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A District-Wide Study Confirming the Relationship Between Professional Learning Communities and Student Achievement in Elementary Schools

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Doctor of Philosophy

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ABSTRACT

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Researchers have studied professional learning communities for over two decades. Educators have utilized the elements of professional learning communities in their schools to improve instruction and student learning. Yet, there is limited empirical evidence that establishes, describes, and confirms the relationship between professional learning communities and student learning. This study was completed to better understand the nature, strength, and types of relationships between the individual elements of professional learning communities and student achievement. The sample for this study was 26 elementary schools, 439 teachers, and nearly 11,000 students. An analysis of professional learning communities and student achievement data through hierarchical linear modeling indicated that each of the eight clearly defined elements of professional learning communities have a significant relationship with student achievement.

Keywords Collaboration – Elementary Schools – Hierarchical linear modeling – Increased student learning – Professional development – Professional learning community – School leadership

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DESCRIPTION OF STRUCTURE AND CONTENT

The hybrid dissertation is one of several formats supported in BYU's David O. McKay School of Education. Unlike a traditional five-chapter format, the hybrid dissertation focuses on producing a journal-ready manuscript, which is considered by the dissertation committee to be ready for submission. Consequently, the final dissertation product has fewer chapters than the traditional format and focuses on the presentation of the scholarly manuscript as the centerpiece. An extended review of literature and a methodological section sufficient for the requirements of an institutional review board will follow the manuscript chapter as appendices.

To effectively meet the scope of the following journal manuscript we had to narrow our focus and eliminate some of the items discussed in the appendices. Instead of analyzing the relationship between PLCs and student achievement in both secondary and elementary schools, we decided to solely analyze this relationship in elementary schools. This decision was made because comparing PLCs with student achievement is like comparing apples and oranges and the scope of our article would not have been clearly focused on the relationship between the PLC elements and student achievement. Also, instead of using multiple measurements of student achievement we focused solely on Utah's CRTs because they were the most comprehensive assessments of student achievement available that allowed us to compare and contrast across grade levels and subject areas. It is important to note that in our analysis of the data we did analyze all of the elementary and secondary data thoroughly before we decided to narrow our scope of the article and focus solely on elementary schools.

The following research question guided this study: Are the eight elements of PLC related with student achievement: *An Interdependent Culture Based on Trust; Mission, Vision, Values, and Goals; Principal Leadership; Participative Leadership; Collaborative Teaming; Data Based*

Decision-Making Using Continuous Assessment; Professional Development; and *Systems of Prevention and Intervention*?

We found that the individual elements of professional learning community are related to student achievement. Using Hierarchical Linear Modeling we constructed 104 models across three subject areas (language arts, math, and science) and five grade levels (2^{nd} to 6^{th}) and found that of the 104 models we analyzed, 40 of these relationships were significant or moderately significant with student achievement. We also found linear and non-linear relationships that described the interactions between professional learning communities and student achievement.

Three elements indicated the greatest number of significant or moderately significant relationships with student achievement: a) An Interdependent Culture Based on Trust, b) Mission, Vision, Values, and Goals, and c) Data Based Decision-Making Using Continuous Assessment. The following school leadership elements also were significantly related with student achievement: a) Principal Leadership and b) Participative Leadership. The other three elements were also related to student achievement but with a lower number of relationships: a) Collaborative Teaming, b) Professional Development, and c) Systems of Prevention and Intervention. These findings should inform and guide future research and encourage practitioners to utilize professional learning communities in their schools.

Introduction

The most ideal school setting is one that truly supports teachers in improving their instruction to ensure students receive the best education possible. All educators in such a school, both leaders and teachers alike, unite their efforts and focus their interdependent work to change the culture to this end. For over two decades, professional learning communities (PLCs) have shown great potential in creating a school culture where teachers' instruction is improved so students can learn and achieve academically. This potential derives in part from the fact that a PLC is not a program that can simply be implemented but is a culture that develops the values, attitudes, and assumptions of those involved in educating students to improve all aspects of the school (Schein, 1990). Some believe establishing a PLC is the best way to continually renew and improve schools to become more collaborative, results orientated, and data-driven. Also, that a PLC facilitates the sharing of leadership in order to move the culture forward in supporting teachers as they help children learn (Blankstein, 2004; DuFour & Eaker, 1998; Hord, 1997; Louis & Kruse, 1995; Louis & Marks, 1998).

Nature of PLCs

PLCs have been studied in the research and practiced in the schools for over two decades. A number of practices have been considered as important elements of a PLC, but, there is not a standard definition or consensus of what a PLC is.

PLC Elements. Student learning is the core and driving purpose of a PLC (DuFour & Eaker, 1998; Hord, 1997; Louis & Kruse, 1995; Louis & Marks, 1998; McLaughlin & Talbert, 2006). A high-functioning PLC connects everything a school does, especially teaching, to student learning (DuFour, DuFour & Eaker, 2008); it is fueled and bound together by an

interdependent culture based on trust (Bryk, 2010; Bryk & Schneider, 2002). The mission and vision unite the minds and hearts of teachers and leaders and direct all the work they do (Hallinger & Heck, 2002). The principal of the school helps establish the PLC, leads it effectively with an undeviating focus on student learning, and shares leadership to utilize the expertise and experience of all involved in the school (Louis, Dretzke, & Wahlstrom, 2010a; Louis et al., 2010b; Marzano, Waters, & McNulty, 2005). In a thriving PLC, collaboration replaces isolation (Little, 1990; Supovitz, 2002; Saunders, Goldenberg, & Gallimore, 2009). The professional development and collaborative efforts of teachers in a PLC are teacher driven, embedded in daily work, and focused specifically on improving instruction (Garet, Porter, Desimone, Birman, & Yoon, 2001). At the school and team levels, teachers use data-driven collaborative processes to make decisions and refine instruction to ensure that the needs of all students are met (Blankstein, 2004; Jacobsen, 2010; Strahan, 2003). These schools develop systems of prevention, intervention, and enrichment that use data to provide targeted additional time and support for students who have not yet mastered essentials and arrange enrichment for those who have already mastered the content (Blankstein, 2004; DuFour, 2004). A high-functioning PLC creates an effective environment and culture for continuous instructional improvement in the service of helping all students learn.

Definition of PLC. PLCs are comprised of several distinct yet related dimensions. A challenge facing the PLC research is the lack of a standard definition (Lomos et al., 2011; DuFour, 2004). It is challenging to measure or examine something that is not clearly defined. Over the past two decades researchers and experts have defined PLCs with considerable overlap, but have not reached consensus of what elements are essential to the definition. DuFour (2004) described what could happen if this problem persists, “The term [PLCs] has been used so

ubiquitously that it is in danger of losing all meaning" (p. 1). If studies continue to measure and analyze different definitions of PLCs, the promise they have may be diminished or even lost. A common language and definition of PLCs are needed so researchers can study PLCs and communicate their findings effectively. Thus, schools can utilize PLC research findings to change their cultures, improve instruction, and help students learn (Lomos et al., 2011).

To clearly state the definition of PLC we use in this study, we share the following definition created by Williams, Matthews, Stewart, and Hilton (2007). Like all definitions, this standard has its limitations and is open to scrutiny, which we hope will further the conversation in the study of PLCs. Williams and colleagues' (2007) definition of PLC was developed by identifying the most critical elements in PLC studies and the work of leading PLC researchers. Their purpose in clearly defining a PLC was to create consistency in the research in order to analyze and measure PLCs more effectively. This research will provide guidelines to ensure that PLCs are developed and cultivated in schools effectively. It is important to note that the definition presented in Williams and colleagues' (2007) definition contains ten elements of a PLC, but was condensed to the following eight elements through scientific processes (See Stewart (2009) for a thorough description of this process). They defined a PLC with the following eight elements:

1. An interdependent culture based on trust
2. Common mission, vision, values, and goals that are focused on teaching and learning
3. Principal leadership that is focused on student learning
4. Participative leadership that is focused on teaching and learning
5. Collaborative teaming
6. Professional development that is teacher driven and embedded in daily work

7. Systems of prevention and intervention that assure academic success for all students
8. Data based decision-making using continuous assessment

Using this definition, Williams and colleagues (2007) created a measurement tool called the Learning Community Culture Indicator (LCCI) to measure each of these important, unique, specific elements of a PLC. The LCCI is a validated and reliable survey that measures each of these clearly defined PLC elements (Stewart, 2009), where teachers provide self-report data on four to seven items in each of the eight PLC elements listed above.

Evaluation of PLC Effectiveness

Many researchers and practitioners have seen the benefits of PLCs, yet there is a limited amount of empirical evidence indicating a relationship between PLCs and student achievement. The combined results of the studies that do provide empirical evidence indicate that the relationship between PLCs and student achievement is positively significant.

Benefits of PLCs in regard to student achievement. When schools live PLC principles, the culture can change for the better and the work of educators combines to build teachers' individual and collective capacity to more effectively enhance student learning (Elmore, 2004). In their review of PLC studies, Vescio and colleagues (2008) found that all of the studies they included suggested "a change in the professional culture of the school had occurred" (p. 84), which led to higher student achievement in many of the schools studied. Stoll and colleagues (2006) said, "Developing professional learning communities (PLCs) appears to hold considerable promise for capacity building for sustainable improvement" (p. 221). In addition, the research on each specific element has indicated that PLCs can improve cultures and that, most importantly, these changes are positively related to student achievement.

Educational researchers have indicated the potential contribution PLCs may make to schools, particularly on improving instruction and student learning. Hargreaves (2008) stated, "At their best, professional learning communities remain powerful organizational strategies to enable and empower teachers and others to learn and work together in improving the quality and results of teaching, learning, and caring for all students" (p. 187). Hord and Hirsh (2008) described, "The surest way to help teachers to help all students is to engage all teachers in professional learning communities" (p. 23). DuFour and colleagues (2005) said, "The use of professional learning communities is the best, least expensive, most professionally rewarding way to improve schools…Such communities hold out immense unprecedented hope for schools and the improvement of teaching" (DuFour, Eaker, & DuFour, 2005, p. 128). Bolam and colleagues (2005) wrote, "An effective professional learning community has the capacity to promote and sustain the learning of all professionals in the school community with the collective purpose of enhancing pupil learning (p. 145)." These educational researchers, as well as many others, have studied PLCs for several years and have come to the same conclusion: PLCs have great promise to improve instruction and help students learn.

Lack of empirical evidence of PLCs relationship with student achievement. Despite the promise claimed by many that PLCs improve instruction and student achievement, few studies have actually provided clear empirical evidence of this positive relationship (Lomos, Hofman, & Bosker, 2011; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006; Vescio, Ross, & Adams, 2008). Recently, PLCs have gained momentum as more books and articles have been published describing and researching PLCs. In fact, the majority of the reviews of PLC literature and studies of PLCs have been published within the past decade, and many of these within the last few years. In addition, PLCs have recently been studied internationally (Bolam et al., 2005;

Meirink, Imants, Meijer, & Verloop, 2010; Moolaner, Sleegers, & Daly, 2012; Siguroardottir, 2010; Stoll et al., 2006; Visscher & Witziers, 2004). Perhaps the limited empirical evidence is due to the fact that the relationship between PLCs and student achievement has only been recently studied in the literature.

This study was conducted to add to the empirical evidence that shows a relationship between PLCs and student achievement. This study of 26 elementary schools, 439 teachers, and nearly 11,000 students was completed in a large suburban district in Utah that has been developing and cultivating PLCs in their schools for the past few years. The following research question guided this study as we analyzed the relationship between PLCs and student achievement: Are the individual elements of a PLC related with student achievement: *An Interdependent Culture Based on Trust; Mission, Vision, Values, and Goals; Principal Leadership; Participative Leadership; Collaborative Teaming; Data Based Decision-Making Using Continuous Assessment; Professional Development;* and *Systems of Prevention and Intervention*?

Evidence of Effectiveness of PLCs. In the past couple of decades only nine studies have been published that indicate a positive relationship between PLCs and student achievement in elementary schools (Berry, Johnson, & Montgomery, 2005; Bolam et al., 2005; Gruenert, 2005; Louis et al., 2010a; Louis & Marks, 1998; Saunders et al., 2009; Siguroardottir, 2010; Strahan, 2003; Supovitz, 2002). The following criteria were used to choose studies that we considered to provide empirical evidence: a) Study analyzed the relationship between PLCs and student achievement in elementary schools; b) Study published in peer-reviewed journals or was a report funded by a national government; c) Study clearly defined PLCs with several elements, instead

of a focus on only one element (e.g. professional development). Heretofore, these nine studies will be referred to as the Evidence Providing (EP) studies.

Even though only nine studies provide empirical evidence of the relationship between PLCs and student achievement, it is important to note that the combined results of these EP studies indicate that this relationship is clear and positive. In addition, all but one of the EP studies was published in peer-reviewed journals (Bolam et al., 2005: an extensive report on a national study in England). Table 1 shows the characteristics of each EP study. All of the EP studies were completed in the past 15 years, 8 in the past 10 years, and 3 in the last 3 years (Louis et al., 2010a; Saunders et al., 2009; Siguroardottir, 2010).

Table 1

Characteristics of Evidence Providing Studies

Authors of study	Year	Country/ state	Peer reviewed	Qualitative	Quantitative	Subjects reported for student achievement	Individual PLC element(s) compared with student achievement
Louis & Marks	1998	US	X	X	X	Math & social studies	
Supovitz	2002	Ohio	X	X	X	Reading, writing, math, science, & citizenship	X
Strahan	2003	North Carolina	X	X		Reading & math	
Berry, Johnson, & Montgomery	2005	North Carolina	X	X		Not indicated	
Bolam & colleagues	2005	England		X	X	Not indicated	
Gruenert	2005	Indiana	X		X	Language arts & math	X
Saunders, Goldenberg, & Gallimore	2009	California	X	X	X	Language arts, reading, spelling, & math	
Siguroardottir	2010	Iceland	X	X	X	Icelandic & math	
Louis, Dretzke, & Wahlstrom	2010	US	X	X	X	Math	X

The majority of the EP studies were conducted in the United States, with both studies by Louis and colleagues (1998, 2010) completed nationally across the United States. The other five U.S. studies focused on schools or districts in individual states (Berry et al., 2005; Gruenert, 2005; Saunders et al., 2009; Strahan, 2003; Supovitz, 2002). Two studies analyzed PLCs internationally in England (Bolam et al., 2005) and Iceland (Siguroardottir, 2010). Two EP studies were solely qualitative (Berry et al., 2005; Strahan, 2003), two quantitative (Gruenert, 2005; Louis et al., 2010a), and the other five utilized mixed methods. EP studies utilized a variety of subject areas to analyze student achievement with the most common being language arts (LA) and mathematics. Social studies, science, and citizenship assessments were also used in a few of the EP studies. Two studies did not indicate the subject areas they used to measure student achievement (Bolam et al., 2005; Berry et al., 2005).

Failure of EP studies to address end effects of PLCs. Only three of the EP studies indicated a direct relationship between individual PLC elements and student achievement (Gruenert, 2005; Louis et al., 2010a; Supovitz, 2002). The rest of the EP studies only reported an overall relationship between PLCs and student achievement and did not show a direct relationship with individual PLC elements. Table 2 shows a breakdown of the relationships indicated in each EP study.

Gruenert (2005) defined PLC with the following specific elements: a) *collaborative leadership*, b) *teacher collaboration*, c) *professional development*, d) *unity of purpose*, e) *collegial support*, and f) *learning partnership*. Louis and colleagues (2010a) used the *Professional Community* definition by Louis and Kruse (1996), which includes five elements: a) *shared values*, b) *focus on student learning*, c) *collaboration*, d) *deprivatized practice*, and e) *reflective dialogue*. Because this definition does not address other important school-wide PLC

elements, Louis and colleagues (2010a) added other PLC elements in their study: a) *trust*, b) *instructional leadership*, and c) *shared leadership*. Supovitz (2002) measured many elements of PLCs but reported solely on the direct relationship between collaborative teaming and student achievement.

Table 2

Relationships Between PLCs and Student Achievement in the Evidence Providing Studies

Authors of study	Interdependent Culture Based on Trust	Mission, Vision, Values, and Goals	Principal Leadership	Participative Leadership	Collaborative Teaming	Professional Development	Systems of Prevention & Intervention	Data Based Decision Making Using Continuous Assessment
Louis & Marks		O			O			
Supovitz		O		O	X	O	O	O
Strahan	O	O		O	O	O		O
Berry, Johnson, & Montgomery	O		O	O	O	O		O
Bolam & colleagues	O	O			O	O		
Gruenert	X	X	X	X	X	X		
Saunders, Goldenberg, & Gallimore			O	O	O	O		O
Siguroardottir	O	O		O	O	O		
Louis, Dretzke, & Wahlstrom	X	O	X	X	O			

X indicates the relationship between the individual PLC element and student achievement was shown.
O indicates the PLC element was combined within an overall construct of PLC and was related with student achievement.

The way the findings were reported in each of the other six EP studies made it difficult, if not impossible, to determine the relationship between the individual PLC elements and student achievement (Berry et al., 2005; Bolam et al., 2005; Louis & Marks, 1998; Saunders et al., 2009; Siguroardottir, 2010; Strahan, 2003). Louis and Marks (1998) used Louis and Kruse's (1995) definition of *Professional Community*, because this was the most current definition of PLC at the

time. This definition does not include other important elements that are found in PLCs today, such as: a) principal leadership, b) participative leadership, c) data based decision-making using continuous assessment, d) systems of prevention and intervention, e) professional development, and e) an interdependent culture based on trust. Saunders and colleagues (2009) and Siguroardottir (2010) used an experimental design in their studies in which they implemented specific PLC elements and then measured their influence upon student achievement over time. However, they did not show direct relationships between each PLC element and student achievement. In their qualitative studies, Berry and colleagues (2005) and Strahan (2003) identified successful schools and analyzed the effective practices that these schools were utilizing to increase student achievement, many of which were characteristic of PLCs; but, they too did not indicate direct relationships with PLC elements and student achievement. Even though each of these six EP studies defined and measured PLCs with multiple specific elements, they did not report a direct relationship with individual PLC elements and student achievement.

In all of the EP studies (refer back to Table 2) collaborative teaming was present as student achievement improved. Collaborative efforts in a school are widely accepted as an important PLC element, and the evidence supports that collaboration is related to higher student achievement. In contrast, two PLC elements have the least amount of empirical evidence from the research indicating a relationship with student achievement in the EP studies: a) Systems of Prevention and Intervention and b) Data-Based Decisions Using Continuous Assessment. This may be due to their recent introduction to the literature and practice within PLCs. In the PLC research, these two elements were included in the PLC definition by Blankstein (2004, 2008), but have yet to be included in much of the research on PLCs and their relationship with student achievement. Several researchers have examined the other five PLC elements and have shown

they were present when student achievement increased: a) trust, b) mission and vision, c) principal leadership, d) participative leadership, and e) professional development. Even considering the multiple designs and contexts, these nine EP studies provide empirical evidence that PLCs are positively related to student achievement.

Methods

Data for this study were collected in the spring of 2010 from a large public school district in Utah. All 26 elementary schools in the district participated in this study. Most schools serve students in suburban cities with a few serving large, rural agricultural areas. By using data from these schools we attempted to answer our research question: Are the eight elements of PLC related to student achievement: *An Interdependent Culture Based on Trust; Mission, Vision, Values, and Goals; Principal Leadership; Participative Leadership; Collaborative Teaming; Data Based Decision-Making Using Continuous Assessment; Professional Development;* and *Systems of Prevention and Intervention*?

The majority of students in the district were Caucasian, nine percent of the student population was Hispanics, and three percent came from other minorities in each of the schools. Across the district, the percentage of minority students averaged 13 percent and ranged from 5 to 27 percent of the student population. In the district, about 42 percent of the elementary students were economically disadvantaged as measured by the percentage of students enrolled for free and reduced lunch program. The population of disadvantaged students ranged from less than a third to two-thirds of students in the schools across the district.

PLC Practices in the District

During the 2008-2009 school year, the district in this study made a strong commitment to

establish PLCs by designating a district-wide hour each Wednesday afternoon for teams of teachers to meet and collaborate together. Collaborative teams consisted of teachers in each school that taught in the same grade level. During the 2009-2010 school year (when this study took place), teams of teachers continued to meet each week to improve instruction and learning for at least one hour after students were excused to go home early.

Data Collection

This study focused on the relationship the specific elements of a PLC had with student achievement. To measure these relationships, data from the LCCI survey that was administered to teachers in order to measure their perceived levels of PLC implementation and student achievement data on Utah's end of year tests were analyzed. The student achievement data as well as the questionnaire measures were gathered roughly at the same time during the spring of 2010.

Measures

Student achievement. The student achievement data in this analysis came from Utah's end of year criterion-referenced tests (CRT). In the spring of 2010, the CRTs assessed nearly 11,000 elementary school students in the district on Utah's Core Curriculum in language arts, mathematics, and science. The language arts and mathematics CRTs assessed students in grades two through six. The science CRTs assessed students in grades four to six. Student achievement data was aggregated to the collaborative team level, to match the level of the explanatory variables. We chose to use CRTs as the measure of student achievement because they were the most comprehensive, universally available assessment in the district. They were also chosen because standardized tests are one of the most effective ways to compare results across grades and multiple content areas. We recognize that CRTs are not the most effective assessment to

measure authentic student learning because they "fail to assess students' ability to think critically and to solve challenging real-world problems" and "have limited ability to measure what students actually know and can do" (Louis & Marks, 1998, p. 536). Nevertheless, we felt for the purposes of this study the CRTs were the best measure of student achievement available for our analysis. Future research should measure student achievement more authentically to determine the true relationship between PLCs and student learning.

In Utah, student performance on the CRTs is reported through raw scores as well as scaled scores for each student. The raw score, which is figured by the percent of items the student answered correctly, can easily be misinterpreted and is difficult to compare across subjects and grade levels. In Utah, scaled scores are typically used to report student achievement because they make it easier to report results and are more easily comparable across subject areas, grade levels, and even across years. For this purpose, we selected to use the scaled scores from the CRTs rather than raw scores to indicate student achievement. The scaling of students' scores on the CRT is the process of placing scores on a numerical scale intended to reflect a continuum of achievement or ability (Peterson, Kolen, & Hoover, 1989). CRT scores are scaled for the State of Utah, including all CRTs, which scale ranged from 130 to 199 for each CRT in 2010, with the proficiency cut set at 160.

Table 3 shows the summary statistics across the subject areas in each grade level aggregated to the district level, which include the mean and standard deviation, the percent of students that are proficient, as well as the range of the scaled scores. The lowest scaled score mean was in 4th grade science (164.17), and the highest scaled score mean was in 2nd grade mathematics (172.23). Overall, science appeared to have a lower percent of students proficient than the other subjects with an average of 78 percent. The 2nd grade appears to have the highest

numbers of students proficient on the CRTs at 86 percent. The ranges of the scaled scores were anywhere between 130 and 199.

Table 3

Summary Statistics of Student Achievement Data on the CRTs at all of the 26 Elementary Schools Aggregated to the District Level

	Language arts				Mathematics			
	Mean	Standard deviation	Percent proficient	Range	Mean	Standard deviation	Percent proficient	Range
Grade 6	167.99	9.10	82 %	136 to 199	167.27	10.65	79 %	130 to 199
Grade 5	167.69	9.53	82 %	138 to 199	168.91	10.30	85 %	131 to 199
Grade 4	166.85	9.68	79 %	132 to 199	168.39	10.40	82 %	130 to 199
Grade 3	167.05	10.03	79 %	137 to 199	167.61	10.99	79 %	130 to 199
Grade 2	169.53	10.96	84 %	133 to 199	172.23	13.01	88 %	132 to 199

	Science			
	Mean	Standard deviation	Percent proficient	Range
Grade 6	167.22	10.32	80 %	130 to 199
Grade 5	166.65	9.62	80 %	130 to 199
Grade 4	164.17	9.12	73 %	130 to 195

Learning Community Culture Indicator questionnaire. From their eight-element definition of PLC, Williams and colleagues (2007) created a measurement tool called the Learning Community Culture Indicator (LCCI). The LCCI was used to measure the degree to which schools had developed the eight elements of PLCs in their culture and in each collaborative team. The LCCI was structurally validated through exploratory and confirmatory factor analyses. Reliability measures indicated internal consistency among the responses to survey items (For a thorough description of this research refer to Stewart [2009]). At the end of this process Stewart (2009) concluded: "The LCCI produced substantial evidence that this survey was a valid and reliable instrument in measuring levels of PLC implementation" (p. iii).

The LCCI is structured around eight sections, each measuring a unique PLC element derived from the definition by Williams and colleagues (2007). Each element had between four to seven items to measure each PLC element. Each question on the LCCI offered a continuum of

responses from 0 (disagree strongly), 2 (disagree), 4 (disagree somewhat), 6 (agree somewhat), 8 (agree), to 10 (agree strongly). The survey ended with ten demographic questions specifying the school and collaborative team in which teachers worked. Teachers were provided time to complete the survey during their weekly meeting time resulting in a high response rate of 82 percent district wide, which is higher than most of the EP studies. The collaborative team is the lowest level of analysis in this study, since the LCCI was anonymous, and student achievement data could not be directly linked to the classroom teacher, but could be linked to each collaborative team.

Table 4 provides the summary statistics for teacher responses on the LCCI aggregated to the district level. The mean and standard deviation are reported for each of the PLC elements at each grade level, as well as the range of average teacher responses. Two elements had the highest average response rates across the grades at 9.10 and 8.93 respectively: a) Mission, Vision, Values, and Goals and b) Data Based Decision-Making Using Continuous Assessment.

Participative leadership and professional development had the lowest average response rates across the grades around 7.70. The rest of the PLC elements averaged around 8.5 across the grade levels. Across the district, teachers' perceived levels of their effectiveness were highest in 2nd grade with an average of 8.66 across all of the PLC elements. Fourth grade teachers' perceived levels of effectiveness were lowest with an average of 8.26. The range of responses was typically between 6 and 9.5, but varied between each PLC element. Outliers were determined by the average responses of collaborative teams that were at least two points lower than any other team in their grade level across the district. Third grade had four outliers, which is more than any other grade level.

Table 4

Summary Statistics of Teacher Responses on the LCCI for Each PLC Element Aggregated to the District Level

	# of Schools	Interdependent Culture Based on Trust		Mission, Vision, Values, and Goals		Principal Leadership		Participative Leadership	
		Mean & (SD)	Range	Mean & (SD)	Range	Mean & (SD)	Range	Mean & (SD)	Range
Grade 6	24	8.59 (.69)	6.17 to 9.54	9.22 (.56)	7.63 to 9.81	8.16 (1.49)	3.4* to 9.9	7.48 (1.49)	2.4* to 9.5
Grade 5	26	8.4 (1.02)	6.39 to 9.83	9.05 (.82)	6.5 to 10	8.42 (1.17)	5.53 to 10	7.6 (1.62)	2.4* to 9.4
Grade 4	25	8.38 (1.07)	5.17 to 9.67	8.94 (.82)	6.75 to 10	8.46 (1.19)	6.1 to 10	7.54 (1.23)	4.8 to 9.6
Grade 3	24	8.46 (1.11)	4.83 to 9.67	9.07 (.79)	6.38 to 10	8.52 (1.29)	3.3* to 10	8 (1.11)	5 to 9.4
Grade 2	25	8.75 (.78)	6.83 to 10	9.23 (.65)	7.25 to 10	8.65 (1.01)	5 to 10	7.95 (1.46)	3.1* to 10
	# of Schools	Data Based Decision Making Using Continuous Assessment		Collaborative Teaming		Systems of Prevention and Intervention		Professional Development	
		Mean & (SD)	Range	Mean & (SD)	Range	Mean & (SD)	Range	Mean & (SD)	Range
Grade 6	24	8.82 (.65)	7.37 to 9.93	8.65 (.71)	7.23 to 9.54	8.30 (.63)	6.92 to 9.5	7.47 (1.06)	4.25 to 9.33
Grade 5	26	9.06 (.82)	6.71 to 10	8.71 (.78)	6.87 to 9.85	8.49 (.92)	6 to 9.67	7.85 (.86)	6.33 to 9.22
Grade 4	25	8.79 (.71)	7.5 to 9.86	8.40 (.89)	6.62 to 10	8.12 (.9)	6.5 to 10	7.44 (1.2)	4.33 to 9.75
Grade 3	24	8.84 (.98)	5.43* to 10	8.57 (1)	4.62* to 9.54	8.39 (1.12)	5.17 to 9.92	7.81 (1.37)	3* to 9.5
Grade 2	25	9.15 (.68)	7.57 to 10	8.84 (.86)	7.33 to 9.92	8.78 (.78)	6.67 to 9.92	7.91 (1.03)	6.08 to 9.67

* Indicates the lowest number in the range is an outlier.

Interestingly, three schools represented all eight outliers when it came to the average responses on the LCCI. The average scaled scores varied for these three schools compared to the other schools across the district. One school was one of the highest performing schools in terms of student achievement in the district across all grade levels, one school was one of the lowest performing in the district, and the last one was average on student performance. In each

statistical analysis, these outliers were omitted due to their strong influence on the relationships between the PLC element and student achievement.

A limitation of this study was that student achievement was influenced by all eight elements of a PLC; however, each element was analyzed individually with student achievement without investigating the interactions of the other PLC elements. This was the first study of PLCs that moved beyond reporting correlations as it indicated the types of statistical relationships between the PLC elements and student achievement. Future research should continue to analyze these different types of relationships, but should also investigate the interactions between the PLC elements in a multi-dimensional way.

Analysis of Data

Whenever student achievement is analyzed, it is important to control for factors that are known to associate with student achievement. In this study, we controlled for five student-level covariates in our analysis: a) socio-economic status (SES, measured by whether the student received free or reduced price lunch), b) student ethnicity (Caucasian, Hispanic, African-American, Native American, Asian, Pacific Islander), c) student gender, d) student receiving special education services, and e) students' prior achievement. Louis and Marks (1998) described the rationale for controlling for such factors: "Because student background influences achievement independently of school or classroom features, it is important to take it into account when evaluating organizational effects on achievement" (p. 540). We measured students' prior achievement with proficiency levels on the 2009 CRTs (proficient or not proficient). No adjustment for prior achievement was made when achievement was being measured for the first time (e.g. science in 4th grade and 2nd grade CRTs).

Hierarchical linear modeling (HLM) was used in this study, which has been acknowledged in educational research to be an effective method to analyze nested data. In this study students were the first level of analysis and collaborative teams were the second level of analysis (Raudenbush & Bryk, 2002; Searle, Casella, & McCulloch, 1992). In our multiple regression analysis, we analyzed each content area (language arts, mathematics, and science) within a grade level (2^{nd} to 6^{th} grade) separately because the student achievement data was nested within collaborative teams. The analysis was guided by our research question and the EP literature on PLCs, as well as the research on each of the eight elements (Williams, et. al 2007). To answer the research question, we first accounted for students' backgrounds. In order to better understand the relationship between each PLC element and student achievement, we allowed for a polynomial or non-linear relationship, which was guided by plots of student achievement and the PLC elements. Using the best type of relationship to fit the data we introduced each PLC element to the model to determine its statistical relationship with student achievement. This resulted in 104 models in our analysis. We analyzed the differences between each subject level in each collaborative team and the relationship they have with student achievement. Each model took the following form:

Level 1: 2010 CRT scaled score for particular subject

$= \beta_0 + \beta_1$ (students' 2009 proficiency)

$+ \beta_2$ (student gender) $+ \beta_3$ (student ethnicity)

$+ \beta_4$ (student lunch assistance) $+ \beta_5$ (special education student)

Level 2: $\beta_0 = \gamma_1$ (PLC element) $+ \gamma_2$ (possible quadratic relationship of PLC element)

$+ \gamma_3$ (possible cubic relationship of PLC element)

Results

The analysis of each of the eight PLC elements (Williams, et. al 2007) confirms that PLCs are related with student achievement. We constructed 13 models for each of the eight PLC elements, which totaled 104 models that were analyzed: 24 for science in 4^{th}-6^{th} grade and 40 for mathematics and language arts in 2^{nd}-6^{th} grade. In all of the models, the control variables were significantly related with each PLC element and student achievement: a) socio-economic status (SES), b) student ethnicity, c) student gender, d) student received special education services, and e) students' prior achievement (See table 5). In each model, the regression coefficient for each control variable had a p-value ranging from less than .0001 (the majority of relationships between covariates and student achievement) to less than .03, indicating each covariate was significant in every model in its relationship with each PLC element.

Table 5

Ranges of Significant Relationships for Each PLC Element with Student Control Variables found in the Regression Coefficients from HLM

Student control variables	Interdependent Culture Based on Trust	Mission, Vision, Values, and Goals	Principal Leadership	Participative Leadership	Data Based Decision Making Using Continuous Assessment	Collaborative Teaming	Systems of Prevention and Intervention	Professional Development
SES Status	< .0001 to .008	< .0001	< .0001	< .0001 to < .02	< .0001	< .0001	< .0001	< .0001
Ethnicity	< .0001 to < .0002	< .0001 to < .001	< .0001	< .0001 to < .001	< .0001 to < .001	< .0001	< .0001 to < .001	< .0001 to <.0001
Gender	< .0001 to < .03	< .0001 to < .02	< .0001 to < .01	< .0001 to < .009	< .0001 to < .01	< .002 to < .005	< .0001 to < .02	< .0001 to < .002
Special education	< .0001	< .0001	< .0001	< .0001	< .0001	< .0001	< .0001	< .0001 to <.0002
Prior proficiency	< .0001	< .0001	< .0001	< .0001	< .0001	< .0001	< .0001	< .0001

Of the 104 models 40 showed a significant or moderately significant relationship with student achievement (See Table 6). Statistical significance was defined as a regression coefficient that had a p-value less than .05, and moderate significance was defined as a regression coefficient that had a p-value less than .10. Twenty-two of the 40 relationships were significant at less than .05 with seven of these less than .01, while the other 18 were moderately significant at less than .10.

The types of relationships (linear or polynomial) varied across the models with eleven linear, sixteen quadratic, and thirteen cubic relationships. The types of relationships in 4th through 6th grade that were significant or moderately significant were primarily polynomial relationships, except for the model in 5th grade for the element mission, vision, values, and goals, which was linear. In the 2nd and 3rd grades the types of relationships that were significant or moderately significant were primarily linear and quadratic, with the exception of 2nd grade mathematics across the PLC elements, each of which were cubic relationships.

The different types of relationships between each PLC element and student achievement followed the same general patterns. For a typical linear relationship there was a positive relationship between the LCCI scores and student achievement that began around an average score of 8 on the LCCI and ended around an average of 10. The typical quadratic relationship had a U-shape with a negative relationship between lower LCCI scores (6 – 7.75) and student achievement and a positive relationship between higher LCCI scores (7.75 – 10) and student achievement. The typical cubic relationship had an S-shape with a negative relationship between lower LCCI scores (6.5 – 8) and student achievement, a positive relationship between higher LCCI scores (8 – 9) and student achievement, and a negative relationship at the highest average LCCI scores (9 – 10) and student achievement.

Table 6

Significant Relationships of PLC Elements and Student Achievement Indicated by the p-values for Regression Coefficients from HLM Adjusted for Student Control Variables

Subject	Grade	Interdependent Culture Based on Trust	Mission, Vision, Values, and Goals	Principal Leadership	Participative Leadership	Data Based Decision Making Using Continuous Assessment	Collaborative Teaming	Systems of Prevention and Intervention	Professional Development
Language arts	6th		.049 (Cubic)		.02 (Quad.)	.03 (Cubic)		.048 (Cubic)	
	5th	.04 (Cubic)							
	4th								
	3rd	.02 (Quad.)	.02 (Quad.)		.07 (Linear)		.02 (Linear)	.06 (Quad.)	.04 (Quad.)
	2nd	.052 (Linear)	.09 (Linear)			.055 (Linear)	.07 (Linear)		
Math	6th	.06 (Quad.)			.09 (Quad.)	.003 (Cubic)	.03 (Quad.)		
	5th	.07 (Cubic)	.08 (Linear)						
	4th	.02 (Quad.)				.097 (Cubic)			
	3rd	.04 (Quad.)	.04 (Quad.)			.06 (Linear)	.002 (Linear)	.03 (Quad.)	.02 (Quad.)
	2nd		.095 (Cubic)	.003 (Cubic)				.09 (Cubic)	
Science	6th		.01 (Cubic)	.097 (Cubic)	.054 (Quad.)	.06 (Cubic)			.01 (Cubic)
	5th	.004 (Cubic)			.04 (Quad.)				
	4th	.06 (Quad.)							
Total significant relations		9	7	2	5	6	4	4	3

Note. Linear: relationship that follows a straight line.
Quadratic: relationship that has one point of curvature.
Cubic: relationship that has two points of curvature.

Perhaps the limitation of teachers' self-report of PLC implementation on their teams may describe the patterns in these different types of relationships. In both the quadratic and cubic relationships it appears that teams of teachers may under-report PLC implementation since student achievement is higher on average for teams with lower scores on the LCCI than some teams that perceive higher PLC implementation on the LCCI. The cubic relationships may indicate that collaborative teams averaging the highest average LCCI scores (9 – 10) may over-report actual PLC implementation since student achievement is lower for these teams than student achievement of some teams reporting lower average scores on the LCCI.

Three PLC elements most frequently showed a significant or moderately significant relationship with student achievement for each subject area: an interdependent culture based on trust (nine significant relationships), b) mission, vision, values, and goals (seven significant relationships), and c) data based decision-making using continuous assessment (six significant relationships). The relationships between the school leadership elements and students' scaled scores indicated two significant relationships with principal leadership and five significant relationships with participative leadership. The two elements, collaborative teaming and systems of prevention and intervention, both indicated four significant or moderately significant relationships. Finally, the relationship between professional development and student achievement was significant in three relationships.

Discussion

As in the nine EP studies treated in the literature review, the results of this district-wide study show that there is a significant relationship between PLCs and student achievement. This study moved beyond just showing the relationship of an overall construct of PLC and student achievement by indicating the direct relationship between each individual PLC element and

student achievement. The presentation of our results is similar to the way findings were reported in the EP studies completed by Gruenert (2005), Louis and colleagues (2010a), and Supovitz (2001) as they reported on the relationships between individual PLC elements and student achievement. As PLCs continue to evolve in research and practice, we encourage studies to focus on the direct relationships of effective elements of a PLC with student achievement.

Reflection on Findings in Regard to PLC Elements

Many of the findings of this study confirm the results of the EP studies as well as research on the individual elements and their relationship with student achievement. The following section will describe the research that relate to the findings from this study.

Trust and Mission, Vision, Values, and Goals. This study also confirms the findings of many of the other EP studies as well as the literature on each individual PLC element. Bryk and colleagues (1999) found the importance of trust in their landmark study, "By far, the strongest facilitator of professional community is social trust among faculty members. When teachers trust and respect each other, a powerful social resource is available for supporting the collaboration, reflective dialogue, and deprivatization characteristics of professional community" (p. 767). The finding in this study that trust had the most significant relationships with student achievement reaffirms the importance of trust as a foundational element of a PLC. High levels of trust serve as the "lubricant for organizational change" as well as "a moral resource for sustaining the hard work of local school improvement" (Bryk, 2010, p. 27). Similar to trust, the results of this study confirm that mission, vision, values, and goals of the school and of each educator are essential for the success of a PLC in ensuring all students master essential knowledge and skills. When trust or mission, vision, values, and goals are absent, other PLC elements struggle to function effectively; thus, student achievement may suffer.

Data Based Decision-Making Using Continuous Assessment. Another important contribution of this study is the findings that two elements of a PLC are significantly related with student achievement: a) data based decision-making using continuous assessment and b) systems of prevention and intervention. The findings for data based decision-making were especially strong across the grades and the three subject areas (six significant relationships). These findings are encouraging given the limited amount of empirical evidence of these relationships within the context of a PLC. Strahan (2003) and Berry (2005) both indicated one of the key findings was that collaborative efforts were facilitated by "data-directed dialogue" (Strahan, 2003, p. 143). Blankstein (2004) also described the importance of effectively using data based decision-making using continuous assessment and systems of prevention and intervention to enhance collaboration and other school-wide decisions. More empirical evidence within the context of a PLC is needed for both of these elements, especially systems of prevention and intervention, since this is the first study to find empirical evidence verifying its relationship with student achievement.

School Leadership. Our findings give school leaders reason to pause. Principal leadership indicated the least amount of significant relationships with student achievement. This may be due to the indirect relationship principals have with student achievement, which has been confirmed in other school leadership studies (Louis et al., 2010a and 2010b). The limited number of significant relationships may be due to the limitation of the language on the LCCI to accurately measure the desired construct. Although the LCCI was validated through scientific processes the questions may not be thorough enough or may be entirely absent to measure all aspects of principal leadership. The five questions on the LCCI mainly focus on instructional leadership roles of the principal and ignore other essential elements of principal leadership such

as transformational leadership or the trust others have in the principal. This limitation in terms of the framing of questions, missing questions, and the thoroughness of what the questions measure may have influenced the findings for each PLC element.

However, even if the LCCI did not completely measure the construct and even though principal leadership may indirectly influence student achievement, the principal still plays an essential role in the success of a PLC. Principal leadership has been described as the most facilitating or impeding factor in establishing a PLC (Bryk, Camburn, & Louis, 1999; Louis et al., 2010a; Louis et al., 2010b; Scribner & Reyes, 1999). Research has found that leadership is second only to classroom instruction among all school-related factors that contribute to what students learn at school (Leithwood, Louis, Anderson & Wahlstrom, 2004). Louis and colleagues (2010b) wrote, "To date we have not found a single case of a school improving its student achievement record in the absence of talented leadership" (p. 9).

Participative leadership was also significantly related to student achievement (five significant relationships). In the study by Louis and colleagues (2010b), they indicated, "when principals and teachers share leadership, teachers' working relationships are stronger and student achievement is higher" (p. 37). Similar to the importance of trust, both principal and participative leadership serve a critical role in a PLC as it influences relationships, culture, and other aspects of the school culture, which impacts the other PLC elements. In this way leadership mediates the relationship between the PLC elements and student achievement.

The clear definition of PLCs in this study (Williams et al., 2007) allowed us to analyze the relationship between each PLC element and student achievement. We encourage a healthy discussion of PLCs in the research and the definition we used in order for researchers to come to a consensus of what a PLC truly is. A common language and definition will create more

understanding between researchers, which will result in clearer findings, so schools can utilize the promise of PLCs to improve instruction and student learning.

Conclusion

The findings of this study confirm that PLCs have great potential to improve the culture of schools to better meet the needs of teachers and students so that instruction will improve and students will learn. This study added empirical evidence that PLCs and the individual elements that comprise them, are related with student achievement. This added evidence should encourage more researchers to analyze the relationship between the individual, clearly defined elements of PLCs and student achievement. In addition, principals, teachers, and district officials should study the PLC elements, put them into practice, and strive to become mature PLCs. Through the efforts of researchers and practitioners PLCs have the potential to improve teachers' instruction and the learning of educators and students alike.

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APPENDIX A: REVIEW OF THE LITERATURE

Many believe that PLCs are an effective way to meet the high accountability demands placed upon schools today (For a few examples see: Blankstein, 2008; Bryk, 2010; DuFour et al., 2008; Hargreaves, 2008; Hord & Hirsh, 2008; Louis, 2006; McLaughlin & Talbert, 2010; Stoll et al., 2006 to name just a few). Educational researchers describe the promise PLCs have in improving instruction so all students will learn. DuFour and colleagues (2005) said, "The use of professional learning communities is the best, least expensive, most professionally rewarding way to improve schools…Such communities hold out immense unprecedented hope for schools and the improvement of teaching" (DuFour, DuFour, & Eaker 2005, p. 128). Stoll and colleagues (2006) wrote, "developing professional learning communities appears to hold considerable promise for capacity building for sustainable improvement" (p. 221). This sustainability is focused on continually improving instruction so students will learn. These leading researchers in education, as well as others, describe the promise PLCs have in improving the knowledge and skills of teachers in order for student learning to occur

Many schools have utilized the elements of PLC and have developed and cultivated them as a part of their culture because they believe in their potential. The elements of a PLC are important in education and many practitioners readily see their relevance. As PLCs have developed in schools, teachers and administrators have seen and felt their positive results in the culture of their schools; they have experienced more support; they are more satisfied with their work; their instruction has improved; and, most importantly, they have seen how PLCs have helped their students achieve academically (Blankstein, 2004; DuFour et al., 2008). These teachers and administrators believe in PLCs because they have seen the success that comes from them. This knowledge is real and moves others to believe in PLCs and begin to develop them

because they desire the same results. Hence, more schools are developing and cultivating PLCs worldwide. However, this knowledge is based on peoples' perspectives and experiences and not on systematically studied and proven results. To become knowledge that is accepted in research, empirical studies must use sound research procedures and methods to establish evidence that is accepted as credible knowledge, and moves beyond testimonials and feelings.

Relationship between PLCs, Instruction, and Student Achievement

The central focus and purpose of PLCs is to improve schools by enhancing instruction and student learning (DuFour & Eaker, 1998; Hord, 1997; Louis & Kruse, 1995; Louis & Marks, 1998; McLaughlin & Talbert, 2010). The focus of each Evidence Providing (EP) study differs as it measures the relationship between PLCs, instruction, and student achievement. A number of studies measure the relationship between PLCs and instruction, and may assume an indirect relationship with student achievement (Vescio et al., 2008); a few EP studies measure the relationship of PLCs with instruction and student achievement (Langer, 2000; Louis & Marks, 1998; Strahan, 2003; Supovitz, 2002); the rest of the EP studies focus specifically on the relationship between PLCs and student achievement and do not measure instruction. These EP studies that do not measure instruction make the assumption that PLCs improve instruction, which results in higher student achievement. With sound evidence from research we believe this is a safe assumption to be made, even when instruction is not measured.

There have been a number of PLC studies that indicate a clear, positive relationship between PLCs and improved instruction (Louis, Kruse, & Marks, 1996; Vescio et al., 2008). In addition, four of the EP studies also indicate a positive relationship between PLCs and more effective instruction (Langer, 2000; Louis & Marks, 1998; Strahan, 2003; Supovitz, 2002). The literature review mentioned previously by Vescio and colleagues (2008) found a number of

studies that show a clear, positive relationship between PLCs and improved instruction (Andrews & Lewis, 2002; Berry, Johnson, & Montgomery, 2005; Dunne, Nave, & Lewis, 2000; Englert & Tarrant, 1995; Hollins et al., 2004; Phillips, 2003). Louis and colleagues (1996) also found a relationship between PLCs and higher levels of authentic pedagogy. Each of these studies provides clear evidence that PLCs are strongly related to improved classroom instruction.

To confirm that it is safe to assume that PLCs are associated with student achievement, the next logical step is to show the relationship between instruction and improved student achievement. Intuitively we know that effective classroom instruction, as well as classroom environments, are essential for students to learn and are the leading factors related to their achievement. The research repeatedly confirms that effective classroom instruction is one of the most significant contributors to improved student achievement (For a few examples see: Cohen, Raudenbush, & Ball, 2003; Marzano, Pickering, & Polluck, 2001; Newmann, Marks, & Gamoran, 1996; Wayne & Youngs, 2003). This is the case even after controlling for powerful moderators such as student poverty or language status (Darling-Hammond, 2000).

One of the strongest confirmations that it is safe to assume that PLCs do improve the achievement of students through effective instruction comes from Louis and Marks' (1998) landmark study. By measuring the PLC of schools, they found that PLCs were positively related to authentic student achievement. However, the strength of this association was accounted for by authentic pedagogy. This is to be expected due to the critical role of high-quality classroom instruction, and how PLCs and classroom instruction are mutually beneficial. Their study provides clear evidence that a PLC creates an ideal culture, which focuses instruction on student learning and provides the necessary support for authentic pedagogy to occur in the classroom. Classroom instruction has one of the greatest impacts on student achievement in a school (Louis

& Marks, 1998). We also recognize that instruction may be partially mediating upon the PLC elements, and that some of them may have a direct relationship with student achievement.

The evidence of the research shows a clear relationship between PLCs and improved instruction, which indirectly relates to student achievement. Evidence also demonstrates that effective classroom instruction is related to higher student achievement. It is safe for studies to make the assumption that PLCs are related to higher student achievement, even when instruction is not measured.

Evidence Providing Studies

Despite the great promise that PLCs have, there is a limited amount of empirical evidence grounded in scientifically proven methods and procedures that establishes a direct, positive relationship between PLCs and student achievement (Bolam et al., 2005; Lomos et al., 2011b; Louis & Marks, 1998). In our review of the literature we only found 13 studies that show a positive relationship between PLCs and student achievement, and none that found a negative or neutral relationship.

Our review of the literature began with the review completed by Vescio and colleagues (2008). Through a thorough reading of the research described in that review, we found four studies that provided clear evidence of a positive relationship between PLCs and student achievement (Bolam et al., 2005; Louis & Marks, 1998; Strahan, 2003; and Supovitz, 2002). In addition to the article by Vescio et al. (2008) we also read the studies cited in the literature review completed by Stoll and colleagues (2006) on the relationship between PLCs and student achievement. We found three additional studies from their review (Lee & Smith, 1996; Visscher & Witziers, 2004; Wiley, 2001).

Although these two reviews cited several other studies that show a positive relationship, we do not include the other studies from these two reviews of the literature for two reasons: 1) the studies only showed a positive relationship between PLCs and instruction, therefore, there was no evidence of a direct association with higher student achievement; 2) the studies simply used a term that refers to PLCs, but in actuality did not measure or analyze a PLC. These additional studies have informed our research, but do not provide direct evidence of a relationship between PLCs and higher achievement of students.

In addition to the two literature reviews on PLCs, we conducted a deeper review of the literature using systematic and comprehensive review methods (Similar to those completed by Lomos et al., 2011b). We searched the EBSCOhost, ERIC, and ISI Web of Knowledge databases, as well as GOOGLE Scholar to find studies showing a positive relationship between PLCs and student achievement. To ensure our review was comprehensive and included all PLC studies showing this positive relationship, we checked the references of each study included in our literature review. Through this deeper review of the literature we found six additional studies (Gruenert, 2005; Langer, 2000; Lomos et al., 2011a; Louis et al., 2010a; Saunders et al., 2009; and Siguroardottir, 2010) that show a positive relationship between PLCs and student achievement. We also found several unpublished studies that investigated the relationship between PLCs and student achievement; however, these were not included in our list of empirical studies because they were not published.

In the conclusion of their literature review, Vescio and colleagues (2008) stated, "Although few in number, the collective results of these studies offer an unequivocal answer to the question about whether the literature supports the assumption that student learning increases when teachers participate in professional learning communities. The answer is a resounding and

encouraging yes (p. 87)." We emphatically agree that the studies in the review by Vescio and colleagues (2008), those Stoll and colleagues (2006) found, as well as the additional studies we have found, provide clear, empirical evidence that PLCs are related to higher student achievement. However, even though 13 studies is an important start, there is still a need for more empirical evidence (Bolam et al., 2005; Lomos et al., 2011b; Louis & Marks, 1998). There is a need because PLCs have not yet become accepted theory, which provides both researchers and practitioners alike the confidence they need to believe in and fully utilize the elements of a PLC in education. With more empirical evidence confirming the positive relationship between PLCs and higher student achievement, the strengthened research on PLCs may encourage more schools to develop and cultivate PLCs to enhance instruction and student learning.

Design of EP Studies and the Relationship They Confirm

Although the EP studies all examine PLCs and their relationship with student achievement, they vary in many ways. The positive relationship indicated in these 13 EP studies completed in different contexts, using varying methods and sampling strategies strengthen the evidence that PLCs are related to higher student achievement. In the research on PLCs there has been little to no attempt to show the differences and similarities between studies providing empirical evidence of the relationship between PLCs and student achievement; as well as to effectively present their findings (Lomos et al., 2011b).

Of the 13 EP studies, the study by Louis and Marks (1998) is the strongest. In their longitudinal study of 24 nationally selected schools (eight elementary, eight middle, and eight high schools) that made "substantial progress" (p. 541), they utilized sound quantitative and qualitative methods to measure PLC and student learning that give credence to their findings. They utilized a validated questionnaire to survey 910 teachers with a high response rate ranging

from 69 to 100 percent across schools. They also analyzed student surveys about their school and class experiences from a questionnaire with a response rate of 82 percent. In addition to the quantitative methods, they also experienced the "life" (p. 541) of schools by having teams of three researchers visit each of the schools during the fall and spring of the year. They interviewed between 25 and 35 teachers, administrators, and other stakeholders at each school; observed the instructional practice of 144 teachers (three math and three social studies teachers at each of the schools); interviewed each of these teachers twice during the school year about their work life; and observed faculty meetings, as well as other meetings at the school.

Trained researchers and practitioners measured the authenticity of assessments within the 144 classrooms, and collected over 5,000 student papers to determine the relationship between PLCs, instruction, and student achievement. Through triangulation and a variety of sound quantitative and qualitative methods, Louis and Marks were able to measure the degree to which schools had developed PLCs , the authenticity of instruction, as well as measure student learning through authentic measures. Their findings are widely accepted as valid and reliable because of the time, work and quality of their study and provide clear evidence that PLCs are related to higher student learning.

The other 12 EP studies also provide empirical evidence of the relationship between PLCs and student achievement. However, they are not as strong as the study by Louis and Marks (1998) because they were unable to analyze instruction and student achievement as thoroughly or utilize as many sound methods. This may be due to limited time, funding, or resources that researchers often face. Each of the EP studies differs, specifically in their design and strengths. Table 1 shows each of the EP studies as well as the different design elements they use.

Seven of the 13 EP studies completed a longitudinal study (Bolam et al., 2005; Langer, 2000; Louis & Marks, 1998; Saunders et al., 2009; Siguroardottir, 2010; Strahan, 2003; Supovitz, 2002). The study with the most recent data came from 2008 (Louis et al., 2010a); the next most recent from 2004 (Bolam et al., 2005; Siguroardottir, 2010); and two EP studies utilize the oldest data, which comes from the National Educational Longitudinal Study in 1988 and follow up studies in 1990 and 1992 (Lee & Smith, 1996; Wiley, 2001).

The methods to gather and analyze data differ between the EP studies. All of the EP studies except for Lee and Smith (1996) collect and analyze original data. Louis and Marks (1998) and Wiley (2001) also use existing data from prior studies, but they also gather original data for their analysis. Five of the EP studies use mixed methods (Bolam et al., 2005; Louis & Marks, 1998; Saunders et al., 2009; Siguroardottir, 2010; Supovitz, 2002); six use quantitative methods (Gruenert, 2005; Lee & Smith, 1996; Lomos et al., 2011a; Louis et al., 2010a; Visscher & Witziers, 2004; Wiley, 2001); and two use qualitative methods to gather and analyze their data (Langer, 2000; Strahan, 2003). All but three studies utilize a survey to gather data to measure PLCs (Bolam et al., 2005; Gruenert, 2005; Lee & Smith, 1996; Lomos et al., 2011a; Louis et al., 2010a; Louis & Marks, 1998; Siguroardottir, 2010; Supovitz, 2002; Visscher & Witziers, 2004; Wiley, 2001). All of these surveys were administered to teachers with the exception of Bolam and colleagues (2005) where only one administrator at each school completed the questionnaire. In addition to teachers completing the surveys, three also had principals complete the questionnaire (Louis et al., 2010a; Siguroardottir, 2010; Supovitz, 2002), and two had in addition to administrators and teachers, students complete a survey (Lomos et al., 2011a; Louis & Marks, 1998).

Table 1

Design of Evidence Providing (EP) Studies

Authors, Year, and Duration of study	Methods Of Study	Target Pop. (TP), Sample & Selection	Explanatory Variables	Outcome Variables	Data Analysis
Bolam, McMahon, Stoll, Thomas, Wallace, Greenwood, Hawkey, Ingram, Atkinson & Smith, 2005, longitudinal from 2002-2004.	Mixed methods: validated survey to one administrator at each school with 17% response rate. 16 case studies: interviews, document analysis, and observations.	TP: schools in England. Stratified random sampling from five regions in England. 393 of 2,300 elementary and secondary schools in England.	PLC elements combined for an overall score of PLC, including collaboration, professional devt., collective responsibility, shared values, & trust.	Schools' value added and raw achievement scores from national standardized assessments ranging across grade levels.	Analysis aggregated to the school level using factor analysis and correlational research. Coding and analysis of transcripts.
Gruenert, 2005, data collected spring of 2003.	Quantitative methods: validated survey to teachers in grades 3, 8, & 10 with 63% response rate.	TP: schools in Indiana. All 81 schools in an Indiana school district, & 2,750 of 4,350 teachers.	Leadership, collaboration, professional devt., unity of purpose, collegial support, & learning partnerships.	Mathematics and language art scores on state standardized assessments across grade levels.	Analysis aggregated to the school level using correlational research.
Langer, 2000, two-year longitudinal study (do not indicate the years data was gathered).	Qualitative methods: comparative case study of succeeding schools and those with typical results using interviews, document analysis, and observations.	TP: secondary English departments in US. Purposive Sampling strategy. 44 Eng. teachers & 528 students in 4 states & 25 schools.	Louis & Kruse (1995) model of "prof. community": shared values, collaboration, deprivatized practice, reflective dialogue, focus on student learning.	Determined whether schools were "beating the odds" or were "typical" in regards to student achievement on state standardized assessments.	Analysis aggregated to the teacher, classroom, and team levels using coding and analysis of transcripts in a nested case design.

Authors, Year, and Duration of study	Methods Of Study	Target Pop. (TP), Sample & Selection	Explanatory Variables	Outcome Variables	Data Analysis
Lee & Smith, 1996, data collected in 1988 & 1990.	Quantitative methods: teacher survey data from the 1988 and 1990 National Educational Longitudinal Study (NELS:88).	TP: secondary schools in US. Systematic random sampling procedure. Used data from 11,692 of 17,424 sophomores in 820 of 1,508 high schools, and 9,904 teachers.	Used model similar to Louis and Kruse (1995) model of "professional community."	Value-added scores between students' eighth and tenth grade scores in mathematics, reading, history, and science standardized assessments.	Analysis aggregated to the school level using ANOVA, HLM, and factor analysis.
Lomos, Hofman, & Bosker, 2010, data collected in 2003.	Quantitative methods: validated survey given to secondary school mathematics teachers and students in the Netherlands, with a response rate of 87%.	TP: secondary mathematics departments in the Netherlands. Stratified random sampling. Data from 2,706 of 2,919 students, 117 of 130 schools, math teachers, and departments.	Louis and Kruse (1995) model of "professional community."	13-year-old students' mathematics proficiency scores on a standardized assessment.	Analysis aggregated to the mathematics team level using HLM and cluster analysis.

Authors, Year, and Duration of study	Methods Of Study	Target Pop. (TP), Sample & Selection	Explanatory Variables	Outcome Variables	Data Analysis
Louis, Dretzke, & Wahlstrom, 2010, data collected in 2005 and 2008.	Quantitative methods: validated survey to teachers and administrators with a response rate of 67% (in 2005) and 55% (in 2008).	TP: schools in US. Stratified random sampling from four quadrants of US. 106 of 157 schools (50 elementary, 34 junior high, 19 high schools, and 3 K-8) in nine states.	Louis and Kruse (1995) model of "professional communities." Also, trust, shared leadership, and instructional leadership.	2005 state standardized mathematics assessments across grade levels.	Analysis aggregated to school level using paired-sample t tests, hierarchical multiple regression, & structural equation modeling.
Louis & Marks, 1998, longitudinal from 1991-1994.	Mixed methods: validated survey to teachers with response rate of 69%-100%. Student survey with 82% response rate. Case studies of each school; interviews of 25-35 teachers, admin., and stake-holders at each school; 144 overall classroom observations.	TP: schools in US. Purposive sampling strategy. 24 nationally selected schools (8 elem., 8 mid., and 8 high), 910 teachers, 5,943 students in mathematics and social studies.	Louis and Kruse (1995) model of "professional communities." Also, authentic pedagogy and social support.	Measures of authentic achievement in social studies and mathematics across grade levels.	Analysis aggregated to the school and classroom level using HLM and one-way ANOVA. Coding and analysis of transcripts.

Authors, Year, and Duration of study	Methods Of Study	Target Pop. (TP), Sample & Selection	Explanatory Variables	Outcome Variables	Data Analysis
Saunders, Goldenberg, & Gallimore, 2009, longitudinal from 1997-2002.	Mixed methods: experimental case study. In experimental schools, principals and team leaders received training and professional development. Also, grade-level collaboration was established.	TP: elementary schools in California. Purposive sampling strategy. 15 Title I elementary schools (9 in experimental group) in a California school district.	Collaboration, professional development, data based decision-making, principal leadership, participative leadership.	3rd through 5th grade student scores on reading, mathematics, language, and spelling subtests of the Standford 9 Achievement Test (SAT-9).	Analysis aggregated to the school level using repeated-measures analysis of variance (ANOVA).
Siguroardottir, 2010, first phase was in spring of 2002. Second phase was longitudinal from 2002-2004.	Mixed methods: validated survey to teachers and principals with average response rate of 89% in phase one, 71% and 84% in phase two. Experimental case study with interviews of 13 teachers/principals, document analysis, and observations of meetings.	TP: schools in Iceland. Selected highest and lowest achieving schools, and a school that was willing to participate. 3 of 19 schools serving 1,800 elementary to secondary students, and 157 teachers in Iceland.	Shared values and vision, principal leadership, shared leadership, trust, collaboration, and professional development.	Students' 10th grade raw scores in Icelandic and mathematics; and value-added scores determined by 4th grade raw scores.	Multiple regression analysis aggregated to the school level. Coding and analysis of transcripts.

Authors, Year, and Duration of study	Methods Of Study	Target Pop. (TP), Sample & Selection	Explanatory Variables	Outcome Variables	Data Analysis
Strahan, 2003, longitudinal from 1999-2002.	Qualitative methods: case studies with 79 interviews of teachers and administrators; observations of instruction and meetings.	TP: elementary schools in North Carolina. Purposive sampling strategy. 3 elementary schools, more than 1,400 students; and 51 administrators, parents, and staff.	Louis and Kruse (1995) model of "professional communities."	State standardized tests in reading and mathematics for grades three through five.	Analysis aggregated to the school level using coding and analysis of transcripts.
Supovitz, 2002, longitudinal from 1997-2000.	Mixed methods: validated survey to all teachers and administrators in district with response rate of 81%, 87%, & 84% three consecutive years. Case studies with interviews of teachers and principals, and observations of instruction and meetings.	TP: schools in Ohio. Selected all 79 elementary and secondary schools in a Cincinnati school district. Around 3,000 teachers and administrators.	Collaboration, collective responsibility, deprivatization, reflective dialogue, and shared leadership.	3rd through 8th grade student scores from district and state assessments in writing, reading, mathematics, science, and citizenship.	Analysis aggregated to the school and team level using ordinary least squares regression analyses and HLM. Also, coding and analysis of transcripts.

Authors, Year, and Duration of study	Methods Of Study	Target Pop. (TP), Sample & Selection	Explanatory Variables	Outcome Variables	Data Analysis
Visscher & Witziers, 2004, does not indicate when data was collected.	Quantitative methods: validated survey to teachers and heads of departmental teams with response rate of 66%. Participants were given different versions/portions of survey to raise response rate.	TP: secondary school mathematics departments in the Netherlands. Stratified random sampling. 39 of 93 secondary school mathematics departments; 169 teachers and heads of departmental teams; and 975 students.	Cooperation, collaboration, shared values, decision-making, principal leadership, shared leadership, and trust.	National mathematics assessment of 15-16-year-old students.	Analysis aggregated to the school level using multilevel regression.
Wiley, 2001, data collected in 1988, 1990, and 1992.	Quantitative methods: teacher survey data from the NELS 1988 study; and 1990, and 1992 High School Effectiveness Study (a subset of NELS:88).	TP: high School mathematics departments in the US. Systematic random sampling. Used 4,329 of 5,449 sophomores in 214 of 247 high schools. Also, 2,265 math teachers.	Shared goals, collaboration, professional development, trust, principal leadership (specifically transformational, transactional, and instructional).	Mean school math achievement at grade 12 from NELS student achievement data.	Analysis aggregated to the school level using multilevel modeling.

Seven EP studies complete case studies to measure and analyze PLCs (Bolam et al., 2005; Langer, 2000; Louis & Marks, 1998; Saunders et al., 2009; Siguroardottir, 2010; Strahan, 2003; Supovitz, 2002). One study uses a comparative case study design to compare the PLCs of schools that were "beating the odds" with "typical" schools in regards to student achievement (Langer, 2000). Two studies complete an experimental case study by utilizing the elements of PLC to develop and cultivate PLCs in the experimental schools and comparing student achievement results with a school(s) in the control group (Saunders et al., 2009; Siguroardottir, 2010). Six studies complete interviews with teachers and administrators, with the exception of Langer (2000) where only classroom teachers are interviewed (Bolam et al., 2005; Langer, 2000; Louis & Marks, 1998; Siguroardottir, 2010; Strahan, 2003; Supovitz, 2002). Two studies only observe meetings at the school and not instruction (Bolam et al., 2005; Siguroardottir, 2010). In addition to school meetings, four of the seven EP studies observe instruction as well (Langer, 2000; Louis & Marks, 1998; Strahan, 2003; Supovitz, 2002).

The target populations and samples of each EP study also differ. The majority of these studies is completed in and attempts to represent schools in the United States (Gruenert, 2005; Langer, 2000; Lee & Smith, 1996; Louis et al., 2010a; Louis & Marks, 1998; Saunders et al., 2009; Strahan, 2003; Supovitz, 2002; Wiley, 2001). The others are completed in and attempt to represent schools in England (Bolam et al., 2005), Iceland (Siguroardottir, 2010), or the Netherlands (Lomos et al., 2011a; Visscher & Witziers, 2004). The range of schools for the target population also differs in these studies. Six studies consider schools from all grade levels between elementary to high school (Bolam et al., 2005; Gruenert, 2005; Louis et al., 2010a; Louis & Marks, 1998; Siguroardottir, 2010, Supovitz, 2002). Four of these studies indicate that PLCs are more characteristic in elementary schools when compared to secondary schools

(Gruenert, 2005; Louis et al., 2010a; Louis & Marks, 1998; Supovitz, 2002). The remaining eight EP studies focus solely on elementary schools (Saunders et al., 2009; Strahan, 2003) or secondary school departments (Langer, 2000; Lee & Smith, 1996; Lomos et al., 2011a; Visscher & Witziers, 2004; Wiley, 2001).

The sample selection processes differ between the EP studies. Two studies complete a census of all schools within one school district (Gruenert, 2005; Supovitz, 2002); three studies complete a stratified random or systematic random sample (Bolam et al., 2005; Lee & Smith, 1996; Lomos et al., 2011a; Louis et al., 2010a; Wiley, 2001); and the others use a purposive sampling strategy (Langer, 2000; Louis & Marks, 1998; Saunders et al., 2009; Siguroardottir, 2010; Strahan, 2003; Visscher & Witziers, 2004).

The sample sizes of the EP studies differ. The largest sample population of schools that are studied was 820 secondary schools (Lee & Smith, 1996); followed by 393 schools from all levels (Bolam et al., 2005), 214 secondary schools (Wiley, 2001), and around 100 schools (Lomos et al., 2011a; Louis et al., 2010a). Two studies focus on an entire school district with about 80 schools in each (Gruenert, 2005; Supovitiz, 2002). The rest of the studies include less than 40 schools in their research (Langer, 2000; Louis & Marks 1998; Saunders et al., 2009; Visscher & Witziers, 2004), with two studies including three schools (Siguroardottir, 2010; Strahan, 2003). The largest sample population of teachers and administrators is a little below 10,000 (Lee & Smith, 1996), followed by about 3,000 (Gruenert, 2005; Supovitz, 2002). The rest of the EP studies have less than 2,000 teachers and administrators in their sample, or do not indicate how many teachers participated (Bolam et al., 2005; Louis et al., 2010a; Saunders et al., 2009). The largest student sample comes from Lee and Smith (1996) with over 11,000 students; followed by nearly 6,000 students (Louis & Marks, 1998); and 4,329 students (Wiley, 2001).

The rest of the EP studies have less than 4,000 students (Langer, 2000; Lomos et al., 2011a; Siguroardottir, 2010; Strahan, 2010; Visscher & Witziers, 2004), or do not indicate how many students are involved in their study (Bolam et al., 2005; Gruenert, 2005; Louis et al., 2010a; Saunders et al., 2009; Supovitz, 2002).

The EP studies also gather and analyze student achievement data in different ways. As described previously, Louis and Marks (1998) collect authentic measures of student achievement to obtain a more accurate assessment of student learning. The rest of the EP studies use some form of standardized assessment to indicate student achievement. Three studies use student achievement results on standardized assessments to identify successful schools that are succeeding and analyze what they are doing to improve student achievement (Langer, 2000; Siguroardottir, 2010; Strahan, 2003). One study focuses solely on language arts student achievement data (Langer, 2000); four studies focus solely on mathematics (Lomos et al., 2011a; Louis et al., 2010a; Visscher & Witziers, 2004; Wiley, 2001); one focuses on mathematics and social studies (Louis & Marks, 1998); four use students' language arts and mathematics scores (Gruenert, 2005; Saunders, 2009; Siguroardottir, 2010; Strahan, 2003); and two use student achievement from not only mathematics and language arts, but also science (Lee & Smith, 1996; Supovitz, 2002) and social studies (Lee & Smith, 1996).

Another important difference between the studies is the level to which they aggregate the data for their analysis. Nine of the 13 EP studies aggregate the data solely to the school level (Bolam et al., 2005; Gruenert, 2005; Lee & Smith, 1996; Louis et al., 2010a; Saunders et al., 2009; Siguroardottir, 2010; Strahan, 2003; Visscher & Witziers, 2004; Wiley, 2001); and one aggregates between the school and classroom levels (Louis & Marks, 1998). Three studies aggregate the data to the team level (Langer, 2000; Lomos et al., 2011a; Supovitz, 2002), where

we believe the strongest associations between PLC elements and student achievement are found, particularly with collaborative teaming, professional development, data based decision-making, and systems of prevention and intervention due to the direct influence teams have on these elements.

The analysis of data varies across the EP studies. Six studies code and analyze transcripts from interviews, and observations of instruction and meetings (Bolam et al., 2005; Langer, 2000; Louis & Marks, 1998; Strahan, 2003; Siguroardottir, 2010; Supovitz, 2002). All but two of the EP studies use statistical analyses of the data (Bolam et al., 2005; Gruenert, 2005; Lee & Smith, 1996; Lomos et al., 2011a; Louis et al., 2010a; Louis & Marks, 1998; Saunders et al., 2009; Siguroardottir, 2010; Supovitz, 2002; Visscher & Witziers, 2004; Wiley, 2001). Three studies use analysis of variance (ANOVA) (Lee & Smith, 1996; Louis & Marks, 1998; Saunders et al., 2009); four utilize hierarchical linear modeling (HLM) (Lee & Smith, 1996; Lomos et al., 2011a; Louis & Marks, 1998; Supovitz, 2002); five use multiple regression modeling (Louis et al., 2010a; Siguroardottir, 2010; Supovitz, 2002; Visscher & Witziers, 2004; Wiley, 2001); two use correlational analysis (Bolam et al., 2005; Gruenert, 2005); two use factor analysis (Bolam et al. 2005; Lee & Smith, 1996); one uses cluster analysis (Lomos et al., 2011a); and one uses structural equation modeling to analyze the data (Louis et al., 2010a).

It is clear that the EP studies differ in many ways. The consistent finding that PLCs are positively related to student achievement regardless of the sample, methods, and different measures of student achievement in the EP studies provides evidence that these findings are valid and reliable. They show that consistent findings persist across various samples and contexts, which allows us to be more confident that there truly is a positive relationship between PLCs and student achievement. Additional studies indicating this relationship in other contexts would

provide further evidence, which would help researchers and educators to be more confident in PLCs and utilize their effectiveness.

Measurement of PLCs and the Challenges Introduced to the Research

One area where the EP studies differ that causes a challenge when comparing the results of these studies is how they measure PLC. Six of them use the definition of "professional community" from Louis and Kruse (1995), which includes: shared sense of purpose, a collective focus on student learning, collaborative activity, deprivatized practice, and reflective dialogue (Langer, 2000; Lee & Smith, 1996; Lomos et al., 2011a; Louis et al., 2010a; Louis & Marks, 1998; Strahan, 2003). The focus of this definition is on the collaborative activities of teams and the other essential elements of PLC are missed, including the *Leadership* elements, data based decision-making, systems of prevention and intervention, and an interdependent culture based on trust. Because of this, in a later study, Louis and colleagues (2010a) add variables to measure other important PLC elements, which include trust, shared leadership, and instructional leadership. Some of the EP studies complete a factor analysis, which combine the elements of PLC into one variable to measure the degree to which PLCs have developed (Bolam et al., 2005; Lee & Smith, 1996; Louis & Marks, 1998; Wiley, 2001). As mentioned before, by measuring an overall level of PLC, a false assumption is made that each of the PLC elements has the same relationship with student achievement. Only two EP studies include some element of data based decision-making (Saunders et al., 2009; Strahan, 2003), while none of them include systems of prevention and intervention. Each of the measurements of PLC has similarities with the other EP studies, but the differences make them difficult to compare.

The different ways the EP studies measure PLC makes it challenging to compare and contrast the EP studies and their findings. Although challenging, we will describe the findings of the EP studies in the following sections.

Collaborative Teaming and Data Based Decision-Making

Since the central focus of PLCs is to increase student learning by improving instruction, determining which elements specifically influence and improve instruction is important. In our conceptualization of PLCs we hypothesize that *Collaborative Teaming* and *Data Based Decision-Making* have the strongest, most direct influence on improving instruction so students will learn. Collaborative teaming is an essential element in the success of a PLC. Data based decision-making has become an important practice in a PLC as schools have been pushed to focus more on the results of student achievement (Blankstein, 2004).

Evidence for collaborative teaming from the EP studies. Collaborative teaming has a direct relationship with improved instruction and higher student achievement. Around thirty years ago, researchers investigated and discussed the problems of teacher isolation, and found the importance of collaboration and teaming for teachers (Little, 1982; Rosenholtz, 1991). Since then, many schools have embraced collaborative teaming to improve teaching and learning. Supovitz (2002) describes the purpose and potential of collaboration well when he said that collaborative teaming is "based on the theory that organizing schools into smaller educational environments will help to build more collaborative and collegial communities of teachers, providing them with the autonomy and motivation to make better curricular and pedagogical decisions in the interest of their students and therefore improving student learning" (p. 1591).

Even though collaboration is a type of professional development, it has been defined as a distinct, critical element in the success of a PLC (Blankstein, 2004; DuFour & Eaker, 1998; Hord, 1997; Kruse & Louis, 1995; Senge, 1990), which we indicate in our conceptual framework. From the Learning Forward website they define professional development effectively, "The term 'professional development' means a comprehensive, sustained, and intensive approach to improving teachers' and principals' effectiveness in raising student achievement" ("Definition of Professional Development," 2012). Professional development can be done with an individual teacher, a team, an entire faculty, and even with an entire district or more. It can occur in multiple settings including a classroom, another location in the school, a conference center, university, or some other location outside the school. Collaboration is a certain type of professional development, but occurs specifically when a team of teachers meets together regularly to address the specific and individual needs of their students by improving their instruction collaboratively. Collaboration usually occurs within the school or one of the teachers' classrooms on the collaborative team. Professional development and collaborative teaming are tightly interconnected, yet they are distinct and both are important in a PLC.

Almost all of the EP studies show a positive relationship between collaborative teaming and improved student achievement (Bolam et al., 2005; Gruenert, 2005; Langer, 2000; Lee & Smith, 1996; Louis & Marks, 1998; Louis et al., 2010a; Saunders et al., 2009; Siguroardottir, 2010; Strahan, 2003; Supovitz, 2002; Wiley, 2001). Five of these found a relationship between collaboration and student achievement, but it was part of an overall measure of "professional community" or was included with multiple other measures of PLC (Bolam et al., 2005; Lee & Smith, 1996; Louis & Marks, 1998; Louis et al., 2010a; Wiley, 2001).

The studies by Saunders and colleagues (2009) and Supovitz (2002) provide the clearest and strongest evidence from the EP studies that collaborative teaming is related to improved student achievement within the context of a PLC. In their experimental case study, Saunders and colleagues (2009) found the effect size on student achievement at the nine schools that practiced effective processes of collaborative teaming more than quadrupled those of the six schools in the control group. Also these nine schools, "which started out well below the district average, appeared to surpass the comparison schools and even the district average by the end of the 5 years" (p. 1021). They describe thoroughly the process they used to establish and support collaborative teams: "1. Identify and clarify specific and common student needs to work on together. 2. Formulate a clear objective for each common need and analyze related student work. 3. Identify and adopt a promising instructional focus to address each common need. 4. Plan and complete necessary preparation to try the instructional focus in the classroom. 5. Try the team's instructional focus in the classroom. 6. Analyze student work to see if the objective is being met and evaluate the instruction. 7. Reassess: Continue and repeat cycle or move on to another area of need" (p. 1016). This protocol for collaborative teams describes thoroughly and accurately the important process teams should follow to ensure student needs are being met through improved instruction.

Supovitz (2002) also found a strong correlation between effective collaborative processes and higher student achievement. When no discernible patterns of higher student performance in team-based schools were found when compared to non-team-based schools, Supovitz analyzed the process of these collaborative teams within the team-based schools. He found that many of the teams were not utilizing effective processes of collaboration, spending the majority of their time on issues irrelevant to improving instruction and student achievement, leaving only an

average of a quarter of their time to address items that would impact instruction. Supovitz found that when collaborative teams were utilizing effective processes the majority of the time (about 25% of the teams) there was a positive and statistically significant relationship between their collaborative efforts and improved student achievement: for each standard deviation more frequently a team employed effective team processes it was associated with about .10 standard deviation higher student test performance.

Four other EP studies also provide evidence that there is a positive relationship between collaborative teaming and higher student achievement (Gruenert, 2005; Langer, 2000; Siguroardottir, 2010; Strahan, 2003). Gruenert (2005) found a significant correlation between teacher collaboration and higher mathematics scores, but not with language arts. Langer (2000) indicated that collaborative teaming was present in schools that were "beating the odds," but were absent in schools that were "typical" in regards to the level of student achievement. Siguroardottir (2010) found that collaboration contributed most to the total scores in their multiple regression analysis of two schools in Iceland, which was confirmed by qualitative methods of an additional school in their study. Strahan's (2003) qualitative study showed that all three schools in the study indicated that collaborative efforts had increased to improve instruction by targeting the academic needs of students. The EP studies provide clear evidence that there is a strong, positive relationship between collaboration and higher student achievement.

The collaborative teaming literature. The research focused specifically on collaborative teaming also indicates a positive relationship between collaboration and improved student achievement (Evans-Stout, 1998; Goddard, Goddard, & Tschannen-Moran, 2007; Moolenaar, Sleegers, & Daly, 2011). The study completed by Goddard and colleagues (2007) in

a large, urban mid western school district found a positive relationship between collaboration and higher student achievement. In their study of 47 elementary schools, with 452 teachers and 2,536 fourth-grade students, they found there was a positive relationship between teacher collaboration and the schools' 4th grade mathematics and reading scores. In another study of 19 schools in Wales where students were achieving higher than other schools they found that collaborative teaming was an important contributor to student achievement (James et al., 2007). A study of 53 Dutch elementary schools showed a positive relationship between teacher collaboration and increased teacher efficacy, which also was positively related to higher student achievement (Moolenaar et al., 2011).

The process the team follows has also been shown in the literature to impact the effectiveness of collaborative teaming as it improves teaching and learning (Gallimore et al., 2009; Goddard et al., 2007; Jacobsen, 2010). Saunders and colleagues (2009) describe the process that successful collaborative teams utilize: 1) begin with setting specific learning outcomes; 2) plan and coordinate instruction to teach these learning goals effectively; 3) utilize best practices in teaching; 4) assess student learning through common assessments; 5) and then analyze the data to determine whether students are ready to move on, or whether they need additional support or enrichment to fully learn the material. As this process is repeated data informs each step to help teachers focus on the specific needs of students and the areas in which they need additional support or enrichment to achieve to their fullest potential. This collaborative process is very similar to that described previously by Saunders and colleagues (2009).

DuFour (2004) describes a similar process through the four essential questions that should guide the work and efforts of collaborative teams to ensure they utilize their time most effectively. He says, "The powerful collaboration that characterizes professional learning

communities is a systematic process in which teachers work together to analyze and improve their classroom practice. Teachers work in teams, engaging in an ongoing cycle of questions that promote deep team learning. This process, in turn, leads to higher levels of student achievement" (p. 3). The cycle of questions he refers to is: "What is it we want all students to learn? How will we know when each student has mastered the essential learning? How will we respond when a student experiences initial difficulty in learning? How will we deepen the learning for students who have already mastered essential knowledge and skills?" (DuFour et al., 2005). Collaborative teams should utilize these processes to be as effective as possible. When collaborative teams are not focused on student learning and are distracted by planning field trips, school events, or simply socializing, their collaborative efforts will not be as impactful on teacher and student learning, and may be a less effective use of valuable time and resources. Similar to professional development, the value of collaboration is not measured solely by the amount of time devoted to the endeavor, but by the use and management of the time according to specific needs of both teachers and students. The literature focused specifically on collaborative teaming aligns nicely with the EP studies, indicating that when effective collaborative processes are practiced and measured, it is likely to show a relationship with improved student achievement.

As mentioned previously, it is essential to have a clear definition of each element to accurately measure and analyze their relationship with student achievement. To measure collaborative teaming within a PLC we will utilize the survey items on the LCCI that measure this relationship (Table 2).

Evidence for data based decision-making using assessment from the EP studies. Data based decision-making is the other element of a PLC that we believe has the strongest relationship with instruction and student learning, even though the EP studies do not provide

clear evidence of this relationship. This may be due to how recently this element has been defined and accepted in the PLC literature. Only three EP studies indicate a positive relationship between data based decision-making using continuous assessment and higher student achievement (Saunders et al., 2009; Strahan, 2003; Visscher & Witziers, 2004). In the process of developing and utilizing collaborative teams in the experimental schools, Saunders and colleagues (2009) encouraged the use of common assessments to inform instruction and improve student achievement. The training provided to principals as well as collaborative-team leaders in the experimental schools helped these nine schools achieve significantly higher academically when compared to the six schools in the control group. In Strahan's (2003) study of schools in North Carolina he found the importance of "data and dialogue" in a PLC (p. 143). Not only should data from common assessments inform collaborative team decisions, but also all decisions made within a PLC. In Visscher and Witziers' (2004) study of mathematic departmental teams in the Netherlands they found that when teams utilized the data from "common tests" to improve instruction and address students' academic needs student achievement was higher (p. 788). The rest of the EP studies did not measure the use of common assessments or data based decision-making within their studies or compare their relationship with student achievement. This may be due to how recently this element was introduced as an essential element of PLCs, or it may be subsumed in the process of collaborative teaming.

Data based decision-making using continuous assessment literature. The demands of NCLB upon schools have increased the need and use of student achievement data and other sources of data to identify those students needing remediation or other interventions. The challenge to PLCs today is for them to reshape the way they use data to ensure that they utilize it in the most effective ways to improve instruction and student learning (DuFour et al., 2008).

Table 2.

Survey Items Measuring Collaborative Teaming from the LCCI.

Item Number	Measurement on the LCCI
11CT	I am on an instructional team that collaborates to improve teaching and learning.
12CT	How often does your instructional team meet to collaborate on improving teaching and learning?
13CT	My instructional team meetings are scheduled during the contracted day (e.g., common preparation periods, early out, late start).
14CT	My instructional team has sufficient collaboration time to improve teaching and learning.
15CT	My instructional team's processes lead to improved student learning
16CT	My instructional team collaborates on finding instructional solutions that help all students improve their learning.
17CT	My instructional team finds the most effective instructional approaches to help students master selected learning targets.

In a PLC, one of the most important uses of student achievement data is in the process of collaboration. Data should be utilized effectively to inform instruction and to help students according to their specific needs as a collaborative team follows sound practices (Halverson et al., 2006; Strahan, 2003). When a collaborative teams' learning outcomes are clearly established, common pre and post assessments should be created to clearly measure whether students understand the learning outcomes. Data from these assessments will also inform collaborative teams as they discuss and analyze these comparable measures. Pre-assessments inform teachers of students' specific needs to ensure first-time instruction is differentiated and is as effective as possible to meet the learning needs of the majority of students. As teachers instruct they should utilize formative assessments to gauge the understanding of students, the effectiveness of their instruction, and to make necessary adjustments while teaching. Throughout instruction, data is used to inform and drive instruction to better meet the learning needs of students. This effective use of assessment to guide instruction has been referred to as "assessment *for* student learning" rather than assessment of student learning (Stiggins, Arter, Chappuis, & Chappuis, 2004, p. 1).

PLCs and collaborative teams should utilize common assessments to inform instruction to best meet the academic needs of students.

Studies on assessment confirm that there is a positive relationship between data based decision-making using continuous assessment and higher student achievement (Black & William, 1998; William, 2007). In a review of studies on assessment of all grade and age levels, Black and Wiliam (1998) reported a 0.4 to 0.7 standard deviation increase in student achievement with the use of frequent formative assessments. Those that improved the most were students that struggled to learn. William (2007) described, "When implemented well, formative assessments can effectively double the speed of student learning" (p. 36). As teachers utilize common assessments to drive their instruction, student learning is enhanced.

After sufficient, effective first-time instruction, a common, summative post assessment should be administered to all students of a collaborative team. The team should then analyze data collaboratively to identify how well students understand the material, and to determine the specific needs of students to ensure they receive the extra support needed to learn the learning outcomes. This process of data based decision-making that leads to improvements because of team common assessments and collaboration can create one of the most ideal settings for student learning to occur (Halverson et al., 2006; Stiggins et al., 2004; Wall & Rinehart, 1998).

To effectively utilize the results of assessments, collaborative teams should display data in a format that is easy to analyze to determine which students understand the essential learning outcomes, and which students need additional support. The format of the display of the data should allow collaborative teams to easily view the data in order to identify the academic needs of students according to specific concepts and skills.

Before data based decision-making was highly encouraged, teams often collaborated about the academic performance of their students according to their observations or what they intuitively felt, instead of making decisions based upon data and identifiable student needs. While these aspects of collaboration were important, using common assessments and focusing on student data increased the likelihood that teachers were collaborating specifically on students' greatest academic needs and finding specific and effective instructional solutions to support them.

Another source of data comes when teachers observe and reflect upon their own instruction and observe that of others. For collaboration as well as professional development to be successful in helping teachers continually improve, the use of instructional data is crucial. The literature shows that use of data to inform instructional practice improves student achievement (Halverson et al., 2006; Stiggins et al., 2004; Wall & Rinehart, 1998). The research on assessment as well as the EP studies provides evidence that there is a relationship between data based decision-making using continuous assessment and higher student achievement. Table 4 indicates the survey items from the LCCI that we will use in our study to measure Data Based Decision-Making Using Continuous Assessment.

Collaborative teaming and data based decision-making are both critical for a PLC to be successful in improving instruction in the service of helping students learn. Ensuring that the collaborative teaming of a school as well as the decisions are derived from and informed by data to lead them to focus on the specific needs of students and teachers is essential for a PLC to be successful. Also, creating and utilizing time effectively will make real improvements in instruction resulting in increased learning of students. Table 3 shows the survey items of the LCCI that we will use to measure data based decision-making within a PLC.

Table 3.

Survey Items Measuring Data Based Decision-Making Using Continuous Assessment from the LCCI.

Item Number	Measurement on the LCCI
24DB	My instructional team uses data from district or state end of level tests to make instructional decisions.
25DB	I use data from common assessments developed by my team to make instructional decisions.
26DB	My instructional team has identified common core learning standards on which we assess student learning.
27DB	I use evidence of student learning to adjust my instructional practice.
28DB	My instructional team has created common assessments.
29DB	My instructional team uses data from common assessments to guide student learning.
30DB	My instructional team continuously assesses student learning to guide instruction.

Professional Development and Systems of Prevention and Intervention

Professional development and systems of prevention and intervention also have a strong relationship with improving instruction and student learning. Professional development is important in improving instruction and meeting the needs of teachers and students. Also, because of the high demands placed upon schools it is necessary that systems of prevention and intervention be well established to ensure the success of all students and to avoid failing AYP.

Evidence for professional development from the EP studies. Many of the EP studies indicate some positive relationship between professional development and improved student achievement (Bolam et al., 2005; Gruenert, 2005; Langer, 2000; Louis & Marks, 1998; Louis et al., 2010a; Saunders et al., 2009; Siguroardottir, 2010; Strahan, 2003). However, the majority of these EP studies measure professional development within an overall measure of PLC, and not specifically on professional development as an individual construct. Gruenert (2005) found the most significant and direct correlation between teachers' attitudes of gaining new ideas and

improving professionally with higher student achievement scores in mathematics and language arts.

In three of the EP qualitative studies, the importance of professional development in the success of a PLC was described (Langer, 2000; Saunders et al., 2009; Strahan, 2003). In Saunders and colleagues' (2009) experimental study, professional development was an important element in the initiation and establishment of PLCs. They describe thoroughly the process they went through to ensure the development of PLCs was successful by utilizing targeted professional development into the experimental schools: 1) They transformed academic standards into explicit instructional goals; 2) identified measures to assess the instructional goals; 3) evaluated school-wide achievement to determine next steps; 4) addressed common instructional challenges through professional development provided by building and district specialists and other formal opportunities; 5) ensured future professional development aligned with these instructional challenges; and 6) held weekly or bimonthly grade-level team meetings to address specific student needs. The schools that received this effective process of professional development improved student achievement scores substantially when compared to schools in the control group. After the third year of Phase 2 of developing PLCs into the experimental schools, "the difference between the GR [experimental] and comparison schools increased over time during the Phase 2 intervention…[and] the effect size had quadrupled over the effect size of the last year of Phase 1" (p. 1022). The scores in the experimental schools also increased from well below the district average to above it.

In Strahan's (2003) analysis of multiple interviews of teachers and administrators, he determined that in each of the three schools' PLCs, professional development was an important factor in their success. Langer (2000) also described the importance of professional development

and that many of the teachers in their study participated in conducting professional development in their schools, districts, or other settings indicating that effective teachers participate in professional development. Many of these teachers were also published in peer-reviewed journals.

In Supovitz's (2002) EP study, he did not find a relationship between professional development and improved student achievement. This encouraged him to analyze professional development deeper. He found that even though schools in his study received extra days of professional development, there was not a statistically significant relationship between student achievement and professional development, because the professional development in these schools focused solely on the processes of teaming and not on instructional content or student learning. He commented, "Continuous well-ordered engagement in the ways that instructional strategies mix with curriculum to produce increasingly higher quality student work that represents standards for student performance does not develop organically but needs to be taught, modeled, and nurtured through ongoing, content-based, localized professional development" (p. 1616). He also described that professional development models "which provide teachers with training and coaching to investigate the relationships between the standards, their lessons, and the work of their students, are effective professional development models" (p. 1616). Even though Supovitz's study did not find a significant relationship between professional development and improved student achievement, it indicates the importance of effective professional development focused on content, pedagogy, and student thinking and learning. In other words, professional development should be driven by the needs of both teachers and students within the school.

The professional development literature. In addition to the EP studies, the research specifically focused on professional development provides evidence that when teachers

participate in effective professional development there is a significant relationship with higher quality instruction and improved student achievement (Yoon et al., 2007). In the literature review completed by Yoon and colleagues (2007), they found nine studies indicating that professional development is related to improved student achievement.

The research indicates that in the process of improving schools, professional development of teachers is essential to enhance instruction so students can learn. The purpose of professional development is to improve instruction by deepening teachers' knowledge, their abilities and skills, and to positively change their beliefs, attitudes, or assumptions so students can more readily learn (Darling-Hammond, 1997; Garet et al., 2001; Hochberg & Desimone, 2010; Little, 1993; Loucks-Horsley & Matsumoto, 1999).

For professional development to be successful in improving instruction, it must utilize effective practices and processes. It should be teacher driven, embedded in daily practice, and clearly focused on improving the learning of teachers in order for students to learn to their full potential (Little, 1993; Loucks-Horsley et al., 2010; Supovitz, 2002). Teachers should also collectively and actively participate in professional development (Hochberg & Desimone, 2010). Too often, professional development is done through workshops, conferences, or other external sources, which are less effective models of professional development since they are not driven by teachers and do not connect directly to their daily practice (Little, 1993).

The needs of both teachers and students should drive content of professional development, and professional development should be responsive to contextual factors of the school (Little, 1993). It should focus on improving instruction by deepening teachers' content knowledge, pedagogical knowledge, pedagogical content knowledge, and understanding of student thinking and learning (Garet et al., 2001; Loucks-Horsley & Matsumoto, 1999; Shulman,

1987). More effective types of professional development that utilize effective practices and content are study groups (Gersten et al., 2009; Hollins et al., 2004; Phillips, 2003), lesson studies (Perry & Lewis, 2009), and peer observations and coaching (Garet et al., 2001) because they are teacher driven and job-embedded and they increase collective and active participation and focus on improving teachers' knowledge, skills, and beliefs in order to improve student learning.

For professional development to be successful in deepening teachers' knowledge, skills, and beliefs so they can better instruct students, several important structural elements must be incorporated. Schools should set and schedule frequent and ongoing opportunities for professional development within the district and school calendars to ensure sustained, ongoing learning for teachers (Garet et al., 2001; Hochberg & Desimone, 2010). Sustained duration of professional development is also important, referring to both the amount of time as well as the span or period of time, measured in days, weeks, and months that teachers are engaged in professional development activities. Professional development that spans over a longer duration of time also allows teachers to apply teaching strategies and obtain feedback on their teaching (Garet et al., 2001). Simply having time for professional development does not guarantee that it will be used productively. It is important for teachers to actively work with others by interacting, listening, observing, coaching, and solving problems together. The use of data also helps to identify specific needs of students and teachers ensuring that the professional development is most effective. Productive professional development with greater sustained duration is more likely to facilitate deeper discussions of content, thinking and misconceptions of students, and pedagogical strategies, resulting in deeper learning and development of teachers.

The successes of educational systems in several countries, such as Singapore and Finland, have drawn the attention of education researchers. A key element to the success of these

educational systems is the large amount of time devoted to the professional development of teachers on a weekly and daily basis (Pak Tee, 2004). They know that student learning is the central purpose of education, and that professional development is necessary to ensure teachers are learning to provide high quality instruction so students can learn. In their book about professional development, Loucks-Horsley and her colleagues (2009) observed: "As we know, student learning *is* the most valuable outcome of schools, but teachers' learning is a major contributor to student learning that is not yet fully acknowledged as a valuable goal of schools. Until the view of learning for all—including teachers and students—changes, educators will continue to bemoan the fact that 'there is not enough time!'" (p. 123). These countries have structured not only time, but also a belief system that supports professional development of teachers to improve instruction and help students better learn.

The evidence from the EP studies as well as those focused specifically on professional development indicate a strong relationship between professional development and improved student achievement. In the context of PLCs, it is important to measure effective practices and processes of professional development to determine whether this PLC element truly improves instruction and student learning. To measure professional development within a PLC we will utilize the survey items on the LCCI that measure this relationship (Table 4).

Evidence for systems of prevention and intervention from the EP studies. None of the EP studies measure the element of systems of prevention and intervention. This element has been described thoroughly by Blankstein (2004), but has yet to be included in the research on PLCs and their relationship with student achievement.

Systems of prevention and intervention literature. The foundational purpose of using data to inform instruction is to meet the individual, academic needs of students by creating

systems of prevention and intervention (Blankstein, 2004; DuFour et al., 2008). Once schools identify the specific needs of students needing additional support, they should implement targeted systems of prevention and intervention to ensure that these students learn according to their specific needs.

Table 4.

Survey Items Measuring Professional Development that is Teacher Driven and Embedded in Daily Work from the LCCI.

Item number	Measurement on the LCCI
31PD	My collaborative team process has been an important source of professional learning for me.
32PD	The professional development in which I participate in this school improves my classroom instruction.
33PD	Teachers participate in lesson studies, in which teachers co-develop lessons, observe a colleague teach the lessons to students, and critique and refine the lessons for us in their own classrooms.
34PD	Teachers help design professional development.
35PD	Teachers share their instructional expertise.
36PD	Teachers new to our school are provided with mentoring in a systematic way.

In a PLC, the principal and teams of teachers should work together to create systems of prevention and intervention that will help the majority of students in need, rather than leaving the responsibility solely upon individual teams. When these remediation programs have been created and established successfully, collaborative teams have the responsibility to identify students needing the additional support and to utilize these interventions effectively to give students the needed support and to help them succeed academically. Schools and teams should create systems of prevention and intervention to support those students needing additional support.

Systems of prevention and intervention allow instruction to improve so students can better learn at their level. Often, the systems of prevention and intervention created at the school or team level organize students into smaller groups, which facilitates a teachers' ability to meet

the academic needs of the students. Research has indicated that smaller class sizes or groupings of students result in higher student achievement (Glass et al., 1982). Systems of prevention and intervention are the best way to individualize instruction to meet the specific academic needs of students.

Response to Intervention (RtI) is one system of prevention and intervention that utilizes data to inform decisions and accurately describes many important aspects of the PLC elements data based decision-making and systems of prevention and intervention (Berkeley et al., 2009). The RtI research describes a tiered model to support the learning of one hundred percent of students, with the three-tier model being the most accepted and regarded in the literature (Fuchs & Fuchs, 2007). The first tier, often referred to as the *prevention tier*, occurs in a regular classroom with whole-group instruction. When first-time instruction is based upon best practices it is expected that about 80% of students will understand. The 2nd and 3rd tiers, the systems of intervention, focus on instruction that is driven by the specific needs of students. Supplemental, tier-2 instruction can help meet the needs of about 15% of students and usually occurs within small-group settings; is based upon more intensive, research-based interventions, in addition to the primary instruction that the rest of the students receive; and student progress is carefully monitored throughout the process. Instruction from Tier 3 is the most intense intervention and can serve about 5% of students. This tier involves "high-intensity, longer duration individualized instruction and frequent progress monitoring," and is provided to students whose needs were not met from the Tier 2 interventions (Berkeley et al., 2009, p. 86-87). The RtI model captures many of the important characteristics of systems of prevention and intervention that should be practiced in a PLC. Although this PLC element has not been measured in the EP studies, it is likely that a positive relationship between systems of prevention and intervention and higher

student achievement exists, due to the direct support students receive through these systems. We will use the LCCI to measure systems of prevention and intervention (Table 5).

Table 5.

Survey Items Measuring Systems of Prevention and Intervention that Assures Academic Success for All Students from the LCCI.

Item number	Measurement on the LCCI
18SP	At my school teachers provide high quality instruction for all students including those who may be at risk for academic failure.
19SP	The faculty in this school has enacted systems for intervening with students who are at risk for academic failure.
20SP	Any student who experiences academic difficulty in my class receives extra time and support.
21SP	In this school, the additional time and support for learning provided to students who experience academic difficulty is developed in a systematic way rather than being left to the discretion of teachers.
22SP	Rather than just being invited, students who experience academic difficulty are required to participate in activities that provide them with additional time and support for learning.
23SP	In my grade level or department team, we systematically assist students who have difficulty mastering core content by providing extra teacher-directed learning time.

When the two elements, data based decision-making and systems of prevention and intervention, are utilized effectively, instruction will more purposefully meet the individual needs of students. When data based decision-making using continuous assessments guides the systems of prevention and intervention, it is likely instruction and student achievement will improve.

School Leadership Elements

School leadership, consisting of both *Principal* and *Participative Leadership*, is crucial for the success of a PLC (Louis & Wahlstrom, 2010; Louis et al., 2010a; Louis et al., 2010b; Marzano et al., 2005). Without leadership a school may lose its focus on the purpose of the PLC as well as the means necessary to continue forward, which will lead to less effective instruction and lower student learning. In our conceptual framework we combine these two leadership

elements because of the close interaction they have with each other, and the relationship they have with the other PLC elements. Hallinger and colleagues (1996) confirmed "the appropriateness of viewing the principal's role in school effectiveness through a conceptual framework that places the principal's leadership behavior in the context of the school organization and its environment and that assesses leadership effects on student achievement through mediating variables" (527). This can also be applied to participative leadership, and describes what many of the EP studies have done, and what we are attempting in this study.

Evidence for principal and participative leadership from the EP studies. Nine of the 13 EP studies measure the relationship between some forms of principal or participative leadership with student achievement (Bolam et al., 2005; Gruenert, 2005; Langer, 2000; Lee & Smith, 1996; Louis et al., 2010a; Saunders et al., 2009; Siguroardottir, 2010; Visscher & Witziers, 2004; Wiley, 2001). We will consider these two elements of a PLC together because of the close interaction they have with each other, and because most of the EP studies combine them in their measures. Overall, these studies confirm a relationship with higher student achievement, though this relationship is often indirect and is mediated by other important PLC elements, which supports our conceptual framework that the *Leadership* elements are mediated by professional development, collaborative teaming, data based decision-making, and systems of prevention and intervention.

Two EP studies focused their research foremost on the leadership of the school to determine its interaction with PLCs, instruction, and student achievement (Louis et al., 2010a; Wiley, 2001). Wiley (2001) focused on the leadership of a school, specifically transformational leadership, and its relationship with PLCs and student achievement. In a survey to mathematics teachers, she measures transformational leadership as how effectively the leadership of the

school develops shared values and beliefs, supports instructional development, and communicates respect and value of teachers. Instead of focusing on how these elements are practiced by the teachers and their collaborative teams, she desired to isolate these practices solely to the leadership of the school to determine its relationship with student achievement. She found that "individual student achievement in mathematics is positively affected by an increase in the amount of learning in a school resulting from the contextual effect from the interaction of transformational leadership and professional community" (p. 24). But, that the construct "professional community only has a positive effect in schools whose math teachers experience above average transformational leadership or better" (p. 22). Similar to Louis and Marks' (1998) finding that authentic pedagogy accounts for the positive relationship between PLC and higher student achievement, Wiley's (2001) findings are important because they indicate the critical role of the principal in successfully leading a PLC, which will likely lead to higher student achievement.

In Louis and colleagues (2010a) multiple stepwise regression analyses study of schools across the United States, they studied the relationship between teachers' trust in the principal, shared leadership, and instructional leadership with professional community and student achievement. Similar to the study completed by Wiley (2001) these elements are closely related to those in our conceptual framework, yet the focus is on how the principal is trusted by the teachers and how the leadership of the school influences professional community and student achievement. In their study, they interviewed teachers, observed their instruction, and surveyed 8,391 teachers and 471 administrators. They found, "when the leadership variables are added…there is a large increase in the R and R^2, which suggest that principal leadership, even if it is indirect, is important" (p. 328). They also describe, "Overall, adding leadership variables

and the building level control variable more than double the percentage of variance in math achievement that is explained" (p. 328). They found the relationship between shared leadership and student achievement to be positive, yet indirect; that instructional and shared leadership are complementary approaches; and that both are necessary for the success of a PLC in improving instruction and student achievement.

The studies by Wiley (2001) and Louis and colleagues (2010a) provide important empirical evidence that there is a positive relationship between the *Leadership* elements, more effective PLCs, and higher student achievement. Even though school leadership is mediated by professional development, collaborative teaming, data based decision-making, and systems of prevention and intervention, its influence on each of the PLC elements is critical for the success of a PLC, which will directly improve instruction and student achievement.

The other EP studies provide further evidence of the positive relationship between the *Leadership* elements and higher student achievement (Bolam et al., 2005; Gruenert, 2005; Saunders et al., 2009; Siguroardottir, 2010). Gruenert (2005) measured principal and participative leadership within the same variable and found a positive correlation between the leadership elements and higher students' mathematics achievement, but there was not a significant correlation with higher students' language arts achievement. In Bolam and colleagues (2005) study of schools in England, they combined the leadership elements within their second factor, which they titled, "Within school policy, management and support for professional learning" (p. 38), and found at the secondary level this factor had a positive, statistically significant, correlation with higher student achievement, but only in terms of schools' value added performance, and not in their raw scores. In Iceland, Siguroardottir (2010) compared two schools to determine the level of effect of each PLC element. She concluded, "Shared leadership

had the strongest relationship with the level of effectiveness" (p. 402). These findings indicate the importance of leadership in a PLC and their relationship with higher student achievement.

In the study by Saunders and colleagues (2009) the principals and collaborative-team leaders played a significant role in establishing and supporting the PLC and collaborative efforts of the school. In fact, in the experimental schools the principals and team leaders were critical in establishing and leading PLCs and collaborative teams effectively. The variable of interest in their study was to provide these leaders with professional development to ensure they successfully developed and lead PLCs and collaborative teams, and then see the relationship this had on student achievement. The ANOVA analysis they completed indicated that students in the nine Title I experimental schools performed significantly higher than those in the comparable Title I schools in the control group.

Two EP studies that measured leadership either found that there was no relationship between the *Leadership* elements or a negative relationship with student achievement (Lee & Smith, 1996; Visscher & Witziers, 2004). Lee and Smith (1996) measured aspects of participative leadership, which they entitled "teacher control" (p. 115). They found there were no direct effects with student achievement. They suggest that this finding indicates the indirect relationship leadership has on student achievement, and that it may be explained by other elements of professional community, such as cooperation among the teachers. In their study of secondary mathematics departments in the Netherlands, Visscher and Witziers (2004) found a negative relationship "between the extent to which department heads act as team leaders and the degree of consultation and cooperation within mathematics departments, on the one hand, and student achievement on the other" (pp. 795-796). They indicate that "school leaders consult very little with mathematics teachers" and "department heads are only considered to be educational

leaders of their departments to a small extent" (p. 794). This may account for the negative relationship between these leadership variables and student achievement found in their study. This is likely the case especially since the other EP studies, as well as the leadership literature, typically indicate a positive relationship with school leadership and effective PLCs, which increase instruction and student achievement.

Principal leadership literature. Principal leadership has been described as the most facilitating or impeding factor in establishing a PLC (Bryk, Camburn, & Louis, 1999; Louis et al., 2010a; Louis et al., 2010b; Scribner & Reyes, 1999). Louis and colleagues (2010b) reported a very strong finding for the relationship between school leadership and higher student achievement, "Leadership is second only to classroom instruction as an influence on student learning" (p. 9). Principal leadership impacts all facets of a PLC. A principal has many responsibilities to lead a school effectively, including the responsibilities to set the school's direction, develop people, and redesign the organization (Louis et al., 2010a; Louis et al., 2010b; Marzano et al., 2005).

Leithwood and colleagues (2004) indicate that even though there are many labels of principal leadership, "these labels primarily capture different stylistic or methodological approaches to accomplishing the same two essential objectives critical to any organization's effectiveness: helping the organization set a defensible set of directions and influencing members to move in those directions" (p. 6). In a PLC, taking a focused, intentional approach to support student learning through effective classroom instruction is one of the most important responsibilities a principal has (Bryk, 2010; Robinson, Lloyd, & Rowe, 2008; Supovitz, Sirinides, & May, 2010). The EP studies by Wiley (2001) and Louis and colleagues (2010a) both measured this type of leadership and confirmed the positive relationship it has directly with

higher student achievement. School leaders may influence instruction directly by giving individual teachers feedback on their practices or provide systems where others provide the support, which in turn improves student learning (Louis et al., 2010a; Louis et al., 2010b).

Research indicates that principal leadership has a strong relationship with improved student learning through its influence on classroom instruction (Hallinger, Bickman, & Davis, 1996; Louis et al., 2010b; Marzano, Waters, & McNulty, 2005; Robinson, Lloyd, & Rowe, 2008). There have been several meta-analyses completed on the relationship between principal leadership and student achievement (Marzano et al., 2005; Robinson, et al, 2008; Witziers et al., 2003). Robinson and colleagues (2008) completed a meta-analysis of 27 studies to determine the relationship between different leadership approaches and student achievement. They found, " the closer educational leaders get to the core business of teaching and learning, the more likely they are to have a positive impact on students' outcomes" (p. 664). Their findings contrast those found by Witziers and colleagues (2003), where they found either no effect or weak effects in their meta-analysis of studies on the relationship between principal leadership and student achievement. Robinson and colleagues describe how this contrast between their study and that completed by Witziers and colleagues (2003) "can be explained by the fact that, at that time, there were few if any studies of indirect effects of leadership on student outcomes" (p. 665). The findings from the meta-analysis completed by Marzano and colleagues (2005) were similar to that of Robinson and colleagues (2008) and affirmed a positive relationship between principal leadership and higher student achievement.

Louis and colleagues (2010b) recently completed a study across the United States in 180 elementary, middle, and high schools. They utilized data from many sources including,

"Survey data from a total of 8,391 teachers and 471 school administrators; interview data from 581 teachers and administrators, 304 district level informants, and 124 state personnel; and observational data from 312 classrooms" (p. 11). They found that principals at the elementary level that scored high on teacher surveys for the way they supported instruction "also led schools in which student achievement was relatively high" (p. 88). This was not the case in most secondary schools in their study, where there was either no relationship or a negative relationship between principal leadership and student achievement. In their study, the interview data indicated that most secondary school principals felt they had too many responsibilities and that supporting instruction seemed to "get placed on the back burner" (p. 88). For the most part, the research on leadership indicates that principal leadership is positively related with improved instruction and higher student achievement. Like the other PLC elements, we will measure principal leadership using the survey items from the LCCI (Table 6).

Participative leadership literature. Another important element in a PLC is to share the leadership with others in the school (Heck & Hallinger, 2010; Leithwood, Patten, & Jantzi, 2010; Louis et al., 2010b; Spillane, 2005). We refer to this element in our conceptual framework as *Participative Leadership.* The best way to lead a school as a principal is to inspire and encourage the active participation of teachers and other stakeholders to solve problems and create the best settings for instruction to

improve, ultimately, student learning. In *Participative Leadership* teachers, parents, and other stakeholders work along with the principal to ensure that all of the PLC elements are established and are being utilized to ensure instruction improves and students learn. The combined work of all involved in the school reinforces the concept that "many hands make light work." Much more

can be accomplished, changed, and improved when teachers, parents, and other stakeholders of the school are actively participating in school decisions.

Table 6.

Survey Items Measuring Principal Leadership that is Focused on Student Learning from the LCCI.

Item number	Measurement on the LCCI
37PL	My principal focuses on improving student learning.
38PL	My principal coaches my instructional team towards improving student learning.
39PL	My principal uses data to improve teaching and learning.
40PL	My principal has helped to create conditions that improve student learning.
41PL	My principal has helped to create conditions that promote teacher learning.

Participative Leadership has been described and defined in many different ways in the literature. These include participative leadership (Louis et al., 2010b; Somech, 2010); collective leadership (Leithwood & Mascall, 2008; Louis et al., 2010b); democratic leadership (Tannenbaum, Weschler, & Massarik, 1961); distributed leadership (Leithwood, Mascall, & Strauss, 2009; Spillane, 2005); collaborative leadership (Heck & Hallenger, 2010); dispersed leadership (Ray, Clegg, & Gordon, 2004); and shared leadership (Louis et al., 2010a; Pearce & Conger, 2003). While each of these lines of research describes sharing the leadership with others through different perspectives and formats, the foundational purpose of participative leadership is that a principal should include others in the decisions, problems, and overall leadership of the school.

The literature indicates that participative leadership is related to higher student achievement (Heck & Hallinger, 2010; Leithwood & Mascali, 2008; Louis et al., 2010b). In their four-year longitudinal study of 195 elementary schools, Heck and Hallinger (2010) found through a reciprocal-effects model that collaborative leadership and capacity building were initially related to initial achievement, and they "positively influenced school growth in math

achievement over time" (p. 245). Leithwood and Mascali (2008) completed a study on collective leadership in 90 elementary and secondary schools and found, "Collective leadership explained a significant proportion of variation in student achievement across schools. Higher-achieving schools awarded leadership influence to all school members and other stakeholders to a greater degree than that of lower-achieving schools" (p. 529). In the study by Louis and colleagues (2010b) they indicate, "collective leadership has a stronger influence on student achievement than individual leadership" (p. 19), which shows the importance of sharing the leadership with teachers and other participants in the school. They also found that "when principals and teachers share leadership, teachers' working relationships are stronger and student achievement is higher" (p. 37). The research on school leadership as well as the EP studies provides evidence that the *Leadership* elements are critical in establishing, guiding, and improving a PLC so instruction will improve and students will learn. Table 7 indicates the questions on the LCCI we will use to measure participative leadership.

Table 7.

Survey Items Measuring Participative Leadership that is Focused on Teaching and Learning from the LCCI.

Item number	Measurement on the LCCI
42PA	Teachers help make school-wide decisions that relate to teaching and learning.
43PA	School administrator(s) seek my input on issues that relate to teaching and learning.
44PA	Most decisions that relate to teaching and learning are made top-down.
45PA	In this school there are many layers of bureaucracy that inhibit teachers in making good decisions regarding teaching and learning.
46PA	Teachers collaboratively exercise leadership with the principal on issues that relate to improving teaching and learning.

Foundational Elements

A PLC is founded upon, guided, and influenced by the *Foundational* elements: The *Mission, Vision, Values, and Goals* of the school and an *Interdependent Culture Based on Trust*. The *Foundational* elements impact the effectiveness of each PLC element. When the mission and vision are clear and each faculty member is committed to truly live and achieve them, all of the other elements operate much more effectively, and have a greater impact on improving teaching and learning. It is also important for teachers and leaders to trust each other and work together interdependently.

Evidence for the foundational elements from the EP studies. The majority of the EP studies indicated a positive relationship between the *Foundational* elements and student achievement (Bolam et al., 2005; Gruenert, 2005; Langer, 2000; Lee & Smith, 1996; Lomos et al., 2011a; Louis & Marks, 1998; Louis et al., 2010a; Siguroardottir, 2010; Strahan, 2003; Wiley, 2001). In his study of a large district in Indiana, Gruenert (2005) found that unity of purpose, which focused specifically on the mission of the school, had the strongest correlation with higher student mathematics and language arts scores. He also found a correlation between trust and higher mathematics achievement, but not with language arts scores. In two qualitative EP studies completed by Langer (2000) and Strahan (2003), they indicated an overall feeling of trust in each of the case study schools, and also concluded that in successful schools teachers and administrators shared values and beliefs, which enhanced student achievement. It was clear that the schools studied worked well together because of the trust and unity they had from shared values and beliefs.

Other EP studies found a relationship between aspects of mission, vision, values, and goals and student achievement, but not with an interdependent culture based on trust. In

Siguroardottir's (2010) experimental case study she found that along with shared leadership, shared values and vision had the strongest relationship with the level of effectiveness in the schools. Three of the EP studies measured PLC with Louis and Kruse's (1995) model of professional community, measured shared values and beliefs within the PLC variable (Louis & Marks, 1998; Louis et al., 2010a; Wiley, 2001), and found a positive relationship with higher student achievement. Bolam and colleagues (2005) study in England measured shared values within one of the factors and found a positive relationship with student achievement. The EP studies provide evidence that there is a relationship between the *Foundational* elements, within the context of a PLC, and higher student achievement.

Mission, vision, values, and goals literature. The mission, vision, values, and goals set the foundation of a school's culture, and facilitate the effectiveness of all other elements of a PLC (Hallinger & Heck, 2002). DuFour and colleagues (2008) said, "The fundamental purpose of the school is to help all students learn the knowledge, skills, and dispositions most essential to their success….When educators embrace that idea and act upon it, all the other elements of PLCs begin to fall into place" (p. 118). As principals and teachers truly embrace the mission, vision, values, and goals they will collectively focus on improving teaching and student learning, which is the purpose of PLCs.

The element *Common Mission, Vision, Values and Goals* is one of the most widely agreed upon elements of a PLC (Senge, 1990; Kruse & Louis, 1995; Hord, 1997; DuFour & Eaker, 1998; Blankstein, 2004). A vision gives hope to a better future and inspires each member of a PLC to act together in order to transform the school into a better learning environment (DuFour et al., 2008; Hallinger & Heck, 2002). Hallinger and Heck (2002) described that, "A vision enables one to *see* facets of school life that may otherwise be unclear, raising their

importance above others" (p. 9-10). The vision of a PLC is a target constantly in the minds and hearts of each member of the school, and their daily actions reflect that vision.

The mission of a school exists when "the personal visions of a critical mass of people cohere in a common sense of purpose within a community" (Hallinger & Heck, 2002, p. 12). A mission helps a school determine why it exists and clarifies its essential purpose (DuFour et al., 2008), which allows teachers and administrators to focus on what matters most in a PLC, "releasing them from the unbounded responsibility of being everything to everybody" (Gruenert, 2005, p. 48). It also gives members of a PLC a source of identification and motivation (Hallinger & Heck, 2002). Student learning is the purpose for every decision made in a PLC and is reflected in the mission and vision of the school. Members of a PLC devote their best efforts to seeing that the mission is fulfilled. Teachers and administrators ensure that all that they do moves them closer to their ideal future of helping all students learn to their highest potential.

The goals of a PLC, as well as the values of its members, are important in the success of a PLC (Hallinger & Heck, 2002). The goals and values stem from the mission and vision of the school. Hallinger and Heck (2002) describe, "Unlike a vision or mission, the power of a goal or management objective lies not in its inspirational power but in its ability to focus the attention of people on a limited frame of activity" (p. 18). The goals and values in the school put the mission and vision into action, which bring about the power and results hoped for: enhanced instruction and higher student achievement.

There has been considerable research done on mission, vision, values, and goals. The literature review completed by Hallinger and Heck (2002) cites a considerable body of literature since the 1980's where mission, vision, values, and goals were utilized in effective program development and academic improvement. One study in particular by Hallinger and colleagues

(1996) found a relationship between a clear school mission and higher reading achievement at the elementary level. In this study, we will use the LCCI to measure Mission, Vision, Values, and Goals within a PLC (See table 8).

Interdependent culture based on trust literature. Trust is also essential in a PLC so teachers, teams, and the school can effectively work together interdependently. Trust has been described as the glue (Morgan & Hunt, 1994) and lubricant (Creed and Miles, 1996) that helps an organization to function effectively. Trust has been described as the strongest facilitator of a PLC, due to its impact on all elements and practices in the PLC (Bryk, Camburn, & Louis, 1999). In a longitudinal study, Bryk and Schneider (2002) found relational trust to be the highest predictor for school productivity. They found that schools with higher levels of trust were three times as likely to have improved in math, science and reading. In contrast, those schools that showed low levels of relational trust had only a one-in-seven chance of improving student achievement. Similarly, Hoy and Tschannen-Moran (1999) found trust to be associated with higher levels of performance. Trust is an important element as teachers work interdependently in a PLC.

Relational trust within a PLC is essential because all elements of a PLC build off of and depend upon that trust. It builds the foundation for collaborative teaming, particularly as teachers open their doors for other teachers to observe their instructional practices. Teachers need trust to be willing to share data of their teaching and students with their team and school to assist in making data based decisions. In their study of 248 elementary schools in Chicago Bryk and colleagues (1999) found, “By far, the strongest facilitator of professional community is social trust among faculty members. When teachers trust and respect each other, a powerful social

resource is available for supporting the collaboration, reflective dialogue, and deprivatization characteristics of professional community" (p. 767).

Table 8.

Survey Items Measuring Common Mission, Vision, Values, and Goals that are Focused on Teaching and Learning from the LCCI.

Item number	Measurement on the LCCI
1CM	The primary purpose of our school is to help all children learn at high levels.
2CM	We are trying to create a school culture in which more students would achieve at high levels.
3CM	I am aligning my efforts with a primary purpose of the school which is to help all children learn at high levels.
4CM	Our school-wide goals and objectives guide teachers' work to help more students achieve at high levels.

The EP studies as well as the literature on the *Foundational* elements indicate the importance of the mission, vision, value, and goals of a PLC and an interdependent culture based on trust. When the *Foundational* elements are firmly established, they guide all of the other PLC elements to ensure instruction improves and students learn. Table 9 shows the survey items from the LCCI that we will use to measure interdependent culture based on trust.

Conclusion

With the high accountability demands placed upon schools today, PLCs have some of the greatest potential to improve teaching and learning to meet the needs of all students to achieve academically. The research for each individual element of a PLC gives reason for hope that PLCs are one of the most effective efforts in improving instruction and student learning. Despite this hope there is only a limited amount of empirical evidence from the EP studies to indicate that PLCs do increase students' academic achievement. There is a need for more research to show that PLCs are related to higher student achievement. Although the EP studies provide some

sound evidence, PLCs have not yet been confirmed theory that practitioners and researchers readily accept. More empirical evidence is needed to indicate a clearer positive relationship between PLCs and higher student achievement so more quality research will be provided to ensure PLCs are as effective as possible, so more schools will utilize their elements.

Table 9.

Survey Items Measuring Interdependent Culture Based on Trust from the LCCI.

Item number	Measurement on the LCCI
5IC	I share my knowledge and expertise with other teachers to solve problems of teaching and learning.
6IC	I seek out other teachers' expertise to help me solve problems of teaching and learning.
7IC	In addition to formal team meetings, teachers in this school spontaneously collaborate to solve problems of teaching and learning.
8IC	The trust I feel among teachers facilitates open decision making and problem solving.
9IC	I feel safe to take the risk of using innovative instructional methods.
10IC	I do not feel safe to express my opinions when I am in the minority.

APPENDIX B: METHODS

This is a study of schools as PLCs, defined by eight elements, and their relationship with a schools' effectiveness, are measured through student achievement. We undertake this study in response to the need for more empirical evidence showing the relationship between PLCs and student achievement. With a clear definition and conceptual framework of a PLC; a validated survey that measures each of its elements; and by utilizing multiple sources of student achievement data, this study has potential to add empirical evidence to the literature.

Sample for This Study

The sample for this study is from a large public school district in Utah. The school district, consisting of 37 schools, is one of the fastest growing in the state. All 26 elementary schools, five of the six junior high schools, and three of the five high schools participated in this study. The majority of these schools served students in suburban cities with a few schools serving large, rural areas in the mountains.

Description of schools in this study. During the 2009-2010 school year in which this study took place, of the 26 elementary schools six smaller with an enrollment of less than 500 students, with the smallest having just fewer than 400 students enrolled. Eleven schools had between 500 and 700 students enrolled; and nine were large schools enrolling more than 700 students, with the highest having nearly 900 students enrolled. The secondary schools also ranged in the number of students enrolled. The junior high school enrollment ranged from about 800 to 1,100 students. Two of the high schools were rather large with around 1,500 students enrolled; the other high school had an enrollment of just fewer than 1,100 students. All schools with fewer students enrolled were in the more rural areas in the district.

The majority of students in the district are Caucasian, with Hispanics being the largest minority, consisting of nine percent of the overall population, with three percent from other minorities. At eight of the elementary schools, less than ten percent of students were minority students; at 14 schools minority students consisted of ten to 20 percent of the student population; and four schools enrolled over 20 percent minority students, with the highest minority percentage being 27 percent of the student population. In the secondary schools, enrollment of minority students ranged from eight to 16 percent.

In the district about 40 percent of the population were economically disadvantaged, measured by the percentage of students enrolled for free and reduced lunch. In six of the elementary schools, less than a third of students were economically disadvantaged; 12 schools had between 33 and 50 percent; and eight schools had more than half of their students enrolled for free and reduced lunch, with the highest being 64 percent. There were four secondary schools that had around a third of their students that were economically disadvantaged. The other four were over 40 percent of students enrolled for free and reduced lunch, with 47 percent as the highest.

PLC practices in the district. The district in this study has been developing and cultivating PLCs for the past decade. Around six years ago, the district made a stronger commitment to establishing PLCs by dedicating an hour a week for teams of teachers to meet and collaborate together. During the 2009-2010 school year, teams of teachers continued to meet together weekly to improve teaching and learning for at least an hour on Wednesdays when students were excused early to provide this time. The way teams of teachers were organized for collaboration differed between elementary and secondary schools. In the elementary schools, teams of teachers were organized by grade level. In the secondary schools, collaborative teams

were organized by subject matter. About once a month, many of the teachers in secondary schools met with teachers from other schools teaching the same content matter (i.e. biology teachers from several high schools), instead of with their regular collaborative team, but the majority of the time was spent collaborating with the team at their home school.

Data Collection and Sources

The area of interest for this study is the relationship PLCs have with student learning, and whether stronger PLCs are associated with higher levels of student achievement. To measure this relationship the LCCI survey was administered and multiple sources of student achievement data were gathered. The student achievement measures as well as the LCCI were gathered roughly at the same time during the spring of 2010. Similar to the way state criterion-referenced tests (CRT) are a snapshot of student achievement, which attempts to measure a years' worth of achievement for a student, the LCCI survey data also attempts to measure a years' worth of accumulated work completed in a PLC during the 2009-2010 school year.

The LCCI questionnaire. For this study we used an existing data set from research done by Williams and colleagues (2010). In the spring of 2010, they administered the Learning Community Culture Indicator (LCCI) to teachers and administrators across the district to measure the degree of PLC to which schools developed eight elements that are found in cultures of high functioning PLCs in each of the schools and collaborative teams of teachers. A research team visited each school and invited teachers and administrators to complete the LCCI.

The LCCI is structured around eight sections, each measuring a different PLC element from the definition by Williams and colleagues (2007). There were between four to seven items for each PLC element. Each question on the LCCI offers a continuum of responses from 0 (disagree strongly) to 10 (agree strongly). The only exception is a question about how frequently

collaborative teams meet together to improve teaching and learning. Respondents were to mark one of the following to answer this question: *more than once a week, at least weekly, at least every other week, at least monthly, about every 3 months*, and *never*. The survey ends with ten demographic questions specifying the school and collaborative team in which teachers participated. Teachers were provided time to complete the survey during their collaboration time resulting in a high response rate of over 82 percent district wide. A total of 920 teachers and 53 principals completed the LCCI survey. Our conceptual framework is based on the definition by Williams and colleagues (2007), as well as the elements measured in the LCCI.

In our analysis we will include those surveys from teachers that align with the collaborative teams. The collaborative teams are the lowest level of analysis of PLC we will have in our study, since the LCCI was anonymous and there is no way to link student achievement data to the classroom teacher. However, student achievement data can be linked to the collaborative team responsible for them. The surveys we include from secondary schools are from the language arts, mathematics, and science collaborative teams, since our outcome variables only measure these three subjects. Also, for the purposes of our analyses we will only focus on the regular collaborative teams at each of the teachers' home school, since the student achievement outcome data aligns with these teams. All other surveys from administrators, other staff, and teachers teaching different subjects were excluded, as well as the survey responses from kindergarten teachers since we only have outcome variables measuring student achievement from first to sixth grade in elementary schools. After omitting the surveys from both elementary and secondary schools that were not included in one of the nine collaborative teams mentioned above, we had 557 surveys, which we will use in our analysis.

The LCCI was structurally validated through exploratory and confirmatory factor analyses, and reliability measures showed internal consistency among the responses to survey items (For a thorough description of this process refer to Stewart [2009]). At the end of this process Stewart (2009) concluded: "The LCCI produced substantial evidence that this survey was a valid and reliable instrument in measuring levels of PLC implementation" (p. iii).

Student achievement data. The student achievement data we will use in our analysis will be Utah's end of year, criterion-referenced tests (CRT) to indicate the relationship between PLCs, their eight elements, and student achievement. In the spring of 2010, the CRTs assessed the knowledge of over 20,000 students on the Utah's Core Curriculum in language arts, mathematics, and science. The language arts CRTs assessed students in grades two to eleven. The mathematics CRTs assessed students in grades two to twelve. After the seventh grade mathematics CRT, the CRTs measured the knowledge of students in content-specific mathematics classes, namely, pre-algebra, geometry, algebra I, and algebra II. The science CRTs assessed students in grades four to twelve, and also assessed students in content-specific classes after the eighth grade in earth systems, biology, chemistry, and physics. We also have access to several other sources of student achievement data that is archived in the district's system, and will use this data to support and strengthen our findings from the analysis of the CRT. We will report those findings from the other student achievement data that are applicable. All sources of student achievement data will be aggregated to the collaborative team level, since our explanatory variables are at the team level.

There are three sources of student scores available from the CRTs as outcome variables at the individual student level: 1) scaled scores of student achievement; 2) Utah Performance Assessment Systems for Students (U-PASS) proficiency scores of student achievement; 3) and

the table-value scores, which indicate the growth or digression students have had from year to year on the CRTs. We will utilize the scaled scores and the table-value scores in our analysis of the relationship between the results of the LCCI and the CRTs. We will not use the proficiency scores in our analysis since they are categorical and they do not give as clear of a picture of student achievement as the other two measures do. Also, the proficiency scores are used to calculate the table-value scores, which not only show the achievement of students, but also how they have progressed from one year to the next.

The scaled scores ranged from 100 to 200 for each CRT, with the proficiency cut set at 160. We will use an example to bring meaning to these scores. Hypothetically, if one of the CRTs had 60 items and a student needed at least 27 correct to meet the standard, then 27 would be set as the cut score, and would become the minimum passing scaled score of 160. In this example, a raw score of 23 would result in a scaled score of 145, which would make a raw score of 31 result in a scaled score of 175.

The table-value scores range from 0 to 400 in elementary and junior high schools, and 0 to 375 in high schools. The U-PASS proficiency scores were used to determine proficiency levels of students on the CRT with the following levels of mastery: 4=substantial, 3=sufficient, 2b and 2a =partial, 1b and 1a=minimal. Scores of three and four are considered proficient. These proficiency levels were used to determine the table-value scores. Table 3 shows the table used by the Utah State of Education to determine table-value scores in elementary and middle schools, and table 4 shows the table they use to determine table-value scores in high schools. These scores were determined by the progress or digression a student had from one year to the next on a particular CRT. The higher the score, the more that student progressed. For example, if an elementary student scored a 2a on the 2009 language arts CRT, and improved to a 2b in 2010, his

value-table score would be 225. The table-value scores are somewhat similar to value added scores, which have been shown to effective ways to account for students' prior achievement (Glazerman et al., 2010), and have been used in several EP studies (Bolam et al., 2005; Lee & Smith, 1996; Siguroardottir, 2010).

We will also utilize a district-wide assessment of first graders in our analysis, since students in first grade were not assessed with a CRT. The assessment was administered to assess first graders' language arts, mathematics, and writing ability. First grade teachers administered the assessments in their own classroom in the spring of 2010. Students' scores ranged from 0 to 30 on the language arts section, 0 to 27 on the mathematics section, and 0 to 40 on the writing section.

In addition to the CRTs and first grade benchmark, we may use other assessments to determine the relationship between the elements of PLCs and student achievement. The district only assessed student achievement in mathematics and science through the CRTs. In language arts, they assessed students' reading and writing abilities with multiple tests. We will use these sources to triangulate the data, to better determine the true association between PLCs and student achievement in language arts.

In the elementary schools, a district benchmark assessment was used to assess students' reading abilities. This assessment was completed in the spring of 2010 in each of the elementary schools. Students' core teacher completed the reading assessment individually with each of his/her students to determine their comprehension and reading abilities. Scores ranged from one to 22 depending on the difficulty of the book and the students' ability to read it.

Table 3.

Elementary and Junior High Value Table

Year 1 level	Year 2					
	1a	1b	2a	2b	3	4
1a	0	200	350	350	400	400
1b	0	125	225	350	375	400
2a	0	50	150	225	350	350
2b	0	0	75	175	275	325
3	0	0	0	100	200	275
4	0	0	0	0	125	225

Table 4.

High School Value Table

Year 1 level	Year 2					
	1a	1b	2a	2b	3	4
1a	0	200	250	300	350	375
1b	0	125	200	300	350	350
2a	0	50	150	175	325	325
2b	0	0	75	175	300	325
3	0	0	0	100	200	300
4	0	0	0	0	125	225

In the junior high schools, Degrees of Reading Power (DRP), a national criterion-referenced assessment, was administered to measure students' reading abilities. All junior high students were assessed in the spring of 2010. DRP consists of nonfiction passages followed by questions to determine whether the student understood the passage. Key words were omitted from the passage and students were asked to select the best response from the multiple-choice options to correctly complete the passage. The reading ability of students was determined by a score ranging from one to nine, with a score of five indicating the students' ability to read at grade level. The higher the score indicated, the better the student could read. Junior high students, as well as high school students, were also assessed in the fall of 2009, but because these

scores were from the beginning of the school year, they did not reflect the efforts of the language arts collaborative teams, therefore, they will not be used in this study.

The Direct Writing Assessment (DWA) was administered in February and March of 2010 to students in the 5th and 8th grades to measure their writing abilities. The computer-based DWA assessed students' ability to write according to the six traits of writing; namely, ideas and content, organization, voice, word choice, sentence fluency, and conventions. Students were given a score from 1 to 5 for each section resulting in a total of 30 possible points.

Analysis of Data

As student achievement is measured, it is important to account for variability between student differences. In this study, we will control for socio-economic status (SES), measured by whether the student received free or reduced price lunch; student ethnicity; student gender; and whether the student received special education services due to the impact each of these variables has on student achievement (Darling-Hammond, 2000). We will be able to account for these control variables for all of the assessments, except the first grade benchmark, since the district did not have this information available for this assessment. Because PLCs have been shown to have a stronger association with higher student achievement in elementary schools, as shown in several EP studies (Gruenert, 2005; Louis et al., 2010a; Louis & Marks, 1998), we will stratify the data to analyze the difference between elementary and secondary schools.

In our data analysis we will use hierarchical linear modeling (HLM; Raudenbush & Bryk, 2002; Searle, Casella, & McCulloch, 1992) and will aggregate the data to the collaborative team level. Since the schools in our study vary considerably because of the different grade levels served in each school (elementary, junior high, and high schools) we will use an analysis of

variance (ANOVA) to measure the observed differences in grade level as well as between the collaborative teams.

Our analysis will be guided by the research done in the field and will focus on those areas that will likely show some kind of relationship, instead of a haphazard approach. To answer our research questions, we will first account for students' backgrounds. Then, we will look at each element of a PLC and the statistical relationship it has with each source of student achievement data. Due to the close relationship professional development and collaborative teaming have with each other, as well as the relationship between the *Leadership* elements, we will analyze them together to determine their relationship with student achievement. We will analyze the differences between collaborative teams throughout the district and the relationship they have with student achievement.

Conclusion

This study has great potential to add much needed empirical evidence to the PLC literature. With a clear definition and conceptual framework grounded in theory and experience; a validated survey to measure each individual element of a PLC; and multiple sources of assessments and variables within those tests to analyze PLCs, the results of this study should be valid and reliable.

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