International Journal of Learning, Teaching and Educational Research
Vol. 15, No. 11, pp. 111-127, October 2016

How Employing DuFour's Professional Learning Community Guidelines Impacted a Mathematics Professional Learning Community

Janet M. Herrelko, Ed.D., NBCT
University of Dayton
Dayton, Ohio, USA

Abstract. This case study followed the work of 12 urban elementary school teachers as they created a professional learning community (PLC) focused on improving the mathematics skills of their students. DuFour's (2004) characteristics of PLCs served as the original guidelines for the group and functioned as an observation tool. DuFour's "Three Big Ideas" for organizing a PLC included 1) ensuring that students learn, 2) creating a culture of collaboration, and 3) analyzing the data results to make plans for the future. This study questioned if these Ideas were consistently employed in order to produce positive changes to their practice. Two conclusions were reached: the more frequently the PLC adhered to DuFour's Big Ideas, the more productive their work. Second, four characteristics emerged that the members exhibited: dedication to students; perseverance; analysis skills; and camaraderie that enabled the group to work and make positive changes to their individual practices.

Keywords: Professional Learning Communities; Mathematics Education; Standards; Elementary School

Introduction

For more than thirty years, research in the United States (U.S.) examined how to improve mathematics curricula to help U.S. students reach higher levels of achievement on international testing such as the Third International Mathematics and Science Study (TIMSS) (National Center for Educational Statistics, 2016) and the Programme for International Student Assessment (PISA) (PISA, 2015). Studies by Ball, Hill, and Bass (2005) and Ma (1999) explained that curricula changes were not enough, the teachers' knowledge of mathematics owned by teachers was fundamental in order to improve the instructional practices (Hill & Ball, 2004). While many educational components contribute to student learning, the primary delivery of learning content depended on the quality of the teacher. For all teachers to keep current in the ever shifting world

of educational theory and research, a dedication to continuous learning must occur (Hord, 2009).

Mathematics teachers who seek to improve their content and pedagogical knowledge search for professional development opportunities that will increase their knowledge of mathematics and their pedagogical skills in order to help their students learn (Hill & Ball, 2004). Finding available opportunities for such development is not simple in this day of constrained school budgets. Sparks and Hirsch (2000) noted that 10% of a school budget should be devoted to teacher professional development. However, the reality as Keller (2002) reported, is that the actual spending is between 1.5% and 4% of that budget. Finding low cost professional development that can address specific needs of mathematics teachers can be accomplished with the creation of a school-based professional learning community (PLC).

PLCs were originally created to keep employees in the business domain current and aware of trends, innovations, and new approaches to a specific field of work. Educational innovators saw this approach as a continuous improvement model for schools in which increasing student learning would be the overarching objective (DuFour, 2004).

This study examined the organization of a group of urban elementary teachers who formed a mathematics PLC. The teachers used the PLC organizing principles of DuFour (2004) to set goals and measure outcomes because these principles focused on the use of data to track changes in student learning. The teachers focused on a different pedagogical problem and its associated mathematics each year. They disbanded after the fourth year. What were the organizational elements that contributed to the improvements to student learning? Did using DuFour's (2004) generic PLC formatting help the teachers achieve their goals? Answers to these questions would help other mathematics teachers who wish to create their own PLCs avoid planning mistakes that are unproductive. The researcher used a case study format to examine how DuFour's principles advanced or hindered the goals of the mathematics PLC.

An evolution of PLCs for educational settings began as researchers observed what made teachers effective in their classrooms. When Rosenholtz (1989) examined teacher quality, he learned that if teachers were supported by their schools regarding their continuous learning and improvement of classroom practices, the teachers were more committed to their schools' improvement. Fullan (1991) analyzed the teacher workplace and recommended that teachers should receive daily activities that included innovations and improvements to the educational program. In 2012, Hargreaves and Fullan added the importance of including data collections and analysis of teachers' and schools' performances when introducing program changes as a means of determining success or failure of those changes. Darling-Hammond (1996) observed a change in teachers' attitudes toward work and teaching when schools provided scheduled time for the teachers to plan and work together. Hord (1997) identified the power of PLCs for putting into action robust programs and procedures in schools.

Today, many groups of teachers who meet for any purpose consider themselves to be a PLC (DuFour, 2004). To ensure that PLCs can be productive, DuFour (2004) put forth a set of three Big Ideas and six Starting Elements as guides to focus the organization and the work of a PLC. These steps help

organize a group of teachers by identifying a unifying objective, determining the means to achieve the objective, and deciding how to assess the any change in the productivity of the students. This study examines how adhering to DuFour's elements or shifts away impact the objective of increasing student learning.

DuFour's Big Ideas for PLCs

DuFour researched schools and defined a PLC as a model professional development program that focused on the central mission of formal education: not to guarantee that students are taught but to guarantee that they learn. This is a basic educational shift from educators teaching to student learning (DuFour, 2004, 1). Teaching would no longer be putting checks next to content taught, but producing evidence that students had learned the content.

DuFour's research narrowed the core principles necessary for successful PLCs to three main concepts. Concept one moves the focus of the educational process from the teachers to the students: "Big Idea #1: Ensuring That Students Learn." (DuFour, 2004, 6). There is the assumption that students are all taught, but DuFour demands accountability that students learned specific content. Teachers needed to respond to those students who have not learned the content. Using a systematic process, the teachers need to determine how to help students having difficulty learning the content under this main principle.

"Big Idea #2: A Culture of Collaboration" (DuFour 2004, 7) discussed the need for teachers to use a school-wide systemic process to analyze and enrich the practices used in the schools. Thorough examinations of the curriculum would be the start of the work of a PLC. After gathering facts, the PLC selected a common goal for the work that would benefit all students.

And "Big Idea #3: A Focus on Results" (DuFour 2004, 9) was needed in order to determine the successfulness of a PLC and how it should move forward. The questions pertaining to Idea #3 asked: What were the students learning results? Was there an improvement in student achievement? Formative assessment strategies were suggested by DuFour as means to collect data to compare student performance on identified skill sets. From these data analyzes, the PLC can identify the areas of success and those that are concerns.

DuFour's Starting Elements

DuFour's next step had the PLC examine the school academic environment seeking answers to what DuFour identified as four starting elements. First, the PLC needed to state a research question that identified the distinctive elements of schools and practices that are used to help all students achieve high levels of success. Second, the PLC needed to create an application question related to the research question: How can we use the elements and practices we note in our research in our schools? Third, the PLC should add a commitment question: What responsibilities must the members pledge to do in order to move the school to that new vision? The last question the PLC should ask is how to measure student change: How will we monitor student success? (Dufour, 2004, 2). These step by step questions were used by the PLC in this study to guide their work during their first year. They determined that their work would center on having students use advanced organizers to analyze mathematics word problems. They would evaluate their processes with the implementation of several formative assessment techniques that supported

students' growth and the students' ability to solve mathematics problems. They measured their progress by the improvements in their students' end of year mathematics scores on standardized testing that achieved higher mathematics scores than the previous year. This was work done prior to the researcher joining the PLC.

PLC Issues. Organizational issues plague PLCs. Meeting time being at the top of the list. Watts and Castle (1993) identified time as the most significant problem for teachers who wish to work collaboratively. Finding time within the school day schedule is rare. Teachers who are part of a PLC usually create their own meeting time that comes out of their time after school. Louis and Kruse (1995) identified physical factors that helped PLCs be successful. These included: common meeting time, the size of a school being small, physical proximity of the teachers to one another, interdependence of teaching roles, school autonomy, and the empowerment of the teachers.

When the teachers were instructed that they would implement the Common Core State Standards in Mathematics (CCSSM)(National Governors' Association and the Council of Chief State School Officers, 2012), the group took on the objective of aligning their old standards with the new CCSSM. And as other groups of teachers started in their schools calling themselves PLCs, they were asked to retitle their group to be the Mathematics PLC to be specifically identified as working on objectives dealing with school mathematics improvements.

Mathematics Professional Learning Communities. Mathematics PLCs (MPLCs) have been encouraged by the mathematics professional organizations such as the National Council of Teachers of Mathematics (NCTM) (NCTM, 2014) and the National Council of Supervisors of Mathematics. A series of books have been published that detail how MPLCs can be organized and work. The series: *Common Core Mathematics in a PLC at Work* (Larson, Fennell, Adams, Dixon, Kobett, and Wray, 2012) addresses specific grade levels and links the work of the MPLC not only to the CCSS Mathematics standards but also to the Mathematical Practices.

MPLCs can be found all over the United States and the world. From Maine to Indiana, to California, MPLCs have web sites that identify what they are doing to improve student learning. New Zealand has MPLCs throughout the country (New Zealand Ministry of Education, 2010). MPLCs are a means to have teachers gather together to share the work and highly successful instructional practices that help students learn rigorous mathematical content.

History of the Urban, Elementary Mathematics PLC in this study. Four years ago, a group of 12 urban elementary level teachers attended professional development sessions that detailed how a PLC functioned as defined by DuFour's format. The teachers organized their group using DuFour's (2004) three big ideas and organizing principles.

These urban elementary teachers decided to meet monthly. They all taught mathematics, but were from 4 different elementary schools and the grades they taught were from kindergarten through grade 8. During the first year of the PLC existence, they renamed themselves the Mathematics PLC

(MPLC). Using the four DuFour's starting elements, they examined the distinctive elements of their schools that helped students achieve. The PLC members' devotion to their students was the best distinctive element. The research question they formed asked: what is an effective means to raise student test scores in mathematics? The PLC members determined that they would use advanced organizers to help students understand mathematical problems. To measure the success of their research, they would examine the student scores on standardized testing administered at the end of the school year. They added frequent formative assessments to track the details of the processes they were using to verify if their students were able to solve more of the extended response style questions. The end of the school year testing produced encouraging results that noted a significant rise in students' mathematics scores. The researcher was not part of this MPLC at the time and had to take the verbal reports of the members regarding this rise in mathematics scores.

In the second year, the teachers grappled with implementation of the CCSSM because the area school administration required the implementation of the CCSSM for the following academic year. This was the year that the researcher began membership in the group.

The third year of MPLC, the teachers worked on coordinating how to help parents understand the mathematics being learned under the CCSSM. To reach a large group of parents, they studied Family Math Nights for each school represented in the MPLC.

Common Core State Standards for Mathematics

To provide some background information regarding the state of mathematical standards in the United States, the CCSSM were a response by the National Governors Association (NGA) and the Council of Chief State School Officers (CCSSO) to the issues facing parents and educators as to what students needed to know and be able to do in order to prepare for college and the workforce (NGA and CCSSO, 2012). Model curricula from high achieving states and international countries were framed into benchmarks for all United States students to know without regard to where they lived. The framework informed teachers as to the depth of knowledge that mathematics instruction needed to delve during each academic year for each grade level. The major change from prior sets of state standards was having these new standards stated as progressions of learning rather than checklists of learning content. These progressions presuppose that each teacher has a depth of mathematical understanding.

When decisions to adopt new standards are made at the state administration, district, or school level, the lion's share of the implementation work falls to the teachers. Often the teachers are asked to implement new programs without help identifying changes between the existing and new curricula nor offering professional development related to those standards and instructional techniques for teaching the new standards. This is a major problem in the educational. More professional development would help solve this dilemma; also helpful may be the use of a PLC which can foster dynamic collaboration between educators. A PLC can be a flexible structure for teacher collaboration with autonomy and as an agency to decide what needs the most attention in a given school.

Theoretical Framework

This research used the theoretical framework created by DuFour (2004) that describes the needed elements (Big Ideas) to create a successful PLC. He described those elements as three Big Ideas: 1) focus on student learning; 2) teacher collaboration; 3) working from results as the framework to examine the work of a PLC. Guiding the researcher's perspective was the organizational concept that in order to sustain a community of learners such as the MPLC, specific guiding principles must be in place. Thus, the question arose how often must each of these three Big Ideas be used in meetings by a PLC to ensure that their work is successful? DuFour did not specify how strictly PLC members must adhere to the three Big Ideas. This researcher observed and took notes at the meetings of a MPLC to determine when each of the three Big Ideas was used.

Method

The goal of this descriptive case study was to observe how often these urban, elementary teachers implemented DuFour's three Big Ideas. The research question addressed was: How did the frequency of the MPLC's implementation of DuFour's (2004) three Big Ideas impact the MPLC's goals to improve students' mathematical learning?

Participants

Twelve elementary school teachers who taught mathematics to grades kindergarten through to grade 8 took part in the MPLC. Some taught mathematics, science and religion, others were in self-contained classrooms. All taught in urban schools in the western part of a Midwestern U.S. state. The socioeconomic status of the participating schools is lower middle class to lower class (Greatschools.org, 2015). The Ohio Department of Education (ODE) reported that the poverty rates for the schools included in this study ranged from 19.5% to 100% (ODE, 2014). Table 1 provides the details regarding the size and populations of the schools. Table 2 notes information about the teachers' backgrounds.

Table 1
Demographics of Participating Schools.

School	Grade	No. Classroom Teachers	No. Students	Single Subject /Multiple Subjects
A	K-9	11	215	Multiple Subj
B	PK-8	16	353	Multiple Subj
C	K-8	22	588	Multiple Subj
D	K-8	10	207	Multiple Subj

Note. PK = Pre-kindergarten, K= Kindergarten, Multiple Subj = mathematics, science, plus other content areas.

Table 2
Sample Demographics of the Participating Teachers.

Teacher	# Years Teaching	Highest Degree	Grades taught	*Prof Devel Sessions last 2 yrs
A	33	BS	PK, 2, 3, 5, 7, 8	6
B	10	BS	4, 5	3
C	14	BS	6, 7, 8	20
D	1	BS	6, 7, 8	1
E	5	BS	6, 7, 8	9

Note. BS =Bachelor Degree; PK = Pre-kindergarten; * Professional Development Sessions attended in the last two years.

Data Collection

Since the researcher was a member of the MPLC, the data collection techniques used in this study were participant observations, field notes taken at the meetings, and reflections after the meetings. The field notes included identifying when the elements of DuFour's (2004) three PLC Big Ideas were used during the meetings, to make group decisions, and action items for next steps.

Data Analysis

Analysis for themes was conducted using card-sorting techniques from the field notes and reflections. The analysis was conducted using DuFour's PLC three Big Ideas as categories at the start. Recording field notes included the date of the meeting, the primary topics, the conclusions or outcomes that the members determined to complete prior to the next meeting, and which of DuFour's three Big Ideas were addressed during the meeting. The researcher included comments on how the teachers interacted within the MPLC. Sensitizing concepts have been regarded by researchers as being useful for providing a focus to guide qualitative methods (Blumer 1979; Denzin 1989; Patton, 1990). In this study, the researcher's knowledge of the mathematical content, pedagogical methods, strategies, CCSSM, and of mathematics education research served as sensitizing concepts and influenced the data analysis.

Verification of the researcher's content and pedagogical knowledge was evidenced by certification as a National Board Certified Teacher in Adolescence to Young Adult Mathematics in 1998 and renewed in 2008. There were two components to this certification that verified the researcher as a mathematician and an accomplished educator. The first component was an eight-hour mathematics examination consisting of five mathematics content areas. It was completed with passing evaluations marks. The second component was a portfolio of assessments, lesson plans, community involvement, and professional development that was evaluated for pedagogical content knowledge. This component was valued as passing as well. Triangulation verification of the researcher's field notes was done by the PLC's secretary. She took attendance and notes covering the meeting discussions and actions. After the meetings she would send the notes to the MPLC members. These notes served to verify the researcher's field note observations.

Results

MPLC Meetings

Over the course of 24 months, the MPLC met to discuss the implementation of the CCSSM in academic year 2012-2013 and how to conduct successful Family Math Nights in academic year 2013-2014. Details of the groups' meetings are summarized in Figures 1, 2, 3. The figures include which of the three Big Ideas from DuFour's work were modeled during the meetings and associated work for the month.

May 2012 - December 2012, MPLC Meetings and Topics

Meeting Date	Topics	Outcomes	DuFour Big Ideas
May 8, 2012	Last meeting of the year, goals for '12-13.	Short cycle assessment work and using the new standards.	1
Sept 11, 2012	-Do a gap analysis study of the new CCSSM. -Create a pacing guide based on that analysis. -Create short cycles	Learning the issues facing the members dealing with the new mathematics standards versus what was taught and learned by students and the textbooks being used.	1, 2, 3
Oct 16, 2012	Comparing the new standards to the former standards	Focusing on one grade level at a time was best for the issues facing the group. Decide the topics to be mastered at what grade level.	1, 2, 3
Nov 13, 2012	Comparing the new standards to the former standards	Fractions at all grade levels were discussed and decided when to cover elements not included in the upper grades.	1, 2
Dec 11, 2012	Comparing the new standards to the former standards Seeking information from public schools dealing with adopting the CCSSM	Great frustration that there are no guidelines for students who are caught in the gaps between what is taught in the new standards and what has been taught in the old standards.	1, 2, 3

Figure 1. **DuFour coding is #1 represents the focus on student learning, #2 represents teacher collaboration, and #3 represents the focus on results**

January 2013 – December 2013 MPLC Meetings and Topics			
Meeting Date	**Topics**	**Outcomes**	**DuFour Big Ideas**
Jan 8, 2013	Using "I can" statements to learn where students are in their grasp of mathematics content	Chose to focus on what students can do in their math classes, what they believe they have mastered using "I can" statements Teachers were uplifted as to what students did master. How to assess the statements will be discussed next meeting.	1, 2
Feb 12, 2013	Assessing "I can" student statements	Assessment needs to be grade level specific.	1, 3
May 14, 2013	Wrap up work of the year and setting goals for next year	Discussion of what was accomplished this year. Issues with the new standards remain problematic.	2, 3
Sept 10, 2013	Review work of last year Determine focus for this year	Introduction of new members, general discussion of what is being used this year that was developed last year. Shared ideas for the focus for the year.	2
Oct 8, 2013	Determine a focus for the year	Lots of discussion. How to help parents become aware of the change in mathematics standards was agreed upon.	1, 2
Nov 12, 2013	Parent involvement	How to plan events to help parents become aware of the new standards and how to help their student. Family Math nights were outlined.	1, 2
Dec 10, 2013	Discussion of Family Math Night	Snowed out. Schools all cancelled.	
Figure 2.	**DuFour coding is #1 represents the focus on student learning, #2 represents teacher collaboration, and #3 represents the focus on results**		

January 2014 – May 2014 MPLC Meetings and Topics			
Meeting Date	**Topics**	**Outcomes**	**DuFour Big Ideas**
Jan 14, 2014	Discussion of Family Math Night Plans	Each teacher shared what they have done in the past: things to avoid and those that worked. I suggested making a collection of the activities so each member would have a resource book.	2
Feb 11, 2014	Discussion of activities for Family Math Nights	Teachers brought copies and shared their activities for Math nights. Shared problems of attendance and activities that were too confusing.	2
Mar 12, 2014	Summaries of Math night events	Lots of stories of how to involve parents, how to keep students engaged in the events, time savers in planning. I encouraged the group to present at the next Education Summit held in July. Planning was discussed.	2, 3
Apr 8, 2014	Presentation planning	How to organize the presentation	2
May 13, 2014	Finalize presentation, Planning for next year	Presentation planning went quickly with those responsible noting what will happen. The planning for next year will focus on helping parents understand the new grading system being implemented	2, 3
Figure 3.	**DuFour coding is #1 represents the focus on student learning, #2 represents teacher collaboration, and #3 represents the focus on results**		

2012-2013 Meeting Topics

Correlating standards. All grades were to use the CCSSM by the start of the fall semester of 2013. What perplexed the MPLC about the new requirement was correlating the old standards with the new since mathematics content was assigned to different grade levels, mathematical elements were taught in different sequences, and determining exactly which mathematical elements were no longer being required of students. These teachers did not want any of their students to have gaps in their understanding of any mathematical concept due to this shift in standards. Since the CCSSM were being imposed on all grades in one academic year, there were concerns for the developmental flow of the mathematics for students. The teachers of the MPLC wanted the new standards would be implemented one grade level a year, that way the students would learn by the new standards guidelines and not miss any content. Having all grades convert to the CCSSM at the start of the next academic year was the challenge. Ensuring that students learn and achieve at high levels with the

mathematics content, the teachers decided to select how to implement the new standards as their focus for the academic year 2012-2013.

Reviews of what was required for each grade level sounded like an easy task until the teachers tried to read two sets of standards simultaneously. They looked for a direct one-to-one comparison of the requirements. However, the CCSSM were written using algebra for the framework (conversation with one CCSSM author, Phil Daro, 11/6/15). The new standards sequence was independent of the previous state standards. The teachers found that being able to identify each new standard and where it was taught in the old standards was similar to the child's game of *Memory© or Concentration©*. The teachers realized this work was extremely time consuming and they were not done within one month, which was their original plan.

Resolutions and Actions. The MPLC leaders supported by the rest of the members determined that they did not have the time during the school year to do extensive comparisons of the CCSSM. The MPLC members rerouted their objective to create student reflection strategies that would inform the teachers if the students were missing any of the mathematical CCSSM background elements while the student assessed how much they mastered.

Transitions within the MPLC. The MPLC meetings were coordinated by two teachers: one who organized the meetings; and the second who recorded the meeting minutes. In February 2013, the organizing leader became a school principal. Thus, the meeting organizer could no longer be involved with the MPLC. Consequently, the meetings did not happen. The other members of the MPLC continued applying the learning strategies of student self-reflection in their classes. A meeting was held in May 2013 and a new meeting organizer was chosen for the 2013-2014 school year.

2013-2014 Meeting Topics

Several meetings at the start of the school year were spent on general discussions of pedagogy and that the MPLC did not arrive at a firm goal until late in the first semester. The researcher wondered if the dynamics of the MPLC were depleted. At the November meeting, the members began to share frustrations with issues of conducting Family Math Nights. They saw this as an objective to be used for the rest of the year and a means to help parents understand the manner in which mathematics was being taught. They did not create an inquiry question to be examined, nor did they fulfill the other starting elements DuFour (2004) described to establish a PLC. Instead, to learn from their past experiences organizing Family Math Nights, they shared successes and flubs as to selecting dates, how many hours the event should be, who should attend, should food be provided, and what type of mathematics should be done so parents could see their child doing the mathematics taught in schools today. The members made copies of their activities for one another. The meetings were conducted more like lesson study, each teacher conducted Family Math Night at their school, brought the successes and problems back to the MPLC and the next member's Family Math Night built upon the successes. At the end of the academic year 2013-2014, each member had a notebook with directions, suggestions, and activities for a successful Family Math Night event.

The directions included location planning, date selections, and what mathematical events to plan for family members who were pre-school age. The mathematical activities were grouped by age with a range of ability levels within those groups. The mathematics for younger students were based on counting games, while the older students made kites and designed transformations using 3 by 5 cards.

Observation Notes Findings. During the card sorting of the observation notes, there were four characteristics frequently identified that went beyond DuFour's three Big Ideas. These included: dedication to students; perseverance; analysis skills; and camaraderie. The researcher used the dictionary definitions of these characteristics to categorize them. During the meetings the side-bar talks described actions of the teachers that demonstrated their commitment to helping their students learn. Their continued attendance at the MPLC monthly meetings and continually grappling with hard classroom problems demonstrated their perseverance. Their analysis skills were observed as the MPLC members explored and probed the data they collected. Through all the hard decisions made by the group, respect for one another, helping each other in the group provided evidence of their camaraderie. These findings can be subsumed within the three Big Ideas of DuFour (2004). Dedication to students was modeled by the MPLC teachers in the first Big Idea of *ensuring that all students learn.* They focused their meeting objectives on increasing student success with mathematics. Perseverance was found in each of the three Big Ideas as the members of the MPLC worked their way through educational issues in order to ensure that their students learned mathematical content and were successful with it beyond their classes. *****

During years two and three of the MPLC, as described in this case study, the MPLC members did not continue to implement an analysis of data results to measure student success for their schools nor did they seek to find problems in their curriculum. Their analysis skills, part of DuFour's third Big Idea of *analyzing data results*, were centered on their own classroom testing results in which they identified problems for specific grades but no analysis was done of a whole school. No patterns were examined to track where a concept was missing. They had the skills to do data analysis, task analyzes of testing results as evident from their first year of work and results. Application of those analysis skills to learn more about their schools' curriculum was not done in the years that I observed their practice. The camaraderie was evident in all three Big Ideas. The MPLC members assisted one another whenever there was a request for help. They went to one another's schools to help out with Family Math Nights. They shared teaching manipulatives. They taught newer members how to do data analyses of classroom test results. They supported one another throughout the time of my observations.

Researcher's Reflections. Reflecting on what the MPLC had accomplished at the end of the 2012-2013 academic year, the teachers were rather discouraged when they compared their work to the project they had created in 2011-2012 - formative assessment by training students to use advanced organizers that raised their students' achievement scores. From my notes, I shared with the teachers the monumental work that they had

accomplished with their examination of the CCSSM standards for their classes and how they implemented strategies that helped students learn meta-cognitive processes in 2012-2013. They were now far ahead of those teachers who would work with the standards for the first time in the fall of 2013.

In the third year of the MPLC, with the lack of selecting an objective for the 2013-2014 school year at the last meeting of the prior school year and not coming to an objective in the fall, the researcher started to examine if DuFour's (2004) Big Ideas were no longer motivating the MPLC. However, once the members determined that planning and conducting Family Math Nights would help each member of the MPLC, they shared their experiences, collected activities, and event planning, they put their energies into creating a resource book. When that work was done, they focused on results of each event to determine what was best for each school. Once the members determined an objective, DuFour's (2004) three Big Ideas were activated and the group became very productive contrary to my assumptions in the fall.

Evaluation

DuFour's Characteristics used by the MPLC

Comparing the researcher's observation notes with the three Big Ideas of DuFour – a focus on student learning, collaboration, and working with assessment results, these MPLC members did utilize these elements (See Figures 1, 2, 3). There were some months when the teachers did not employ all three of DuFour's (2004) Big Ideas and these were the less productive months. Less productive was defined as the teachers not having a knowledge product by the end of the meeting.

Table 3
The Total Number of DuFour's PLC Organizing Principles Used During the Three Year Study.

DuFour's Big Ideas	Focus on Student Learning	Collaboration	Using Assessment Results
# of Identified Big Ideas used at the meetings	9	14	7

Using DuFour's Big Ideas

#1 - Ensuring that all students learn. A prominent characteristic of the MPLC teachers, but coming in as the third Big Idea as far as teacher implementation, was a dedication to increasing the achievement for each of their students. They recognized the importance of providing solid background knowledge in mathematics to each student. During the 2012-2013 year, persevering through several months of work devoted to identifying what mathematics content moved grade levels in the CCSSM, and what would be needed to fill in the gaps in the various age groups, the teachers followed DuFour's (2004) first (*ensuring that students learn*) Big Idea.

In the second year, helping parents know what mathematics their students were learning was a major theme of the Family Math Nights. Throughout the semester, they scrutinized the summaries of what happened at

each member's Family Math Night regarding content presented at each grade level, number of attendees, which grade levels had the most parent or guardians attending, what incentives were provided to increase participation, which date was selected and why. They explored ways to for the event to be more productive and provide more information about the CCSSM for parents. To fulfill their objective of having parents grasp the teaching changes required of the CCSSM, the teachers added details to the Family Math Night events that had parents trying to work on mathematical problems as taught through inquiry-based practices.

Issues dealing with Ensuring that All Students Learn. Given the focal points of standards and dealing with parents, the participants did not correlate the results of the matching standards nor with parental involvement with student assessment. Knowing what to teach and how to do that in ways that promote the highest percentage of students achieving procedural fluency and content knowledge were not examined. The MPLC did not collect any data that provided evidence of changes in students' testing scores based on their work with CCSSM nor the involvement of parents.

#2 - A culture of collaboration. The camaraderie of the MPLC teachers allowed for great trust within the group. The teachers freely shared their successes and problems teaching mathematics. When one teacher brought forth an issue with a student, several of the other members would share what they had done with similar students to help the student learn or to remediate learning. When another teacher noted that she had a student who would not complete any work, the other members of the MPLC contributed their strategies to motivate such a student. Motivational strategies such as time rewards, allowing the student to use a prized math manipulative, or allowing the student to use a specific book about mathematics that would be extracurricular such as the *Grapes of Math* by Greg Tang (2004) were some of the suggestions to engage students in the learning of mathematics. The sharing by the MPLC members allowed them to realize that they were not alone in their struggles or in the successes. They were able to share with one another their delights and burdens of the teaching profession.

Goddard, Goddard, and Tschannen-Morse (2007) studied the impact of teacher collaboration. In their study of 452 elementary teachers in 57 schools, they found a positive correlation between teacher collaboration and an improvement in student achievement in mathematics and reading. McClure (2008) noted that when large schools allowed time for teacher collaboration, over three years, there were substantial gains in academic scores. McClure noted that new teachers, when offered the opportunity to become part of a collaborative group of teachers, tended to remain in the profession and focus on student achievement. The major importance of collaboration, McClure noted, was that it empowered teachers.

Issues dealing with A Culture of Collaboration. One problem for this group is that while it is very collaborative, the teachers are from several schools in the area. There were pairs teachers from a couple of the schools, but when the teachers represented grade levels from Kindergarten through eighth grade, their sharing of ideas for teaching did not assist one another due to the

developmental differences in the age span. The mathematical issues discussed by the group usually centered around mathematical concepts of grades four through eight. The kindergarten teachers did not participate verbally as much as the upper grades teachers did. Once a second grade teacher joined the group, these early childhood grades teachers had a very vocal spokesperson who would try to make connections between what was being discussed and how the early grades laid the ground work for that concept. All the teachers attended to each speaker in the group with interest.

#3 - A focus on results. The identification of missing parts of the present curriculum when compared to the CCSSM raised a prolonged debate about how to evaluate the students in order to learn what in the students' background knowledge was missing and how to fill in those absent parts. Identifying these analysis skills provided key elements that helped focus the work of the MPLC in 2012-2013. The commitment to accomplishing Big Idea three (*focus on results*) doing the analysis work of the CCSSM could not accomplished during that academic year since the CCSSM implementation would not occur until the following academic year.

The teacher's analysis skills used when examining the CCSSM were very different from the analyses of the Family Math Night summaries. Their analyses of the Family Math Nights followed the lines of Lesson Study as described by Lewis (2002). The Family Math Nights were examined for specific points of information that overlapped in the plans for each school's event and how to improve the impact of the activities.

Issues surrounding Focusing on Results. There was a distinct lack of using recorded data in years two and three of the MPLC. Their work correlating standards was not tested. While they did a good job finding the shifts made to the mathematical content areas, they did not compare testing results. They were very concerned with laying the ground work for concepts and discussed this multiple meeting times. There was never a discussion of testing the new standards and examining how their order impacted their students. Perhaps, they were waiting for the high stakes tests to see how these new standards would be tested. At the meetings, no mention was made of using the classroom testing results nor of the high stakes testing results to inform their work.

Conclusions

The distinctive elements of this MPLC were the focus and dedication of the members of the MPLC. All the teachers continuously reflected on their practice and how to help all students reach higher levels of academic success which was noted by Darling-Hammond in 1996. The teachers kept up with changes in their profession with continuous research, readings, and attendance at professional development seminars elements identified by Danielson (2007) as means to grow professionally. They brought back ideas presented in these sources to the MPLC to discuss and help improve the practice of the whole group. The members were definitely committed to taking on new responsibilities that the MPLC determined would help their students achieve at higher levels.

While belonging to a professional learning community that meets on a regular monthly basis is time consuming, the benefits to its members are extensive. This MPLC drew its members from four schools which is not the ideal according to Louis and Kruse (1995). These teachers came together and found support for their work. Their collaboration introduced multiple teaching strategies to one another. They were problem solvers for issues that arose regarding the teaching of mathematics at their schools. The teachers found a sanctuary in the MPLC where they could confide their teaching problems and hear several possible solutions. The meetings took time away from the teachers' lives, but gave them rich resources, fellowship, and helped them work on best methods to increase student learning in their classes.

MPLCs can be started in any school where there are teachers willing to commit to the three big ideas of DuFour (2004). Starting with one academic area helps focus the participants and engages those most interested in extending their professional development in that content area. Administrators can benefit from the work of a PLC by allowing the PLC autonomy to select their area of focus and offering assistance by providing meeting space for the group. Helping the members of the PLC to implement the results of their work helps schools to improve ensuring DuFour's (2004) first big idea becomes a reality - that students learn.

References

Ball, D. L., Hill, H. C., & Bass, H. (2005). Knowing mathematics for teaching. *American educator*, *29*(3), 14.

Bulmer, M. (1979). Concepts in the analysis of data. *Sociological Review 27*, 651-677.

Danielson, C. (2007). *Enhancing professional practice: A framework for teaching.* (2nd Ed.). Alexandria, VA: Association of Supervision and Curriculum Development.

Darling-Hammond, L. (1996). The quiet revolution: Rethinking teacher development. *Educational Leadership*, 53, 4-11.

Denizen, N.K. (1989). *Interpretive biography: Qualitative research methods series.* (Vol. 17). Newbury Park, CA: Sage.

Dufour, R. (2004). What is a "Professional Learning Community"? *Educational Leadership*, May 2004. 1-6 Retrieved from http://staffdev.mpls.k12.mn.us/sites/6db2e00f-8a2d-4f0b-9e70e35b529cde55/uploads/What is a MPLC. DuFour Article 2.pdf on June 25, 2014.

Fullan, M. with Suzanne Stiegelbauer. (1991). *The new meaning of educational change.* New York: Teachers College Press.

Goddard, J., Goddard, R., & Taschannen-Moran, T. (2007). A theoretical and empirical investigation of teacher collaboration for school improvement and student achievement in public elementary schools. *Teacher College Record*, 109 (4), 877-896.

Greatschools.org. (2015). Multiple schools with teachers as members of the MPLC. Retrieved from http://www.greatschools.org on Janury 15, 2015.

Hargreaves, A., & Fullan, M. (2012). *Professional capital: Transforming teaching in every school.* New York, NY: Teachers College Press.

Hill, H., & Ball, D. (2004). Learning mathematics for teaching: Results from California's mathematics professional development institutes. *Journal for Research in Mathematics Education, 35*(5), 330-351. doi:1. Retrieved from http://www.jstor.org/sta

Hord, S. M. (1997). *PLC: Communities of Continuous Inquiry and Improvement.* Austin, TX: Southwest Educational Development Laboratory.

Hord, S. M. (2009). Professional learning communities: Educators work together toward a shared purpose. *Journal of Staff Development*, *30*(1), 40-43.
Kelleher, J. (2003). Professional development that works: A model for assessment-driven professional development. *Phi delta kappan*, *84*(10), 751.
Keller, B. (2002, January 30). Illinois teacher shortage grows. *Education Week, 21*(20), 20.
Larson, M., Fennell, F., Adams, T. L., Dixon, J., Kobett, B., and Wray, J. (2012). *Common core mathematics in a PLC at work.* Bloomington, IN: Solution Tree.
Lewis, C. C. (2002). *Lesson study: A handbook of teacher-led instructional change*. Research for Better Schools.
Louis, K. S., and Kruse, S. D. (1995). *Professionalism and Community: Perspectives on Reforming Urban Schools*. Thousand Oaks, CA.: Sage.
Ma, L. (1999). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States*. Mahwah, NJ: Lawrence Erlbaum Associates.
McClure, C.T. (2008). The benefits of teacher collaboration. *District Administrator. Sept*. Retrieved from http://www.districtadministration.com/article/benefits-teacher-collaboration on June 20, 2014.
National Center for Educational Statistics. (2016). Third International Mathematics and Science Study. Retrieved on from https://www.oecd.org/pisa/aboutpisa/ on November 6, 2016.
National Council of Teachers of Mathematics. (2014). *NCTM Foundational Priorities*. Retrieved from http://www.nctm.org/mission.aspx on June 29, 2014.
National Governors' Association and the Council of Chief State School Officers. (2012). *Common Core State Standards for Mathematics*. Retrieved from http://ww.corestandards.org/Math on June 28, 2014.
New Zealand Ministry of Education. (2010). New Zealand maths: Professional learning communities. Retrieved from: http://nzmaths.co.nz/plc on June 28, 2014.
Ohio Department of Education. (2014). *Office of Child Nutrition MR 81 Report for October 2014.* Retrieved from ftp://ftp.ode.state.oh.us/MR81/MR81_October_2014/October_2014_MR81_Traditional_Text.txt on March 29, 2015.
Patton, M. Q. (1990). *Qualitative evaluation and research methods*. Los Angeles, CA: SAGE Publications, Inc.
Programme for International Student Assessment. (2015). Retrieved from https://www.oecd.org/pisa/aboutpisa/ on November 6, 2015.
Rosenholtz, S. (1989). *Teacher's workplace: The social organization of schools.* New York: Longman.
Sparks, D., & Hirsh, S. (2000). A National Plan for Improving Professional Development. National Staff Development Council, Oxford, OH. Opinion paper.
Tang, G. (2004). *The grapes of math*. New York: Scholastic Corp.
Watts, G. D., and Castle, S. (1993). The time dilemma in school restructuring. *Phi Delta Kappan,* 75 (4): 306-310.