Questioning Effective Professional Development on Questioning

Valerie Schovanec
Omaha, NE

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Abstract

In this action research study of five middle and high school mathematics teachers, I investigated the impact of a group professional development experience involving professional reading, discussion, and observation of classroom practices on secondary mathematics teachers in my district. The focus of this professional development was on questioning practices in the mathematics classroom. I discovered that this type of professional development had a slight impact on teachers’ knowledge and beliefs on the role of questioning and its impact on student discourse, engagement, and conceptual understanding as well as some teacher questioning practices such as the use of wait time and engagement of all students in questioning. Little or no change was found in teacher participation as the professional development experience progressed or on the types of questions asked by teachers in the classroom. As a result of this research, I plan to offer additional professional development series beginning early in the school year and for more specialized groups of teachers.
Introduction

In the publication *Principles and Standards for School Mathematics*, the National Council of Teachers of Mathematics (NCTM, 2000) presents a vision for school mathematics as: a classroom, a school, or a district where all students have access to high-quality, engaging mathematics instruction. There are ambitious expectations for all, with accommodation for those who need it. Knowledgeable teachers have adequate resources to support their work and are continually growing as professionals. (p. 3)

This vision, by the Council’s own admission, is lofty and ambitious. To envision such a classroom, school, or district, the NCTM (2000) challenges educators to imagine a world where “all mathematics teachers continue to learn new mathematics content and keep current on education reform” (p. 367). The NCTM Teaching Principle addresses what and how teachers might accomplish this.

In the Teaching Principle, the NCTM (2000) suggests that the current approach to teacher learning, including professional development as periodic workshops, is not sufficient. Instead, collaboration is a more effective approach; the NCTM states that “teachers are better able to help their students learn mathematics when they have opportunities to work together to improve their practice…[and] time for personal reflection” (p. 370).

In my current position as the Math Lead Teacher for the Omaha Public Schools, I have the opportunity and privilege of working with secondary math teachers in various settings. I am interested in improving mathematics instruction. Thus, my action research focus centered on professional development for mathematics teachers. Specifically, I was interested in finding out if learning about a topic in a book study format combined with observations impacted teachers’ beliefs about teaching and learning and their use of effective questioning.
Currently, professional development for mathematics teachers in the Omaha Public Schools is done in two ways. First, if approved by their administrator, teachers can attend professional conferences and workshops that interest them. A second format for professional development is district-wide training. This type of training is offered several times throughout the year on curriculum days. In recent years, the calendar has included a total of three and one-half days for district curriculum time; these include a half-day curriculum day in August, a full day in September, a half-day in February and then another half-day in May. On the full days, all secondary mathematics teachers gather together; on the half-days, middle and high school teachers meet separately. With a staff of approximately 100 high school math teachers and 75 middle school math teachers, providing professional development that captures the interest of each individual and relates directly to each teacher’s classroom has proven to be difficult for one or two persons to lead.

There are times when it is necessary to gather our entire staff. For example, we will soon be adopting new math materials. The overview of those materials can be done in a large-group setting. However, I believe that to make an impact on the daily teaching and learning of mathematics, professional development must take a different form. Many teachers agree with this, as evidenced in their comments on the evaluation sheets completed at each curriculum day. While it is not my intention, nor is it within my locus of control, to change the structure of the district calendar, I would like to impact the teaching and learning of a few teachers. These teachers, in turn, might serve as catalysts for change in the way we can make use of the district curriculum days.
Problem Statement

I believe the main purpose of professional development is to improve classroom practice. In order to impact a teacher’s daily practice, professional development must be embedded within the teacher’s work. I believe that effective professional development must be coherent, sustained, and include opportunities for teachers to implement their learning into their classroom. Additionally, teachers must be given the time and means to reflect upon their practice and implementation of their learning. This implies that teachers must work together to form a true professional learning community.

I chose to focus my action research professional development group on questioning. I selected this area for two reasons. The first is that questioning is a topic with which teachers have some familiarity but could still greatly benefit from examining their questioning in the classroom. By choosing a somewhat familiar topic, teachers may feel less intimidated than if I had chosen something completely unfamiliar to them. The second reason I chose questioning is because it can be used to examine the relationship among curriculum, instruction and assessment. Examining the types of questions used could cause teachers to examine the tasks they offer their students (the curriculum). Questioning is a powerful instructional tool that can change the structure of a classroom; good questions can lead to more student discourse and deeper understanding of concepts. Questioning is a formative assessment; teachers can use questions to better understand their students’ thinking and drive their instruction. Thus, using questioning as the focus of the book study allowed for many avenues of teaching and learning to be explored.

This study is worth knowing about because all districts must plan for and deliver effective professional development in some manner. Districts must find a way to make the most
of teachers’ time with limited budgets. While this research is not investigating any new practice, it adds to the body of research on professional growth of mathematics teachers and thus contributes to public knowledge.

**Literature Review: Professional Development Focus**

This study examines a professional development opportunity focusing on teacher questions that allows teachers to work and study together as well as reflect on current teaching practices. In a review of literature related to effective professional development and questioning, several themes emerge. In regard to professional development, the themes are that teacher beliefs impact classroom practice, and that questioning techniques can be an effective topic for professional development. Themes related to questioning are: teacher questioning impacts student discourse and there are varied means to categorize questions.

**Teacher beliefs impact classroom practice**

“Teachers’ beliefs do influence…[teachers’] instructional practice” (Handal, 2003, p. 54). This summarizing statement offers insight to the extensive research on teacher beliefs and instructional practices. Handal (2003) conducted a review of research to examine “the nature and role of teachers’ mathematical beliefs in instruction” (p. 47). In this review, he explained that there appears to be a consistent definition among researchers on what constitutes teachers’ mathematical beliefs. Those aspects are “(a) what mathematics is, (b) how mathematics teaching and learning actually occurs, and (c) how mathematics teaching and learning should occur ideally (Ernest, 1989a, 1989b; Thompson, 1991)” (Handal, p. 47). The relationship between beliefs and instructional practice has been studied from different perspectives.

Much research has been done on whether teacher practice impacts their beliefs or if teacher beliefs impact their practice. Handal (2003) cited several studies that concluded the
latter: “teachers hold well-articulated educational beliefs that in turn shape instructional practice (Buzeika, 1996; Frykholm, 1995; McClain, 2002; Stipek, Givven, Salmon, & MacGyvers, 2001; Thompson, 1992)” (p. 47).

Cross (2009) agreed with Handal’s definition of teacher beliefs and also his statement regarding the impact of teacher beliefs on daily instructional practice. In a collective case study involving five ninth-grade algebra teachers, Cross investigated the “alignment of these [teachers] professed beliefs with their daily instructional practice” (p. 329). Through multiple interviews, face-to-face sessions and electronic communication, Cross found that teachers’ “general beliefs were very influential on the teachers’ daily pedagogical decisions” (p. 325). This supports Handal’s (2003) findings that teacher beliefs impact daily instructional practice.

In a case study involving three junior high mathematics teachers, Thompson (1984) found similar results as she investigated the relationship between teacher practice and their beliefs and conceptions. Over a four-week time period, the participants were observed daily. During the latter half of the study, interviews followed the observations. Thompson found that “teachers’ beliefs, views, and preferences about mathematics and its teaching, regardless of whether they are consciously or unconsciously held, play significant, albeit subtle, role in shaping the teachers’ characteristic pattern of instructional behavior” (p. 125). This study, too, supports the claim that teacher beliefs influence practice. However, there are studies that found that beliefs and practice do not always match.

There is evidence that teachers’ instructional decisions are not always congruent with their beliefs. Citing multiple studies, Handal (2003) concluded that:

In general, inconsistencies between teacher’s beliefs and practices are due to constraining forces out of a teacher’s control, such as parental and administrative pressure to follow
traditional oriented methods of instruction. Other factors include the traditional oriented mathematical learning style of the students as well as a lack of time and materials. These factors seem to act as major barriers for some teachers in implementing their progressive beliefs, constraints that current approaches in mathematics education do not take into account (Nolder, 1990). (p. 53)

Regardless of a teacher’s beliefs, there are factors that keep teachers from incorporating their beliefs fully into practice.

In summary, research suggests widespread agreement on what constitutes teachers’ mathematical beliefs, as evidenced in Handal’s (2003) research review. Likewise, there is evidence to suggest that teacher beliefs impact practice. Handal (2003) cites multiple studies that support this. Additionally, Cross’s (2009) and Thompson’s (1984) studies support this research. However, there is evidence to suggest that regardless of a teacher’s beliefs, there may be inconsistencies between a teacher’s beliefs and actual practice. Again, Handal (2003) cites multiple studies supporting this. Even with the possibility of inconsistencies between teacher beliefs and instructional practices, there is compelling research suggesting that beliefs have great potential to impact practice. One potential way to influence teacher beliefs is through professional development.

**Questioning techniques as professional development**

Professional development can take many forms. In the following studies, little information was given on the resources used for teachers to learn about questioning during the professional development. In those studies that did provide some explanation of that aspect of the study, it appeared that the methods varied greatly. However, reflection on teacher’s questioning practices was consistently part of the professional development experience.
Sitko and Slemon (1982) studied the change in questioning practices of 20 elementary teachers from Ontario as they participated in a professional development experience on questioning. In this quasi-experimental study, teachers participated in four three- to four-week phases of professional development that was intended to enhance their knowledge of questioning categories and effective questioning techniques. During each phase, data were collected on the questions used by both the teacher and students during classroom observations. In two of the four phases, teachers received computerized feedback on their questioning practices. The results of this study showed that there was a “significant increase in the percentage of high-level teacher questions” (Sitko & Slemon, p. 116) as a result of the professional development and feedback.

An increase in effective questioning was also found in a Moyer and Milewicz (2000) descriptive case study of 48 elementary pre-service mathematics teachers. To learn about questioning, teachers examined a video of the instructor interviewing a student. After the video, teachers participated in a discussion in which examples of various types of questions were highlighted. The second part of the study involved the preservice teachers interviewing children on the topic of rational numbers. Data were collected on the type and number of questions each teacher used during the interviews. Teachers then analyzed and reflected on their questioning practices. Upon further analysis of the questioning patterns, the researchers stated that “the preservice teachers who participated in this project did exhibit some important beginning characteristics of competent questioning” (Moyer & Milewicz, p. 310). Additionally, they suggest that “identifying and labeling typical questioning patterns allows educators to have shared discussion about the kinds of questions to expect of the beginner and strategies for developing higher level questioning skills for classroom use” (Moyer & Milewicz, p. 311).
Sitko and Slemon (1982) and Moyer and Milewicz (2000) varied in the structure to the professional development used in their studies. However, both did include having teachers reflect on their questioning practices. Whether teachers are pre-service teachers or simply novices in their knowledge of effective questioning techniques, these studies suggest that professional development on questioning may serve as a tool for impacting classroom questioning practices.

**Teacher questioning impacts student discourse**

When describing learning with understanding, the NCTM (2000) explains:

Learning with understanding can be further enhanced by classroom interactions, as students propose mathematical ideas and conjectures, learn to evaluate their own thinking and that of others, and develop mathematical reasoning skills (Hanna and Yackel forthcoming). Classroom discourse and social interaction can be used to promote the recognition of connections among ideas and the reorganization of knowledge (Lampert 1986). By having students talk about their informal strategies, teachers can help them become aware of, and build on, their implicit informal knowledge (Lampert 1989; Mack 1990). Moreover, in such settings, procedural fluency and conceptual understanding can be developed through problem solving, reasoning, and argumentation. (p. 21)

This clear promotion of student discourse relates well to the role of the teacher, also described by the NCTM. Throughout the NCTM’s Teaching Principle are references to the teacher’s role in incorporating student discourse into the classroom. The NCTM asks, “Are students’ discussion and collaboration encouraged? Are students expected to justify their thinking?” (p. 18). In creating such a classroom environment, the NCTM states that “effective teachers know how to ask questions” (p. 18). Questioning, then, is related to classroom discourse.
In a comparative study of first-grade mathematics classrooms in Japan, Taiwan, and the United States, Perry, VanderStoep and Yu (1993) examined the types and frequency of questions asked in the classrooms in an effort to offer a potential explanation of the well-documented achievement differences between United States’ students and students from Asia. They found similarities across the three nations in computation, rote recall, rule recall, and problem make-up question types as well as in the frequency of those questions. Questions focusing on computing in context, problem solving and conceptual knowledge were asked significantly less often in American classrooms. In the discussion of their findings, Perry et al. stated: 

Asian teachers acted as though they expected the children not only to engage in a dialogue about how a solution was achieved (i.e. problem-solving strategies questions) but also to compare solutions across problems and to explain differences across operations (i.e. conceptual knowledge questions). This contrasts sharply with the view of the U.S. child held by U.S. teachers that we infer from the types of questions U.S. teachers posed. (p. 38) 

The questions asked less frequently in the United States were types of questions that required students to explain their thinking beyond computation; those that require discourse. One can infer, then, that teacher questions influenced the classroom discourse.

In a related study, Franke et al. (2007) studied the relationship between teacher questions and supporting students’ mathematical thinking. Their case study involved three teachers who were actively involved in a professional development focusing on students’ algebraic thinking. The algebraic reasoning professional development supported teachers in “encouraging students to solve problems in their own ways…[and] on teachers’ engaging their students in conversations to help them explicate their thinking and debate their reasons for thinking as they
This study on teacher questioning involved taping teachers’ classrooms twice within one week. The results of the Frank et al. study showed that “whether students elaborated on their explanations depended greatly on whether teachers asked questions about students’ explanations” (p. 17). Again, this study suggests that classroom discourse is influenced by teacher questions.

Embedded within this theme is the importance of wait time in effective questioning. Studies suggest that increased wait time enhances student discourse. Tobin’s (1986) experimental study involving sixth and seventh grade mathematics and language arts lessons examined the effects of wait time on student discourse. Twenty classes from Australia served as the participants for this study. The 10 teachers serving as the experimental group were observed and received “advice on the magnitude of the wait time used in the previous lesson and suggestions on how to maintain a 3-second average wait time” (Tobin, p. 196). The 10 teachers serving as the control group received placebo feedback. Tobin found in the experimental classrooms, the “number of utterances per unit time was reduced, the number of times teachers interrupted student discourse was reduced, and student failures to respond to teacher solicitations were reduced” (p. 198). Because the length of time for student responses also increased, Tobin suggests “that students used the [wait] time for thinking” (p. 198).

“The quality of discourse can be markedly improved by increasing to three seconds or longer the average wait time used by teacher after a question and after a response” (Rowe, 1986, p. 48). This statement was made in a research article by Rowe. In this article, she highlights her two decades of research on wait time and identifies several findings of her research, which she explains were “subsequently verified by other researchers” (Rowe, p. 44). These findings support
that there are “pronounced changes (usually regarded as improvements) in student use of
language and logic as well as in student and teacher attitudes and expectations” (Rowe, p. 43).

These studies, when considered in conjunction with the NCTM’s description of the
teacher’s role in creating a learning environment, offer good reasons for teachers to consider
their questioning practices. Perry, VanderStoep and Yu (1993) found that teachers in the United
States asked fewer questions that required students to engage in discourse, suggesting this may
attribute to the difference in achievement between students from the United States and from
Asia. While the Franke et al. (2007) study involved only teachers in the United States, the
finding was that teachers ask few questions that promote students discourse. Teachers’
awareness and use of wait time increases student discourse, as found in Tobin’s (1986) study.
Rowe’s (1986) research review supports Tobin’s finding as well. While these studies suggest that
teacher questioning influences student discourse, the categorization of the questions can vary.

**Varied categories to teacher questions**

There are varied methods to categorize questions. In a review of literature, questions
were categorized according to cognitive levels, by question purpose, and by questioning patterns
or sequences.

In his monograph report, Wilen (1991) stated that in a review of research on questioning,
21 different classification systems were identified. He explained that most categorizations are
based on cognitive levels. He used such a system in his categorization of questions. Wilen’s
system first categorized questions as convergent or divergent; then as low or high levels. He
stated “the purpose of convergent questions is to determine basic knowledge, skills, and
understanding in order to prepare student to apply learnings. Divergent questions require
students to engage in critical thinking as they process information” (Wilen, 1991, p. 13). The low and high levels related closely to Bloom’s taxonomy levels.

In their previously described study, Sitko and Slemon (1982) categorized questions in a similar fashion. They classify questions in either an “affective judgment category” (Sitko & Slemon, p. 111) or in a cognitive category. They defined six cognitive categories: discrimination, recall, sequencing/paraphrasing, conceptual relating, inference or problem solving (Sitko & Slemon, p. 111).

Other resources categorize questions as they relate to questions’ purpose. Questions were classified as engaging, refocusing or clarifying in Bright and Joyner’s (2004) Dynamic Classroom Assessment: Linking Mathematical Understanding to Instruction in Middle Grades and High School Core Participant’s Guide. In this resource, engaging questions are defined as ones that “invite students into a discussion, keep them engaged in conversation, invite them to share their work, or get answers ‘on the table’”(Bright & Joyner, p. 127). Refocusing questions “help students get back on track or move away from a dead-end strategy” and clarifying questions “help students explain their thinking or help you [the teacher] understand their thinking” (Bright & Joyner, p. 127). These two types of questions serve different purposes and together are an example of how questions may be identified by purpose.

Perry et al. (1993) used the classification scheme for questions that included computation/rote recall, rule recall, computing in context, make up a problem, problem-solving strategies, and conceptual knowledge in their previously described comparative study. Their classification system also stemmed from the purpose of the question in a mathematical setting.

A third study that categorized questions according to purpose is Moyer and Milewicz (2002). In their professional development, teachers were taught to categorize questions in this
manner. Questions were classified as ones that “help children to make sense of mathematics” or “that helped children rely more on themselves to determine whether something was mathematically correct” (Moyer & Milewicz, p. 299). Other classification include questions that “helped children to reason mathematically” or “helped children to conjecture, invent and solve problems” or even “connect mathematics, its ideas, and its applications” (Moyer & Milewicz, p. 299). These question types are also examples of how questions may be identified when categorizing by purpose.

Another form of classifying questions was based on questioning patterns or sequences rather than cognitive level or purpose. In the Franke et al. (2007) case study, questions were grouped into one of five categories. The first, general questions, are defined as ones “not related to anything specific that a student said” (Franke et al., p. 12). A “question about something specific that a student said…was considered a specific question” and “a series of more than two related question about something specific…was defined as a probing sequence of questions” (Franke et al, p. 12) were the second and third categories. “Bundles of questions” was the fourth kind of question. These were “instances in which the teacher asked more than two questions and did not provide the student any opportunity to answer any of the questions” (Franke et al., p. 12). Finally, leading questions were a “series of questions [that] provided opportunities for students to respond by guiding students to particular answers or explanations” (Franke et al., p. 13).

Similarly, questions were analyzed and grouped according to teacher questioning patterns in the Moyer and Milewicz (2002) case study. These researchers found that question patterns could be categorized as “checklisting, where the interviewer proceeded from one question to the next with little regard for the child’s response…”, as “instructing rather than assessing…”, or
“probing and follow-up” (Moyer & Milewicz, p. 301) questions. These categories were in addition to the purpose categories previously explained for this study.

There are multiple approaches to categorizing questions. Wilen (1991) and Sitko and Slemon (1982) study used cognitive levels to identify and categorize questions. Question purpose was the categorization method used by Bright and Joyner (2004), Perry et al. (1993) and Moyer and Milewicz (2002). Franke et al (2007) chose to categorize questions by the patterns in which they were asked. In the review of literature, it is evident that classification systems vary and are designed to best fit the researcher’s intent and needs.

**Concluding Statement**

My study investigates the impact of a small-group professional-development experience involving professional reading, discussion and observation of classroom practices on secondary mathematics teachers. The focus of this professional development is on questioning practices in the mathematics classroom. This study examines changes in regard to teachers’ quality and quantity of participation in the study sessions, teachers’ knowledge of and beliefs in the role of questioning and its impact on student discourse, engagement, and conceptual understanding knowledge, and on teachers’ questioning practices.

While Thompson (1984) examined the relationship between beliefs and practice, this study examines whether collaborative professional development impacts teachers’ beliefs and practices. This study incorporates teacher reflection on teaching practices, as teachers receive feedback on the types and frequency of questions asked and student responses to the questions. The intent of this feedback is to offer teachers an opportunity to engage in discussion of their practices and the impact it may or may not have on student discourse, engagement, or conceptual understanding. Although Sitko and Slemon (1982) also incorporated feedback to teachers, the
studies differ significantly. The first difference is in the intent of the feedback. Sitko and Slemon examined the impact of feedback on questioning practices. The feedback was not further incorporated into the professional development. Secondly, the format of the feedback differs. The feedback in the Sitko and Slemon study was given nearly immediately, privately, and in an electronic format.

The categorization of question types for this study combines the approaches of Bright and Joyner (2004) and Perry et al. (1993). Questions are categorized according to their purpose. For those questions with a purpose to further investigate thinking, questions are categorized according to Bloom’s taxonomy.

This action research study is intended to impact local knowledge. This research is not investigating any new practice, rather it gleans from a variety of studies to help gain a deeper understanding of the effects of professional development for a small community of math teachers.

**Purpose Statement**

The purpose of my study was to measure the impact of a small group professional development experience involving professional reading, discussion, and observation of classroom practices on secondary mathematics teachers in my district. The focus of this professional development was on questioning practices in the mathematics classroom.

I examined three themes within this project. The first was in regard to effective professional development. Effective professional development is embedded within the teacher’s daily work. It is coherent, sustained and offers opportunities for teachers to implement their learning into the classroom and reflect upon that implementation.
The second and third themes centered on teacher beliefs and practices. Teachers’ beliefs on the impact of effective questioning on students discourse, engagement and conceptual understanding impacts their classroom practices. Teachers’ knowledge of effective questioning techniques influences their questioning practices.

Using these themes, I sought to answer the following research questions:

1. What happens to the quality and quantity of teacher participation throughout a small-group professional-development experience involving professional reading, discussion and observation of classroom practices?

2. What happens to teachers’ knowledge of and beliefs in the role of questioning and its impact on student discourse, engagement and conceptual understanding when they participate in a small-group professional-development experience?

3. What happens to teachers’ questioning practices when they participate in a small-group professional-development experience?

4. What happens to my teaching as I lead secondary mathematics teachers in professional development related to questioning?

By examining these questions, I hoped to better understand the impact such a professional development experience has on teachers in my district.

Method

This research began by the researcher inviting all secondary mathematics teachers to participate in the professional development. On November 10, 2009, the invitation was sent via an in-house e-mail conference that is a main source of communication to all secondary math teachers. The initial posting described the professional development as a study group for middle and high school teachers with a focus on effective questioning. It indicated that the sessions
would begin in early spring and that participants would receive a book and extra-duty pay as required by contract. Teachers were asked that they contact the researcher if interested. Of the approximately 175 teachers eligible in the district, 14 expressed interest. After the initial contact, a personal e-mail was sent to each of the 14 teachers with more information.

Of the 14 teachers, five had participated in a similar type of book study during the previous school year. To those teachers, the personal e-mail to them explained that the format of the study sessions would be similar to what was done the previous year. They were also informed that I would be conducting my action research during the book study for those willing to participate in the research. I explained that the research participation would involve keeping a weekly journal, completing surveys and questionnaires, being interviewed, and being observed in their classroom and as a participant in the book study sessions. I indicated that they could choose to decline to participate in the research and still be part of the book study.

For those who had not participated the previous year, a similar e-mail was sent. It included the same information in regard to the action research participation but also provided some details on the structure of the book study. These details included that we would meet six times and the group would decide the times and locations. They were informed that last year’s book study met from approximately 3:30-5:30, and a similar time frame was likely. These e-mails ended with an offer to answer any questions and a request that teachers respond whether they were still interested in participating in the book study.

All 14 of these teachers expressed a continued desire to participate. On November 30, 2009, a second personal e-mail was sent to each with suggested dates and times. They were asked to respond with any conflicts or concerns with the dates, suggestions for alternate dates, and any questions. At various times after this e-mail was sent, seven of the 14 teachers responded
that they could not participate. Conflict with the dates and additional school duties such as Title 1 after school programs were the two main reasons given for declining to participate.

The six dates agreed upon by the remaining seven teachers were January 21, February 4, February 18, March 4, March 18, and April 1, 2010. All meetings were to be held at the Teacher Administration Center from 3:30-5:30. However, we all agreed to be flexible in the time and dates as needed.

The seven teachers who began the professional development included five high school teachers and two middle school teachers. On February 8, 2010, after the first two study sessions, a high school teacher withdrew from the professional development due to additional assigned school duties. On February 18, 2010, a middle school teacher withdrew, citing family reasons. The five teachers who completed the professional development ranged in experience from two to seven years. No teachers had teaching experience outside the Omaha Public School District. The courses taught by the teachers varied. All had experience teaching either Pre-Algebra or first-year Algebra. Three had experience teaching Geometry. One had experience teaching dual-language. Four of the teachers had taught a course for students achieving below grade level. These five teachers are identified in this paper as teachers A, B, C, D and E.

During late December of 2009 and early January of 2010, the researcher met with each of these teachers individually to explain the action research, the questions being studied in the research, and the data collection processes that would be used. The data collection processes included two classroom observations, two teacher interviews and two surveys/questionnaires. Further data collection was done by recording comments and questions during three of the book study sessions by use of a videotape. And finally, teachers were asked to journal weekly. During this meeting, I shared how to select a target class (to be used for observations) and the process
for collecting student and parent permission forms. Once teachers sent and received permission forms, initial classroom observations were scheduled.

The original dates set for the observations were interrupted with school cancellations due to snow. Although the researcher had intended to do all the observations prior to the first book study meeting, this proved impossible. The initial classroom observations were done between January 19, 2010 and January 28, 2010.

During these observations, the lesson was audio-recorded. Additionally, the researcher recorded in a notebook the questions asked by the teacher and the student response(s) to the question. Later, the notes and the audio-recording were used to record and tally the question types used by the teacher and the student responses to each. The table used to tally the questions and responses is included Appendix A. Questions types were defined as one of the following: managing, mathematics procedural or recall, clarifying, orienting, or prompting mathematical thinking. Student responses were recorded as: no answer or answered with a question, short, discrete answer, or extended answer.

A managing question is one that is intended to assist with classroom management, organization or directions. For example, a question asking if students need more time is a managing question. A mathematics procedural or recall question is one that asks students to identify a step-by-step procedure or asks students to recall or state facts about mathematics. Examples of procedural or recall questions are: What is five times four? and What is the correct vocabulary for the bottom part of a fraction? Clarifying questions ask students to clarify their thinking or explain their work and asks for no further thinking. Asking a student how they got their answer is a clarifying question. A question intended to get students thinking started or “unstuck” is an orienting question. For example, a teacher might ask if a student has made a
chart to orient their thinking during problem solving. A prompting mathematical thinking question asks students to apply, analyze, evaluate or create mathematics or mathematical proofs, or asks students to further their thinking beyond their initial explanation of their process. Examples of this type of question are: Why did you choose to divide? and Do you see a pattern?

Student responses to teacher questions were also recorded. One type of response category was no answer or answered with a question. A second response category was a short, discrete answer. These were yes or no answers or answers that contained only the factual information requested in the question. For example, if a student was asked “how did you get 5 for your answer” and responded with “I divided,” the response would be recorded as a short, discrete answer since the student answered only what the teacher has asked. A third type of response is an extended answer. These answers included explanation of the process or thinking that took place. For example, an answer such as “I divided $100 by 4 because four people shared the cost” would be recorded as an extended answer since the student provided an explanation of the process.

These question types were used because they specified what the question’s purpose was. The book used for the book study, *Quality questioning research-based practice to engage every learner* by Walsh and Sattes (2005), explained four steps to effective questioning. Those steps are deciding upon a question’s purpose, deciding the important concepts for which you are asking the question, deciding on the appropriate cognitive level of the question, and writing the question clearly. These questions categories nicely supported the reading done in the book study.

Recording questions during class time was much more difficult than anticipated. The researcher attempted to record each question asked by the teacher and the student response to that question while noting on a seating chart which student responded. After the first observation, teachers were asked to address students by name when asking a question. This made the process
much easier as the audio recording could be used to know which students responded. Observations were scheduled for a lesson that was primarily teacher-led instruction. However, there were times when the teachers addressed students individually. It was not possible to collect data during this time of the class period. This occurred during the first observation of Teacher A and the final observation of Teacher B. During the final observation of Teacher D, students were discussing probability involved in the game “Let’s Make a Deal.” For much of this student discussion, the teacher was not involved.

The first book study session was held on January 21, 2010. A reminder e-mail with the location and directions was sent to teachers. Despite advanced preparations, the room that had been reserved was being used by another department. At the last minute, an alternate location had to be found. It was late enough that an e-mail alerting everyone to the room change could not be sent. With the assistance of secretarial staff and rooms signs, all teachers were able to find the new room, and we met without further incident. During this first meeting, Teachers C, D and E attended on time. Teacher B did not attend and later explained the absence as “getting swept up with planning and just forgetting.” Teacher A was in attendance but was late. Prior to the meeting, this teacher explained that he would have a recurring conflict with child care and would likely have to withdraw. In our discussion, we mutually agreed that he could attend and bring his young child with him. For each session Teacher A attended, this did occur. In addition to these teachers, one of the two original seven teachers also attended.

Since I had not yet done all of the initial classroom observations, this first session was informational rather than a discussion of effective questioning. The first thing we did was adjust the meeting dates. This was necessary due to a conflict with high school parent teacher conferences. The new dates were: February 4, February 18, March 9, April 1, and April 15.
Next, the two books each teacher received as part of the book study were dispersed. The books were, *Quality questioning research-based practice to engage every learner* by Walsh and Sattes (2005) and *Good questions for math teaching why ask them and what to ask* by Shuster and Anderson (2005). I explained that we would use the Walsh and Sattes book as our main reading for the sessions. The second book would be theirs as a resource for writing good questions in mathematics. After previewing the books, I reminded the teachers of the research questions I was examining as part of this action research. I used that to lead into the first administration of a survey on their knowledge of and beliefs in the role of questioning and its impact on student discourse, engagement, and conceptual understanding. This survey/questionnaire is Appendix B. The second administration of the survey took place on April 15, 2010, which was the final book study session.

After giving teachers additional time for questions and their reading assignment, Chapters 1 and 2, the first study session ended much earlier than the planned 5:30 time. The original data collection plan included videotaping session 1 of the book study. The session was indeed taped. However, because the session was more informational than originally intended, it was not analyzed for participation.

The second session for the professional development was held on February 4, 2010. Teachers B, C, D and E attended. Teacher A was absent. The two teachers who eventually withdrew also attended this session. During this meeting, we were to discuss Chapters 1 and 2 of the text. A few teachers mentioned that they had read only part or none of the assigned reading or had read so long ago, they had forgotten. Regardless, we had a good discussion and did not even finish discussing all of the assigned reading. Since this was first real study session where teachers were active participants, it was videotaped to collect data on teacher participation.
Data on teacher participation during the book study was done by coding the type of statements made and questions asked by each teacher during three book study sessions. The comments and questions were categorized using the following groupings. Questions were recorded as either a general question, meaning it was not related to the topic of questioning, or as a question about questioning practices. Statements were recorded in one of five statement categories. The first was a statement about others’ questioning practices. The second was a statement about the teacher’s own personal questioning practices. Statements about students’ responses to questioning were a third category. A statement about students that is not about their responses to questioning, for example, a statement about a student’s behavior, was a fourth category. The fifth category was a general statement. This was a statement that is not about questioning or students. These general statements were often off-topic and included statements about various topics such as instructional practices or upcoming events.

When a teacher made multiple statements or asked questions in an extended, uninterrupted vocalization, they were coded in the following manner. If the vocalization included a question, it was recorded in the appropriate question category. If it did not include a question but included a statement on students’ responses to questioning, it was coded in the students’ responses to questioning category. Extended vocalizations that did not include a question or statements on students’ responses to questioning were coded in the most appropriate statement category. The table used to tally teacher participation is included in Appendix C.

The first round of interviews was completed between February 11, 2010, and February 23, 2010. The second round of interviews was completed between April 1, 2010, and April 8, 2010. All interviews were held at the teacher’s school at a time selected by the teacher. In lieu of a final face-to-face interview, the interview questions were sent out via e-mail and written
24 responses were requested. This was done due to time constraints. The questions used for the interviews are included in Appendix D.

Teachers were asked to journal weekly. The list of these prompts is included in Appendix E. After the first book study, no particular prompt was assigned. Instead teachers were asked to select any prompt from the list. At the second book study, it was made known that no one had completed a journal. From then on, journal prompts were e-mailed to the teachers. The journal prompts assigned after certain sessions are included in Appendix F. At times, teachers were asked to do an additional task. These are also included in Appendix F.

I provided a notebook for each teacher with a list of journal prompts organized around the three research questions inserted in the front cover. I also gave teachers the option to word process their journals and send those to me. The list of questions was e-mailed to them. Only one teacher chose to journal in the notebook while others journaled electronically. In spite of weekly requests, few journals were completed. A total of 33 journal entries were received.

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Number of Journal Entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>21</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
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<tr>
<td>D</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>2</td>
</tr>
</tbody>
</table>

The remaining book study sessions occurred without incident. All five teachers attended session 3 on February 18, 2010. For the March 9 session, all but Teacher A attended. This session was videotaped. Teacher E was absent for the April 1, 2010, session. All attended the April 15 session, which was also videotaped.

The researcher also kept a journal from January 14, 2010, through April 15, 2010. An entry was made prior to the first book study session, after each book study session, during a
week when observations were being done, and after a conversation with a participant outside the study session. Entries described what happened in the book study, my reactions and thoughts in regard to the session, and the general process being used for the research.

That data were organized in several manners. A document was created that listed each research question separately. Each journal prompt was listed under the appropriate question. Teacher journal entries were then analyzed and various quotes and dates were listed under the prompt to which it pertained. Interview questions were organized in a similar format. A spreadsheet was made for the classroom observations. It showed the number of times a type of question was asked and the number of each type of student response for each observation. For the book study participation, a spreadsheet was created that included the number of each type of comment made or question asked. The data was organized for each teacher individually. A similar spreadsheet was made for the survey/questionnaire results. All spreadsheets separated the data by date so that the researcher could find any trends or unusual data. These documents and spreadsheets provided an organized manner from which to examine and summarize teachers’ thoughts, questioning practices, and participation.

**Findings**

This action research involved six book study sessions. While each session had its own focus, there was some consistency in how the sessions were structured. From the beginning, I felt pressure to provide a quality professional development experience for teachers. In my first journal, I mention my struggle of finding a good balance of providing instruction in questioning and letting the teachers go where their conversations take them. In my second journal, this comes up again as I “want to keep a balance of time for teachers to share and really build a professional learning community and ‘instruction’ by me, the professional development leader” (January 22,
The first study session followed a pre-set agenda. Since the meeting was informational, I was prepared to share certain information and have the teachers complete certain tasks. The second session was much less structured. Although the session was to focus on certain reading, I had not pre-planned any particular instruction. I let the conversation flow as it may, but I had made notes in my own book for things that I wanted to be sure were brought up in the discussion. For the third and all remaining sessions, I had an agenda prepared but did not share it with the group. This agenda was in response to my own concerns with finding a happy medium between providing instruction and letting teachers take charge of the discussion. The agendas were also in response to teacher feedback from interviews and journal. In the interviews, teachers indicated that they want some time to talk about their own experiences but do want to learn about questioning. A few specifically asked for me to help keep the group on track. Teacher B wrote in his February 5 journal that the sessions “need a more structured agenda so we can discuss more of the topic in the reading.” Having my “just in case” agenda was the way I chose to honor their requests. I explained that I “chose not to print it for them to maintain the ‘loose’ structure” that the teachers enjoy.

I began the February 18, 2010, study session by asking teachers to read the barriers to effective questioning identified in our text. I asked them to identify which of the barriers they would like to focus on during the professional development experience. From then on, each study session began with a reflection on the progress each teacher was making toward eliminating their barrier. After teachers had shared their thoughts on their progress, we would use the text to begin our conversation.

For each my agenda, I identified key points of the text to help focus our discussions. The conversation still went off-topic, although they were always education-related. I allowed some
time for this. When the conversation turned from sharing information or asking questions to a
less-positive purpose, I re-directed the group back to the text and the topic of questioning. We
never accomplished everything on the agenda. By the end of the sixth study sessions, we had
only discussed four of the eight chapters of our text. Each study sessions ended with a preview of
what would happen at the next session, identifying the assigned journal prompts, and a thank you
for participation. The following day I would send the same information in an e-mail to the
teachers.

**How does teacher participation change?**

The first research question asked what happens to the quality and quantity of teacher
participation throughout a small-group professional-development experience involving
professional reading, discussion and observation of classroom practices. When examining the
data quantifying the number of comments made and questions asked during the book study, little
change in participation is seen. Teachers’ participation in the book study session is recorded in
Table 1. As seen in the table, all teachers participated consistently in the book study. Although it
appears that Teacher A did not participate as much, this is the teacher who was consistently late.
The fewer statements could be due to the amount of time he was present in the session. No
teacher appeared to dominate in any of the sessions.

General statements were made more often than any other type of comment or question. Many
of these statements were made when the discussion had moved off-topic. For example, in the
April 15 session, Teacher C said, “I have to pilot the state math test.” One such statement tended
to bring the group off-topic for several minutes during which many general statements were
made and general questions were asked.
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<thead>
<tr>
<th></th>
<th>Teacher A</th>
<th>Teacher B</th>
<th>Teacher C</th>
<th>Teacher D</th>
<th>Teacher E</th>
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<td></td>
<td>Pre</td>
<td>Mid</td>
<td>Post</td>
<td>Pre</td>
<td>Mid</td>
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<td>General Question</td>
<td>Abs</td>
<td>Abs</td>
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<td>4</td>
<td>6</td>
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<tr>
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<td>questioning practice</td>
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<td>Statement about personal</td>
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<td>questioning practices</td>
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<td>9</td>
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<td>Statement about students'</td>
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<td>responses to questioning</td>
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<tr>
<td>Statement about students</td>
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<tr>
<td>(not related to questions)</td>
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<td>Abs</td>
<td>1</td>
<td>4</td>
<td>0</td>
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<td>General statement</td>
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</table>

I believe the quality and quantity of teacher participation in the professional development is reflective of these teacher’s personalities and the make-up of the group rather than a result of the professional development. This finding is supported in teacher interviews and journals. In the February 23, 2010, interview, Teacher D described the group and participation as one with “an interesting dynamic…very energized and very good….no one is dominating.” Teacher C journaled on February 8, 2010, that she “enjoyed the [most recent study group session] and conversation flowed.” On February 26, 2010, Teacher B wrote that he doesn’t always feel that he has “a lot to say to [the more experienced teachers]. But as we get more into the book, discussing the specifics of questioning, I find that I have some things to contribute that may be beneficial to the group.” In the initial February 18, 2010, interview, Teacher C expressed that she was first afraid to speak up but during the first session, she found “others also felt that way. I was worried about being an outcast but not so now.” She goes on to say that she was “looking forward to others’ input since she knows them now.” These types of comments, as well as my own
experience in working with these teachers in other settings, suggest that they were comfortable with each other early on and were willing to participate at all times.

**How does teachers’ knowledge of and beliefs in the role of questioning change?**

Evidence suggests that teachers’ knowledge of and beliefs in the role of questioning and its impact on student discourse, engagement and conceptual understanding has changed as a result of their participation in this book study. The strongest evidence for this comes from my journal and the teachers’ journals and the interviews. In my January 14 journal, I write that Teacher A said “he never thinks about his questions.” This statement was made before the book study began. In another journal, I wrote how teachers’ discussion in the February 4 study session focused a lot on the need to foster an environment for questioning and the importance of setting norms. I wrote that in the February 18 study session, teachers were discussing how to decide on a question purpose and a clear content purpose for the question. This comment suggests teachers are learning that planning is required to implement effective questioning. In that same study session, Teacher A said, “tell me how to write a high level question about adding fractions” and then added that he believes better questions can help students become engaged. Teacher E expressed the belief that questioning matters, even though she struggles with implementing it due to time.

Teacher interviews and journals also suggest a change in teachers’ knowledge and beliefs. In the initial interview, when asked what the role of questioning is, the most common answers were to find out what a student knows and learned in a lesson, to get students to think, and to engage learners. Teacher B responded in a January 29 journal that he believes the purpose of questions are to keep students active, to check for understanding, and to pace the lesson. Then, in an April 15 journal, he responds that questions are still “to keep the flow going. But more and
more, [he finds himself] asking questions with the intention of leading the students down the path to discovery.” When asked to journal about what their most significant learning thus far has been, teachers reported that setting up classroom norms, time and preparation it takes to ask good questions, wait time, and the importance of having a few good, key questions during a lesson were the most important. Specifically, Teacher E wrote in an early journal that she struggles with “visualizing how these questioning strategies work in a math class.” In a later journal, she stated that “higher level questioning does have a very good place in math.” Teacher B wrote in the April 15 journal that he now believes that “good questions aren’t happy accidents. [The teacher] need[s] to structure the lesson and integrate the questions into it.” These comments provide some evidence that teachers are learning about questioning in math and altering their beliefs.

In the final interview, teachers were asked in what ways their beliefs had changed. Teacher A responded that he has “come to think that practice is not the only way to learn math. You have to talk about it….When you create an answer out of your own thinking then you have moved into a higher level of understanding. Now you are learning.” Teacher E responded that prior to the book study she “didn’t see the place that higher level thinking had in math. I thought that math was naturally higher level thinking. Now I see that there are several ways to promote thinking math.” She goes on to say that questioning “definitely has a purpose [in math].” Both Teacher C and D stated that the professional development has “confirmed,” “made stronger,” or “reinforced” their beliefs on the role of questioning in the classroom. Teacher D added that this is especially true “in cultivating an environment in which students ask questions. [He] has also realized that asking good questions takes a lot of hard work and planning.”

Two surveys were administered to examine this change. Surveys were administered in the first and last study session. Teacher B was absent during the first session. He completed his
survey during the second session. The results of the surveys reveal little change with no consistent patterns (See Appendix G). The reliability of this survey and results from it are in question. When administering the final survey, Teacher B commented that he “could answer this differently every day depending on [his] mood.” All teachers nodded or expressed agreement with him.

How do teachers’ questioning practices change?

The third research question examined in this study is what happens to teachers’ questioning practices when they participate in a small-group professional-development experience? A slight increase in teachers’ awareness of their questioning practices and change in the use of wait time and engaging all students was found. Evidence suggests little or no change occurred in the types of questions asked by teachers. However, there is evidence to suggest that teachers believe change will occur at the beginning of the next school year.

To gather information on teachers’ questioning practices, two classroom observations were conducted. The number and types of questions and student responses are included in Appendix H. The quantitative data reveal no change in the types of questions asked by teachers. The most common type of question was consistently a mathematical procedural or recall question, which most frequently generated a short, discrete answer from students. The following question and response scenario observed in Teacher C’s classroom is a typical classroom questioning sequence observed: “What is -2 times 7?” with a response of “-14” followed by “and x cubed times x cubed is?” with a response of “x to the 6th power.” The data from the observations were shared with each individual teacher. No teacher expressed any surprise at the types of questions he or she asked. Teacher A was surprised at how many procedural questions were asked during the class.
Teachers noted that they are more aware of their questioning practices. Teacher B stated in the second interview conducted on April 1, 2010, that he “thinks more about the questions” he asks. In her April 2, 2010, interview, Teacher C said she has “caught” herself making changes in wait time. Teacher A shared in his April 7, 2010, interview that he also has begun to practice more wait time. Teacher D stated in the final interview is “more mindful of which students are answering questions” and “is trying to engage more students in answering questions” (April 22, 2010).

Although teachers expressed being more aware of questioning and making slight changes, they also expressed difficulty in implementing any classroom change. They identified three reasons that they are not implementing change. Those reasons are: the content they teach makes it difficult to ask higher-level questions, time, and lack of classroom norms to support questioning. As noted in my February 19, 2010, journal, during a study session Teacher A said, “tell me how to write a high level question about adding fractions.” He then added that he believes better questions can help students become engaged, but it is difficult to write them for the content he is asked to teach. He also stated that students do not participate when he does ask questions. When asked in the April 15, 2010, study session what progress had been made in addressing her identified barrier, Teacher E replied “not good” and then added that she is “struggling to get through the content.” Teacher D answered that question by saying his questioning is “not getting any better” and that “students seem to be getting more disengaged” as the year winds down.

Comments were made that indicated that teachers believe any change in their questioning practices would not begin until fall when a new school year begins. Teacher B responded in the final interview that he believes he “can run a class predicated on both student and teacher
questions about mathematics. It won’t happen this year….however, [he] must make every effort over the summer to ensure that next year is better.” Teacher A said that he has made some progress in saying to himself “you’ve got to wait, you’ve got to wait” to help with wait time. He added “but [students] will wait me out.” He is “looking forward to next year when [he] can start the year by putting these expectation in place. [He’ll] start with ‘these are the rules’.”

**What happens to my teaching?**

The fourth question examined in this action research is what happened to my teaching as I led secondary mathematics teachers in professional development related to questioning. The most noticeable change made in my teaching is the adjustments I made to the study session structure as a result of feedback from the teachers. Other than those immediate changes, little else has been modified in my practice of working with teachers at this time. In my journals, I wrote that I believe I am attentive to teachers’ needs and wants. This has not changed. As a result of this action research, I better understand what teachers want in this type of professional development. I anticipate making changes to future professional development offerings.

**Conclusions**

The findings from this action research indicate that teacher knowledge and beliefs have changed while their classroom practices have not. The goal of professional development is to impact classroom practices and, therefore, student achievement. With this in mind, the professional development was unsuccessful. However, I believe this professional development did have some positive impact on the teachers.

In the final interview, teachers were asked to state their feelings regarding the professional development experience. All responded with positive comments. Teacher C said she “enjoyed it, learned from it, and would do it again.” Teacher D “was challenged…and
encouraged by the group discussions.” Teacher B was glad he was invited, wish he had more time, and hopes to do it again. It was evident that having time to talk with other math teachers was valuable to the participants. Teacher B believed the book was “beneficial but…the thing that influenced me the most was my colleagues’ advice on situations they have encountered.” Similar sentiments were shared in journals. Teacher E said she “definitely look[s] forward to discussing other math teachers’ ideas on higher level questions in math.” Teacher A appreciates “the fact that we have teachers’ input and skills are shared. That helps.” These findings tell me that the professional development experience was worthwhile for teachers.

My findings loosely support both the Sitko and Slemon (1982) and the Moyer and Milewicz (2000) studies. Both of these studies showed a positive change in the questioning behaviors of teachers, including the types of questions asked, as a result of a professional development experience. My study only showed slight changes in awareness, the use of wait time, and engaging all students in answering questions.

In my study, results indicated that the changes in teachers’ knowledge and beliefs had not yet fully transferred to classroom behavior. This disconnect between teacher beliefs and practice found in my study appears to support the findings of the 1984 Thompson study. Thompson found that teacher beliefs influence teachers’ instructional practices. The slight changes made in classroom practices indicate that teachers’ changes beliefs are influencing their classroom behaviors, although only in a limited manner. Thompson’s results and the positive response of the participants in my study give me hope that with more time, classroom practices may be influenced to a much greater degree.
Implications

As a result of this study, I will continue to offer this type of professional development for teachers. In the final interview, I asked teachers if they would participate in this type of professional development again. They all responded positively. In interviews, I asked what should be changed about the study. The main suggestion was to firm up the structure of the sessions, which I did for the remainder of the sessions. Other suggestions include offering professional development specifically for teachers of a certain course such as geometry. Teacher B suggested that the professional development include time to write lessons or activities that could assist in making changes in classroom practices. One teacher suggested the sessions be held more frequently.

There was a general consensus to begin the sessions earlier in the year when teachers are still establishing classroom norms with students. While I find value in all their suggestions, I will definitely begin the professional development earlier next year. Throughout this professional development, I could sense how tired the teachers were. Teacher B even wrote in his final interview that this professional development “has caused tremendous disappointment.” He went on to explain that he can “see how much fun it could be for both the students and the teacher, how hands on it should be but how the system gets in the way of all that, while in doing so, having done it with the best of intentions.” He later states that “this professional development isn’t solely responsible for this view, in fact, in may have very little to do with it.” I think this captures the overall feeling of tiredness that was communicated in the latter book study sessions. I believe starting this earlier in the year will allow teachers more time to implement changes and avoid the end-of-year exhaustion.
I also plan to offer this type of professional development for teachers of certain courses. Teachers did find the suggestions of their peers valuable. Holding sessions with teachers who are teaching the same course will only add to the pool of knowledge for which teachers can pull.

In future book studies, I will likely keep the structure of the sessions the same. I will continue to adapt it to the teachers’ needs. It is my greatest hope that as I continue leading this type of professional development, teachers will begin to see the value in meeting with their peers and begin to form their own professional learning communities.
References


## Appendix A

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Comment Code</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>General question</td>
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<tr>
<td>Teacher A</td>
<td></td>
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<tr>
<td>Teacher B</td>
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<tr>
<td>Teacher C</td>
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<td>Teacher D</td>
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<tr>
<td>Teacher E</td>
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</table>
Appendix B

Directions

Please mark the response that best answers:
To what extent do you agree or disagree with each of the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Neither Agree nor Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Mathematics should be learned as sets of algorithms or rules that cover all possibilities.</td>
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<td>b. Solving mathematics problems often involves making conjectures, testing, and modifying findings.</td>
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<td>c. It is important for student learning to make connections between mathematics and other subject areas.</td>
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<td>d. All students can learn challenging content in mathematics.</td>
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<tr>
<td>e. The purpose of assessment is to determine which students “have it” and then assign grades and placement accordingly.</td>
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<tr>
<td>f. Students master and retain mathematical algorithms more efficiently through repeated practice than through the use of applications and simulations.</td>
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<td>g. Is it important for students to learn basic mathematics skills before learning algebra and other more advanced mathematics concepts.</td>
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<td>h. The goal in mathematics is to obtain the right answer.</td>
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<tr>
<td>i. The purpose of assessment is to inform instruction.</td>
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<tr>
<td>j. Students learn mathematics by discussing mathematical concepts and applications.</td>
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<td>k. Students learn best by imitation and memorization.</td>
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<td>l. Teacher questions can lead student discussions beyond short, discrete responses to in-depth dialogue.</td>
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<td>m. Questions can be used to engage students in mathematics.</td>
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<tr>
<td>n. There are different ways to solve most mathematical problems.</td>
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<tr>
<td>o. It takes time, practice, and planning to ask effective questions.</td>
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<tr>
<td>p. The purpose of questioning is to guide students to the correct answer.</td>
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<tr>
<td>q. Questioning is an essential component of effective instruction</td>
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Additional comments:
Appendix B (continued)

**Directions**

**Please mark the response that best answers:**
**How often do you:**

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**Additional comments:**
Appendix C

Questions and student response types will be categorized in the chart in the following page.

Questions types are defined as:

**Managing question**: A question intended to assist with classroom management, organization, or directions.

**Mathematics procedural or recall question**: A question that asks students to identify a step-by-step procedure or asks students to call or state facts about mathematics.

- Example: Mathematics procedural--What do you do next in this equation? What is five times four?
- Example: Recall question—What is the correct vocabulary for the bottom part of a fraction? What is the inverse of addition?

**Clarifying question**: A question that asks students to clarify their thinking or explain their work and asks for no further thinking.

- Example: How did you get your answer?

**Orienting questions**: A question that is intended to get students started or “unstuck”.

- Example: Have you made a chart?

**Prompting mathematical thinking**: A question that asks students to apply, analyze, evaluate, or create mathematics or mathematical proofs or one that asks students to further their thinking beyond their initial explanation of their process.

- Examples: Why did you choose to divide? Do you see a pattern?

Student responses are defined as:

**No answer or answered with a question**: A student does not respond to the teacher’s question or asks the teacher what he/she means.

**Short, discrete answers**: Yes or no answers or answers that contain only the factual information requested in the question.

- Examples: 5; I divided.

**Extended answer**: An answer that includes explanation of the process or thinking that took place.

- Example: I divided $100 by 4 because four people shared the cost.
Appendix C (continued)

Teacher ID: _________________________________________  Observation number: ________________________________

<table>
<thead>
<tr>
<th>Question type</th>
<th>Student response type</th>
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<tr>
<td>Managing question</td>
<td>Mathematics procedural or recall question</td>
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<td></td>
<td>Orienting question</td>
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Appendix D

Round 1 interview questions:
1. For how many years have you been teaching? How many of those years have been in OPS?
2. What grade(s) and/or courses do you teach?
3. Why were you interested in participating in this professional development?
4. What were your feelings when before, during, and after the first study session?
5. What are your thoughts on the value and direction of the study sessions?
6. Explain your thoughts on how students best learn mathematics. What is the role of the teacher in this process?
7. Explain your thoughts on the role of questioning in the classroom.
8. After participating in a study session and reading about questioning, in what ways have you altered what you do in terms of teaching?
9. Do you have anything else to add?

Round 2 interview questions:
1. What would you like to say thus far about the study sessions?
2. What changes would you make to the book study?
3. Now that we have met several times and you have read about questioning, how has your teaching been impacted?
4. On a scale of 1 to 10, with 1 being the highest, where would you rank questioning in terms of its importance in your teaching?
5. If I had asked you to rank questioning prior to this professional development, where do you think you might have ranked it?
6. Explain your thoughts on how students best learn mathematics. How do you see your role as a teacher in the learning process?
7. Explain your thoughts on the role of questioning in the classroom.
8. Do you have anything else to add?

Final interview questions:
1. In the first interview, you were asked why you were interested in this professional development. Has it met your expectations? Please explain.
2. What in this professional development has impacted your practices as a math teacher?
3. In what ways has this professional development impacted your beliefs and understanding of teaching mathematics?
4. How has this professional development impacted your beliefs and understanding of questioning in the mathematics classroom?
5. What during this professional development influenced you the most? The least?
6. Overall, what are your feeling regarding this professional development?
7. Should a similar professional development be offered again, what modifications would you suggest and why?
8. Do you have anything else to add?
Appendix E

List of journal prompts provided to teachers:

1. What are your thoughts on the most recent study group session?
2. In regard to the reading, what has been your most significant learning thus far? Why do you feel that way?
3. Are the study group session proving to be valuable to you in anyway? Please explain.
4. As this professional development experience has progressed, has your participation in the study sessions changed? Why or why not?
5. What is the purpose of questioning in your classroom?
6. As this professional development has progressed, has your view on the purpose of questioning in your classroom changed in any way? Please explain.
7. Write about classroom discussions that are taking place in your class. Are you satisfied with the quality and depth of the discussion?
8. Do the types of questions you ask in your classroom impact students’ mathematical thinking?
9. How do students respond to the various types of questions you ask? Can you give an example?
10. Give an example of a questioning experience/student response in your classroom that you feel was enhanced because of your participation in this professional development?
11. What do you notice about your questioning practices and students’ responses to your questions?
12. Reflect on your recent classroom experiences. Give examples that you might consider a “missed opportunity” to further question students?
Appendix F

Assigned Journal prompts:

After January 21 book study:
• No prompt assigned

After February 4 book study
• Choice from:
  o What are your thoughts on the most recent study group session?
  o In regard to the reading, what has been your most significant learning thus far? Why do you feel that way?
  o Are the study group sessions proving to be valuable to you in anyway? Please explain.
  o As this professional development experience has progressed, has your participation in the study sessions changed? Why or why not?
• Refer to the list of reflection questions on page 19 of the text. The first one is "does the culture of my classroom support quality questioning?". Tell me a little bit about your classroom culture and your thoughts on building a culture as was described in Chapter 1.

After February 18 book study
• In regard to the reading, what has been your most significant learning thus far? Why do you feel that way?
• What do you notice about your questioning practices and students’ responses to your questions?

After March 9 book study
• Write about classroom discussions that are taking place in your class. Are you satisfied with the quality and depth of the discussion?
• Give an example of a questioning experience/student response in your classroom that you feel was enhanced because of your participation in this professional development.

After April 1 book study
• Are the study sessions proving to be valuable to you in anyway? Please explain.
• As this professional development experience has progressed, has your participation in the study sessions changed? Why or why not?
• Do you think your questioning practices are changing? If so, how and why? If not, why not?
• Between now and next time (April 15), intentionally plan and implement at least one good question. By this I mean, while lesson planning, decide on a question purpose, mathematical content, and cognitive level and then be sure the question is worded clearly.

After April 15 book study
• No prompt assigned
### Appendix G

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<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Neither Agree nor disagree</th>
<th>No response</th>
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<tbody>
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<td>a. Mathematics should be learned as sets of algorithms or rules that cover all possibilities.</td>
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<td>A, D, E</td>
<td>C</td>
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<td>D, E</td>
<td>A, C</td>
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<tr>
<td>b. Solving mathematics problems often involves making conjectures, testing, and modifying findings.</td>
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<tr>
<td>c. It is important for student learning to make connections between mathematics and other subject areas.</td>
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<td>d. All students can learn challenging content in mathematics.</td>
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<td>A, C, E</td>
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<td>e. The purpose of assessment is to determine which students “have it” and then assign grades and placement accordingly.</td>
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<td>f. Students master and retain mathematical algorithms more efficiently through repeated practice than through the use of applications and simulations.</td>
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<td>B, C, D</td>
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<td>g. Is it important for students to learn basic mathematics skills before learning algebra and other more advanced mathematics concepts.</td>
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<td>A, B, C</td>
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<td>B, C, E</td>
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<td>h. The goal in mathematics is to obtain the right answer.</td>
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### Appendix G (continued)

#### i. The purpose of assessment is to inform instruction.

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<tbody>
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<td>B, D, E</td>
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<td>A</td>
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#### j. Students learn mathematics by discussing mathematical concepts and applications.

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<td>A, B, C, D, E</td>
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<td>A, B, C, D, E</td>
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#### k. Students learn best by imitation and memorization.

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#### l. Teacher questions can lead student discussions beyond short, discrete responses to in-depth dialogue.

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<td>B, D</td>
<td>A, C, E</td>
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#### m. Questions can be used to engage students in mathematics.

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#### n. There are different ways to solve most mathematical problems.

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#### o. It takes time, practice, and planning to ask effective questions.

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#### p. The purpose of questioning is to guide students to the correct answer.

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#### q. Questioning is an essential component of effective instruction.

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