission of School had a combined effect of 17.72 points in reading IRT achievement; collaborative factor Colleague resulted in a combined growth of 27.48 points in reading IRT achievement; and support factor Parent Support resulted in a cumulative gain of 33.44 points in reading IRT achievement. Once more, these results established the positive effect of PLCs on student achievement over time from 3rd grade to 5th grade. A substantial amount of gain was experienced by students whose teachers reported high levels of collegiality and parent support. When added together, these two factors resulted in a gain of 60.92 points in reading IRT achievement experienced by students. In comparison, the remaining four factors combined to produce a gain of 49.12 points in reading IRT achievement during 3rd grade and 5th grade. Administrators who are looking to improve student achievement in K-5 schools should take note of the extremely positive results in this study that occurred due to healthy relationships among and between teachers, parents, and administrators.

The statistically significant impact of PLCs on growth in reading IRT achievement reported in this study supports findings from other studies which reported the positive influence of PLCs on student achievement (Newmann & Wehlage, 1995). As established in Chapter 2, Newmann and Wehlage (1995) found that students who were in schools with the highest levels professional learning community (highest levels of support and collaboration) gained 31 percentile points on the SRS measure compared to students who were in schools with the lowest levels of professional learning community (lowest levels of support and collaboration). The quantitative research findings of the positive impact PLCs have on student achievement found in Newmann and Wehlage (1995) is supported by current qualitative research. Where there are
well-established PLCs in schools in which parents, teachers, students, and administrators share a positive rapport, students are more likely to experience academic success (Saphier, 2005; and Goldring, Porter, Murphy, Elliott, and Cravens, 2007). The results in this study support the findings in the aforementioned quantitative and qualitative research.

Discussion of Results

The purpose of this study was to examine data from the Early Childhood Longitudinal Study: ECLS-K Fifth Grade (ECLS-K) report, to identify questions and statements that correspond with the dimensions of PLCs, and determine the effect PLCs have on student achievement over time. Eight factors correlated to the five dimensions of PLCs and were analyzed in order to determine the effect that each had on student achievement.

Through multilevel analysis, results revealed that specific dimensions of PLCs did have a statistically significant \( p > .05 \) impact on student growth in math and reading IRT assessments for 3\(^{rd}\) grade and 5\(^{th}\) grade elementary children in America. The results of the current study are supported by current literature detailing the positive effects of PLCs. Hughes and Kritsonis (2006) noted that creating an organization with an emphasis on developing the attributes of a PLC will have the potential of allowing schools to improve both instructional practice and student performance. In addition, Feger and Arruda (2008) stated that in order to increase student achievement, educators need to create a collaborative school culture focused on learning. Furthermore, the establishment of PLCs indicates that a school is exhibiting the intellectual behavior that will ensure its success as an institution (Fullan, 2005; and Senge, 1990).

The results in the current study indicated student achievement did increase based on well established dimensions of PLCs within K-5 elementary schools. Specifically, the dimension of
Supportive Conditions had a major amount of impact on student achievement in this study. On average, the combined growth in math and reading IRT achievement from 3\textsuperscript{rd} grade and 5\textsuperscript{th} grade for the three predictor factors in the Supportive Conditions PLC dimension was 20.99 points for a student whose teacher reported the highest levels of parent support and collegial acceptance. Although the dimensions of Shared and Supportive Leadership, Shared Values and Vision, and Shared Personal Practice had a smaller impact on student achievement, there was still noteworthy growth. In fact, on average, the combined growth in math and reading IRT achievement from 3\textsuperscript{rd} grade and 5\textsuperscript{th} grade was 10.30 points for a student whose teacher reported the highest levels of support and collaboration. The combined growth experienced as a result of the factors within each of the remaining PLC dimensions is the following: Shared and Supportive Leadership resulted in 8.30 points of combined growth, on average, in math and reading IRT achievement; Shared Values and Vision accounted for 12.13 points of combined growth, on average, in math and reading IRT achievement; and Shared Personal Practice resulted in 6.68 points of combined growth, on average, in math and reading IRT achievement. Administrators in K-5 schools should take note of the positive impact of the predictor variables within each of these PLC dimensions on student achievement. In fact, PLCs proved to be an answer to some of the problems administrators are having with increasing student performance.

Relationship of Current Study to Prior Research

There many qualitative research studies regarding the effects professional learning communities on student achievement. Current research suggests that developing professional learning communities is a concept that offers educators the best hope for substantive school improvement and increasing student achievement (Symonds, 2004; DuFour, DuFour, and Eaker,
2005, Saphier, 2005; and Eaker & Gonzalez, 2007). Darling-Hammond (1996) noted participation in PLCs through school and teacher networks also “deepens teachers’ understanding” (p.753) of how to improve student achievement. In addition, when teachers and administrators carefully assess data, they make better decisions regarding curriculum reform and decisions about the transformation of teaching roles due to this analysis of data. As a result, this ensures improvement in academic achievement (Symonds, 2004; Lencioni, 2005; Schlechty, 2005; and Reeves, 2006). Furthermore, Hord (1997a) argued: “As an organizational arrangement, the professional learning community is seen as a powerful staff development approach and a potent strategy for school change and improvement” (p. 2).

Quantitative research regarding the effects of professional learning communities is not as abundant as the qualitative research. The results detailed in the study by Newmann and Wehalge (1995), and the results detailed in this study regarding the effects of professional learning communities on student achievement, confirm the research found in the qualitative literature on PLCs. However, much more research needs to be conducted regarding the effects of PLCs on student achievement over time in elementary grades.

**Recommendations for Educators**

While a single study cannot provide a sound basis for the practice of implementing PLCs, this study would suggest a way to increase scores in elementary school in math and reading is to have a well-established PLC. In fact, the findings of this study indicate that the increase in student achievement will not only be substantial, it will also be statistically significant. However, this is one study. The following recommendations for educators are based on the literature review, results, and conclusions of this study.
1. Research what a well developed professional learning community is and seek out exemplars of well developed professional learning communities.

2. Practice the five dimensions of professional learning communities detailed by Huffman and Hipp (2003) in your school, grade level, or subject area.

3. Provide schools with the necessary funding and support to begin establishing professional learning communities.

4. Provide training on how to assess the effectiveness of professional learning communities in schools.

5. Become trained in multi-level modeling analysis and other statistical methodologies.

Suggestions for Further Research

The following suggestions for further research are based on the literature review, results, and conclusions of this study.

1. Additional research is needed specific to analyzing the factors that impact academic growth of students beginning in 3rd grade.

2. Conduct future research on the effect of PLCs student growth over time in math and reading from 3rd grade to 8th grade.

3. Conduct future research on which PLC dimension has the most impact on student achievement over time.

4. Conduct future research on how PLCs impact student achievement over time for students at various socio-economic levels.

5. Conduct future research on how PLCs impact student achievement over time for students from different races.

6. Conduct future research on how PLCs impact student achievement over time for students who are at-risk.

Summary

This chapter summarized and discussed the results based on the research questions from
Chapter I. The discussion of results included the relationship of this study to prior research, recommendations for educators, and suggestions for additional research based on the results of this study which originated from the initial research questions.
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