EXPLORATORY STUDY INTO THE RELATIONSHIP BETWEEN FACTORS
RELATED TO TEACHER QUALIFICATION, SCHOOL CONTEXT, AND THE
REPORTED PROFESSIONAL DEVELOPMENT OUTCOMES

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EXPLORATORY STUDY INTO THE RELATIONSHIP BETWEEN FACTORS
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REPORTED PROFESSIONAL DEVELOPMENT OUTCOMES

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DEDICATION

I dedicate my dissertation work to my heart of hearts, my family. A special feeling of gratitude to my loving and very patient husband, Johnathan M. Smith whose words of encouragement, daily reminder that grit is needed throughout this process, and the cheapest proofreader I could hire. My children Zane and Samantha who have never left my side and are very special. All three of you have been my best cheerleaders.

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LIST OF ABBREVIATIONS

Abbreviations	Explanation
1. ANOVA.....	Analysis of Variance
2. BA/BS	Bachelor Degree
3. CK	Content Knowledge
4. DESE.....	Department of Elementary and Secondary Education
5. DHE.....	Department of Higher Education
6. EdS/EdD	Education Specialist/ Doctorate in Education
7. HNSD	High Needs School District
8. HOUSSE	High, Objective, Uniform State Standards of Evaluation
9. HQT.....	High Quality Teacher
10. LEA	Local Education Agency
11. ITQG	Improvement Teacher Quality Grant
12. NCLB	No Child Left Behind
13. MA/MS/MSEd	Master’s Degree
14. MANOVA.....	Multivariate Analysis of Variance
15. MDHE	Missouri Department of Higher Education
16. PCK.....	Pedagogical Content Knowledge
17. PD.....	Professional Development
18. PDEI.....	Professional Development Evaluation Instrument
19. PhD	Doctor of Philosophy
20. PI	Project Investigator
21. PDT	Professional Development Trajectory

22. RFP	Request for Proposal
23. RQ	Research Question
24. SPSS	Statistical Package for Social Sciences
25. TPD	Teacher Participant Data
26. USDE.....	United State Department of Education
27. ZPD	Zone of Proximal Development

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ABSTRACT

This study addressed the question: Is there a relationship between teacher qualifications and school context on reported professional development (PD) outcomes? Data was collected from archived PD for state funded grants awarded in 2006 in the state of Missouri. Seven of the 14 PD programs were selected for this study. A sample of teacher participants that attended the PD program during the summer and academic year 2006-2007 to identify possible relationships between the teachers' qualifications and school context had on the self-reported PD outcomes. The teacher participant data questionnaire (TDP) was the first data source (n=126). The second data source consisted of a questionnaire taken at two points in the PD program, the first was at the end-of summer (n=126) and the second at the end-of-program (n=74).

Quantitative data was obtained from each of the data sources in order to determine 1) teacher qualifications, repeat participant, and school context, 2) if the self-reported PD outcomes differ at end-of summer across teacher factors and school context, and 3) if PD outcomes from the end-of summer were different than outcomes reported at the end-of program. Quantitative analysis was conducted using MANOVA to analyze data comparing the teacher qualifications, repeat participant, and school context on the self-reported change in PD outcomes. Findings showed no significant quantitative

differences in PD outcomes for RQ2. However, they do show significant main effects and interaction for RQ3 as related to a teacher's experience and type of major possessed by the participant.

Chapter 1: Introduction of the Study

There is widespread consensus that teacher quality is critical to student learning. Research provides evidence that teacher quality is an extremely important determinant of student test scores (Rockoff, 2004; Rivkin et al., 2005; Hanushek and Rivkin, 2006; Kupermintz, 2002; Mendo 1998; Wright et al. 1997; McCaffrey et al. 2003). Researchers and policymakers are increasingly focused on measuring student achievement as a primary indicator of teacher quality (Darling-Hammond, 2000; Wenglinsky, 2000; Rothstein, 2008). Nye et al. found “substantial differences among teachers in the ability to produce achievement gains in their students” (2004, p. 253), with students who were placed in the classroom of less effective teachers resulting in scores that were one third of a standard deviation less than that of their peers who were placed in the effective teacher’s’ classroom. Indeed, Wright et al. claim “more can be done to improve education by improving the effectiveness of teachers than by any other single factor” (1997, p.63).

In light of this, calls for reform and increased accountability have been accompanied by calls for improving teacher quality. For example, the United States has initiated an environment of high stakes educational assessment and change. Federal policies like the NCLB of 2002 called for sweeping changes in state and national accountability systems, new certification requirements and procedures, and incentive systems for mathematics and science teachers. States were mandated to ensure that schools hire only “highly qualified” teachers beginning in the 2005 school year. The federal definition of a highly-qualified teacher (HQT) is one who meets all of the following criteria: 1) holds at least a bachelor degree (BA) from a four-year institution, 2) fully certificated or licensed by the state and 3) demonstrates competence in each core

academic subject area in which the teacher teaches (U.S. Department of Education, 2002).

Each state then clarified the meaning of HQT, for example, the Mid-Western's Department of Elementary and Secondary Education (DESE) in 2002 defined a HQT as a teacher that:

Has obtained full State certification as a teacher or passed the State teacher licensing examination and holds a license to teach in the State, and does not have certification or licensure requirements waived on an emergency, temporary, or provisional basis; hold a minimum of a bachelor's degree; and demonstrated subject-matter competency in each of the academic subjects in which the teacher teaches (p.10).

Since the enforcement of the No Child Left Behind (NCLB) Act of 2001 ("No Child Left Behind Act of 2001: Qualifications for Teachers and Professionals," 2001) were mandated, states have experienced increased demands for accountability and ways to quantify teaching, student learning, and teacher training. Not all states demonstrated progress, and some policies have proved more impactful than others.

States experiencing progress in increasing student learning are taking two clear policy steps: 1) they are identifying teaching standards that identify what teachers should know and be able to do at different points in their careers, and 2) they use these standards to develop more thoughtful certification and licensing systems, more productive teacher education and induction programs, and more effective professional development (PD) (Loucks-Horsley et. al 2003, p. 69).

In this way, NCLB influenced not only K-12 education but also teacher preparation program/s and PD design. That is, PD has become a primary means to improving teacher quality.

PD providers, supported by federally funded monies via programs such as *Mathematics and Science Partnerships* and *Improving Teacher Quality Grants (ITQG)*, are designing and delivering a growing number of opportunities for in-service teachers to strengthen their teaching practices. With the significant amount of money, approximately \$1.2 million each year in federal funds invested in this PD initiative through the department of higher education (Department of Higher Education, 2015), it's expected that the program/s supported would produce measurable improvements in teacher quality that would, in turn, improve student achievement. As a result, the outcomes of PD program/s are increasingly under scrutiny (Rowe, 2003; McMahon, 2005; Rice & Roelike, 2009). However, program outcomes are determined by more than just the quality of the PD design.

Background of the Study

Factors that Influence PD Outcomes

Outcomes of PD such as improved teacher classroom practice may be influenced by a number of factors. These include but are not limited to: structural features of program/s (e.g., length), contextual factors (e.g., school support), process features (e.g., emphasis on content; active learning; examination of student work; feedback; follow-up) and characteristics of the PD participants themselves (e.g. non-assessed measures like highest degree obtained) (Guskey, 2000; Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2009; Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009).

The Design of PD Program/s. According to Loucks-Horsley (2001), “the nature of professional development program in which teachers participate will, to a large extent, determine the changes in students’ learning experiences” (p. i). Research by Loucks-Horsley et.al (2003), has identified several characteristics of effective PD program/s. These seven principles that are present in effective PD experience are:

- driven by a well-defined image of effective classroom learning and teaching,
- provide opportunities for teacher to build their content and pedagogical content knowledge and skills and examine practice critically,
- research based and engage teacher as adult learners in the learning approaches they will use with their students,
- provides opportunities for teacher to work with colleagues and other experts in learning communities to improve their practice,
- support teacher to serve in leadership roles,
- provide links to other parts of the educational system and,
- designed based on data that determine their focus and priority as they related to student learning and they are continually evaluated to ensure a positive impact on teacher effectiveness, student learning, leadership and school community. (p. 46-47)

PD program providers who do not account for these principles when planning PD will fall short in accomplishing the reform task they set out to achieve.

In addition, Guskey (2000) suggested that there are four values to look for in effective PD. These are 1) a focus on learning and learners, particularly the students; 2)

an emphasis on both individual and organizational change; 3) the inclusion of small, manageable change guided by a grand vision; and 4) continuously embedding the PD practices in all aspects of a teacher's work. By combining the seven principles and the four values of effective PD, teachers and students will profit from a stronger PD program/s based on the needs of the individual school district.

School Context. Richard DuFour (2001) writes, “In the right school context, even flawed PD activities (such as the much maligned single-session workshop) can serve as a catalyst for professional growth. Conversely, in the wrong school context, even program/s with solid content and training strategies are unlikely to be effective” (p. 14). *Designing Professional Development for Teachers of Science and Mathematics* (2003) by Loucks-Horsley et al. relies on many dimensions to describe the contexts that are involved in influencing student outcomes when planning and designing a PD program. The authors have several dimensions that would fall under the contextual factors category. The first-dimension states, PD planners must have a “clear picture of who the students in the system are, what standards are in place for them, and how they are performing [on state assessments] in relation to those standards” (p. 56). The second dimension in this category would be related to the organizational culture or school culture, “because the culture can make or break a professional development program, strengthening the learning community must be a central and consistent goal of all professional development” (p. 62). The third dimension related to contextual factors that influence PD program/s is the school’s organizational structure and quality of their leadership, the school’s leadership “asserts a powerful and pervasive influence on individual behavior and professional development” (p. 66-67).

School districts are often instrumental in overall change in instructional change. When a district does decide to encourage a total school make-over, the results of the total change can be successful if handled correctly (Johnson, 2007). In addition, Wei et al. (2009), found that if PD was not connected to local reform efforts, the PD was not as effective. The authors found some secondary benefits to overcoming professional isolation. Teachers working together or with professional relationships across grade levels or subject areas were beneficial for the long-term effect of the PD program/s. Mentor coaching, peer observations, videotape classroom methods can help overcome professional isolation. PD is successful when the PD providers like the ones described in Wei et al. (2009) assesses a variety of techniques for improvement based on the willingness of the district to support the program on an extended basis; not just an afternoon instructional presentation.

Teacher Characteristics and Qualifications. A third influence on PD outcomes are the characteristics and qualifications of the teacher participants themselves. These qualifications and characteristics are described by researchers as the toolbox that each teacher brings to the classroom. Researchers have identified the contents of this toolbox to include; teacher behaviors, practices and beliefs; subject knowledge, pedagogical knowledge, experience; certification status; and general ability (Croninger, Rice, Rathbun, & Nishio, 2007; Lakshmanan, Heath, Perlmutter, & Elder, 2010; Moyer-Packenham, Bolyard, Kitsantas, & Oh, 2008; Wayne & Youngs, 2003). Other researchers classified these characteristics as “teacher quality” or more simply their credentials, knowledge, and experience. (Clotfelter, Ladd, & Vigdor, 2007a, 2007b; Metzler & Woessmann, 2010; Rockoff, 2004); and still, another uses the term “teacher

effectiveness” when it comes to dealing with teacher background qualifications (Palardy & Rumberger, 2008). One article goes as far as categorizing the characteristic by whether they are “variables gathered as assessment measured (i.e., response to test items or teaching performance during an observation) and non-assessment measures (i.e., highest degree obtained or number of year of teaching experiences)” (Moyer-Packenham et al., 2008, p. 564). For the purpose of this study Geo & Stickler’s definitions of teacher qualifications and characteristics will be utilized:

Teacher qualifications are the credentials, knowledge, and experience that teachers bring with them when they enter the classroom, such as Coursework, grades, subject-matter education, degrees, test scores, experience, certifications), and evidence of participations in continued learning (e.g. internships, inductions, supplemental training, and professional development), while teacher characteristics are the attitudes and attributes that teachers bring with them when they enter the classroom such as Expectations for students, collegiality or a collaborative nature, race and gender (2008, p. 2).

When exploring the literature regarding the first category, teacher qualifications, research shows that certain types of teacher qualification matter and are associated with increased student achievement. In particular, the two-key qualification that show a strong positive effect on student learning are the teachers’ knowledge, which includes both content knowledge (CK) and pedagogy content knowledge (PCK), along with teachers’ level of experience. Teacher experience has an added caveat, “that experience, especially during the first couple of years in the classroom, is positively associated with student achievement in mathematics and reading at the elementary and middle school levels

(Cavalluzzo, 2004; Hanushek et al., 2005; Rockoff, 2004; Rowan, Chiang, & Miller, 1997)” (Goe & Stickler, 2008, p.6) but after five year the experience level of the teacher doesn’t seem to have such an impact on student achievement scores (Carr, 2006; Gallagher, 2004). Participation in continuing education is also considered a teacher qualification. Studies have shown that PD that is sustained, aligned with curriculum and focused on instruction has a positive impact on school-level achievement (Johnson, Kahle, & Fargo, 2007a, 2007b).

There are some teacher qualifications that are not strongly associated with student achievement gains which are related to the teachers’: 1) possession of an advanced degree (Monk, 1994), 2) licensure or recertification test scores (Hanushek et al., 2005), and finally 3) the undergraduate institution the teacher attended (Cavalluzzo, 2004).

When exploring the literature on the second category, that of the teacher characteristics, the teachers’ social capital, expectations and race all showed little variability when determining the effectiveness of PD program/s that were linked to student achievement. (Johnson, 2006; Clotfelter et al., 2007a). This is due, in part, to the fact that these attributes were measured at the school-level, or due to insufficient sample size. While not statistically significant, these characteristics did offer some ideas for tailoring professional development program/s to participant (Frome et al., 2005; Rowan et al., 2002; Goddard, Hoy, & Hoy, 2000; Hanushek et al., 2005; Metzler & Woessmann, 2010).

Purpose of the Study

The purpose of this study is to explore the extent to which various teacher qualifications are associated with outcomes of PD program/s offered by the ITQG in one

Midwestern state. The study was designed to further our understanding of how factors related to participants themselves may account for variations in PD outcomes of program/s supported under ITQG.

Context of the Study

In September 2005, the Mid-Western State's Department of Higher Education (DHE) announced a request for proposal (RFP) for Cycle A of the ITQG Program. These grants replaced the former Eisenhower PD Program. The purpose of the grants was to offer PD for teachers "to improve math and/or science achievement in Mid-Western's high-need school districts, targeting all grade levels four through eight (4-8) in mathematics and/or science content areas" (Abell et al., 2007, p. 1). The ITQG program/s are an excellent source of data to identify if there is a relationship between teacher qualities, school context, and the PD program outcomes. This analysis would inform research in the field of PD with the potential of improving the design of PD as a whole. Thus, in turn, advances the field of research related to teacher qualifications with the "optimistic goal of helping policymakers and others develop and implement policies and practices that hold the greatest promise for improving student learning" (Goe & Sticker, 2008 p. 16).

Research Question(s) and Hypotheses

The primary purpose of the study is to examine teacher qualifications and school context and their relationship to PD outcomes for ITQG first year participants and 2+ year participants. There for the first objective is to answer the following research question (RQ):

1. What are the reported teacher qualifications, repeat ITQG participant, and school context on the Teacher Participant Data Questionnaire (TPD)?

2. How do self-reported Professional Development Evaluation Instrument (PDEI) PD outcomes differ at the end-of-summer institute across teacher qualifications, repeat ITQG participant, and school context?

H₀₁- There is no significant difference PDEI PD outcomes at the end-of-summer institute across teacher qualifications, repeat ITQG participant, and school context.

3. Are self-reported PD outcomes from PDEI at the end-of-summer different than outcomes reported at the end-of-program? Does this vary based on participant's demographics?

H₀₂- There is no significant difference between the self-reported PD outcomes between early career teachers (0-5 yrs.) and beyond (6+ yrs.)?

H₀₃- There is no significant difference between the self-reported PD outcomes between reported education levels of the participants (Bachelors+ or Masters +).

H₀₄- There is no significant difference between the self-reported PD outcomes between participants who have a science or science education degree and participants who hold any other reported degree?

H₀₅- There is no significant difference between the self-reported PD outcomes between PD program participants who teaching in a high needs school districts (HNSD) and those that do not teach in a HNSD?

H₀₆- There is no significant difference between the self-reported PD outcomes between repeat PD program participants and non-repeat PD program participants?

Assumptions

This study makes the following assumptions:

1. Modern quantitative research (post 1970) tends to be post-positivists and insists that “while any knowledge produced is inevitably fallible, this does not mean that all knowledge claims are equally to be false” (“Teaching and Learning Research Programee: Capacity,” 2009).
2. Outcomes of PD (even high quality program/s) are influenced by a number of factors.
3. In correlation research there is no manipulation of the independent variable by the researcher. There are usually too many other reasons why we might observe the relationship (i.e. The correlation or the difference between groups); that is, there are usually too many extraneous variables that are left unexplained and act as rival or alternative explanations for why something occurs in the world (Creswell, 2009).
4. Correlational research cannot conclude that a relationship is causal when an independent variable and a dependent variable in a non-experimental research (without controls). Therefore, generalization across groups is invalid (Creswell, 2009).

Scope and Delimitations

There are specific boundaries for this study. This research focuses on only teacher participants that participated in science ITQG PD programs from one Midwestern state during one particular RFP cycle. Thus, the study did not include PD programs that provided a combined science and mathematics PD from the same RPF cycle (Cycle A).

Nor did this study look at RFP cycles prior to the one selected nor ones that came after. Thus, the target population of this study is a group of teacher participants who have completed one of seven ITQG science PD projects. All participants had a chance to respond to the TPD and the PDEI instruments.

Limitations

Following is a list of limitations of the study:

1. The study was limited to a non-experimental design (Creswell, 2009). The design weakness was further accentuated by lack of treatment and a control group.
2. The data collections are from an archived source. Researchers do have to be aware of concerns when using archival data; as Rudestam and Newton (2007) state, “archival data sets often suffer from missing, incomplete, or compromised data” (p. 101).
3. Results of the study were reflective of data gathered during PD programs’ summer institutes and following academic school year (July- May) and could not be generalized to other time frames.
4. Selection of the instrument responses (TPD or the PDEI) may have been influenced by participants’ self-reporting, since the participants may report what they believe the project investigators (PI) expect or what reflects positively on their own abilities, knowledge, or opinions.
5. The researcher is part of the evaluation team that utilized the instruments during later cycles of the ITQG program in this Midwestern state employed. Researcher bias was probable due to pre-existing tacit knowledge of PD program/s.

Significance of the Study

While PD providers can influence the outcomes of their PD program/s by adhering to “best” practices suggested by research, there is a lack of information about the practices of PD program/s with regard to how they take into account characteristics of teacher participants that also influence PD outcomes. Borko’s study entitled *Professional Development and Teacher Learning: Mapping the Terrain* (2004) mentions this as a central issue to be research when comparing multiple PD programs and the four elements of PD systems: “facilitator, PD providers, teacher as learners, and context” (p.4). The researcher goes on to say that in order to have comparative data between multiple PD programs, researcher themselves need to gather and analyze data using longitudinal field studies of multiple PD programs using tools that don’t yet exist. Borko goes on to say that the “instruments to measure change overtime in teacher’s subject matter knowledge for teaching and instructional provides, and analytical tools that can separate out the influence of various programs, schools, and individual factors on teacher and student leaning” (2004, p.13.) That is, data regarding teacher qualifications and characteristics appears to be primarily used for program evaluation, and not program design (e.g., tailoring PD efforts toward a specific group or differentiating PD for different attendees). Enhanced understanding of the role teacher qualifications play in predicting project outcomes could support improvements to the design and implementation of PD and enhanced PD outcomes.

Organization of the Dissertation

This chapter provides an introduction to the study, its purpose, and the research questions. Chapter two is a review of the related literature. The review focuses on the

importance of teacher quality, the link between PD, teacher quality, and student achievement, factors that affect PD outcomes, and characteristics of PD participants. In Chapter three, research methods and procedure, research questions and hypothesis, and a discussion of the instruments and the data collection and analysis are presented. Findings are presented in Chapter four. Chapter five contains a summary of the study, major findings, a discussion of results and suggestions for future research.

Chapter 2: Literature Review

The purpose of this chapter is to provide a review of the literature related to this study. The chapter begins by examining PD as a means to improve teacher quality. The next section reviews the factors that affect PD outcomes. The third section provides a summary that identifies the current gaps in the literature and questions for further research. The chapter concludes with a justification for the dissertation study.

Importance of Teacher Quality

When teachers participate in PD as learners, they “penetrate the process of becoming a full participant in a social community by developing identities, engaging with artifacts and apprenticing with experts” (Yerrick, Ambrose, & Schiller, 2008, p. 136). With the advent of school systems encouraging their instructors to improve student achievement and better prepare students for entering the workforce or furthering their education, PD has become a preferred method of updating teachers’ knowledge and skills. However, an assessment of the PD program being implemented is vital to the goal of improving teacher skills in the classroom and student achievement. The NCLB Act of 2001 mandate has solidified the need to improve staff skills and show improvements in student test scores. In that same vein, effective measurement techniques are required to be better understand the reported results. This is the reason that it is vital for research to focus on PD projects that utilize research-based and research-supported models (e.g., Loucks -Horsely et al., 2003 and Luft, Hewson, & Ntemngwa, 2013) to improve teacher quality.

Professional Development as a Means to Improve Teacher Quality

The NCLB Act of 2001 mandated that schools hire only “highly qualified” teachers beginning in the 2005 school year (U.S. Department of Education, 2002). The Mid-Western’s DESE (2002) further clarified the definition of a highly-qualified teacher as one whom:

Has obtained full State certification as a teacher or passed the State teacher licensing examination and holds a license to teach in the State, and does not have certification or licensure requirements waived on an emergency, temporary, or provisional basis; holds a minimum of a bachelor’s degree; and has demonstrated subject-matter competency in each of the academic subjects in which the teacher teaches (p. 10).

Therefore, after college education and state licensure exams, PD can fill the gap in content knowledge and support ongoing education requirements educators need to attain and maintain “highly-qualified” status. An important aspect of reform is the amount, kind, and effectiveness of teacher education that occurs via professional development. The education and PD aspects are significant because of their overall effect on the teaching career itself. “Historically, state policymakers have paid little attention to the form, content or quality of PD...the needs are too urgent and resources too scarce to simply continue or expand today’s inefficient and ineffectual arrangements” (Chval, Abell, Pareja, Musikul, & Ritzka, 2008, p. 32).

PD will come into play when dealing with reform issues. In (2001), Loucks-Horsley defined PD as “a concerted effort to help teachers understand and change their practice and beliefs as they improve their learning experience they provide for students

within their school and districts” (p.i). Loucks-Horsleys continues by saying, “the nature of professional development programs in which teachers participate will, to a large extent, determine the changes in students’ learning experiences” (p.i). Deciding what path the local boards of education will be required to or choose to take in hiring, firing, assessing, and paying teachers is an important element for school districts in the future. Because of the importance of the decided path, a review of the empirical literature to explore teacher characteristics is essential to facilitate the best reform for strengthening the teaching profession

The Link Between PD, Teacher Quality, and Student Achievement

There are several theories related to the effectiveness of the current method of teaching, or the transference of information between teachers and students (Brown, Collins, & Duguid, 1989; Bruce, Esmonde, Ross, Dookie, & Beatty, 2010; Lakshmanan, Heath, Perlmutter, & Elder, 2011). The point of supporting a PD program is to improve teacher effectiveness, thereby improving student outcomes (Wei, Darling-Hammond, & Adamson, 2010; Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009). These types of programs employ varying orientations to assist teachers with the implementation of new teaching strategies and improved CK. These new strategies and the prioritized content they employ are designed to better reach students, engage them in the learning process, and improve their subject knowledge. The present study was designed to explore the extent to which various teacher qualifications are associated with outcomes of PD program/s. The study was designed to further our understanding of how factors related to participants themselves may account for variations in PD outcomes of program/s supported under ITQG.

Teachers' participation in inquiry-based PD program/s, explored in Von Secker's (2002) study, indicated a growth in science achievement when the demographics of the students were calculated as a variable that influenced teacher practices and student learning. Von Secker noted that "inquiry-based instructional practices are associated with academic excellence, regardless of social context" (p. 158). There were indicated limitations in achievement gaps between gender and minority subgroups of students; but overall, inquiry-based programs were shown to be effective.

Even when science PD is combined with other content areas, such as literacy, the same holds true. Lee, Deaktor, Enders, and Lambert (2008) found that, for a large urban school district, offering PD that involved instructional units and workshops in improving teaching practice and fostering positive beliefs about science and literacy achievement led to significant educational gains by students:

Students demonstrated statistically significant gains and large effect magnitudes (Cohen's d) at the end of each school year. The results indicated that the intervention was overall effective in promoting achievement and equity with students from diverse backgrounds. Because our research involved the pre – post experimental design, the absence of a control or comparison group presents a major limitation because of threats to internal validity in establishing the causality of the intervention on students' achievement outcomes (Lee et al., 2008).

In this case, teachers participated for two consecutive years in instructional units on measurement and matter, water cycle and weather, and the living planet (ecosystems and

earth/space science) and focused on inquiry-based science instruction. During the second year, the teachers:

...shared their teaching experiences in small groups by focusing on the problems they had experienced, difficulties their students had faced with particular concepts or skills, and strategies they had used to help their students. Using selected lessons from the instructional units, teachers worked in small groups, presented suggestions for implementing the lessons and activities, discussed students' common misconceptions, and brainstormed about ways to make inquiry tasks more open-ended and student-centered (Lee et al., 2008, p. 731).

There has been much discussion in the educational literature about how certain forms of professional development create "effective" teachers, the final result being that teachers who participated achieve better outcomes for their students. Johnson's (2006) work helps to define what effective teachers accomplish. Effective teachers have lessons that are well designed, flexible and responsive to student needs; thus, their instruction is purposeful and leads to a high level of engagement among pupils.

Factors that Affect PD Outcomes

For as long as a formal educational system has existed, there has been a need for a process to support and sharpen the skills of the teacher. Without PD, a teacher's CK and familiarity with teaching techniques would come only from his or her college experiences, prior to his or her career, and would not undergo any enhancement until retirement. PD is the means by which teachers enhance their teaching skills or PCK and increase or update their CK. Different researchers have identified characteristics that must be present for an effective PD program to accomplish this goal. Effective PD

programs have characteristics that contribute to their effectiveness; these characteristics are summarized in Table 1 and with each research article expanded upon in the section that follows.

Table 1

Characteristics and Dimensions of PD Program/s

Characteristics of PD program/s	Dimensions from supporting literature
Focus on content knowledge (CK)	Opportunity for real-world interactions (Garet, Porter, Desimone, Birman, & Yoon, 2001); Increased knowledge when joined with PCK and student learning (Heller, Daehler, Wong, Shinohara, & Miratrix, 2012)
Focus on Pedagogical skills (PCK)	Needs to be grounded (Loucks-Horsley et al., 1999)
Emphasizes reform-based practices	Plan and practice new strategies (Ingvarson, Meiers, & Beavis, 2005)
Opportunities for active learning	Better translation to the classroom when teachers experience authentic learning (Dubner et al., 2001)
Build learning communities-collaboration	Receive feedback/coaching from colleagues (Garet et al., 2001; Ingvarson et al., 2005); Entire school faculty increased test scores (Johnson, Kahle, & Fargo, 2007a)
Link to the educational system	Focus on the standards (Ingvarson et al., 2005); Student learning (Heller et al., 2012)
Extended length of time to participate in PD	Two months to 1 year in duration (Yoon, Duncan, Lee, & Shapley, 2008); Considered a structural feature of the PD (Capps, Crawford, & Constanas, 2012)

Characteristics of PD Program/s

What characteristics must PD programs possess in order to be effective?

Researchers like Darling-Hammond and McLaughlin (1995) have identified the following elements: PD must engage teachers in concrete tasks of teaching, assessment,

observation, and reflection; engage participants in inquiry, reflection, and experimentation; promote collaboration between participants and developers; connect to or be coherent in the context of current classroom work; offer sustained and continued support; and connects to other aspects of school change, i.e., reforming curriculum policy and teacher training. These elements were expanded upon in the Loucks-Horsley and Matsumoto (1999) study that identified the following components: PD must emphasize inquiry-based learning, investigations, and problem-solving, help build pedagogical skills and CK, model the strategies teachers will use with their students, build learning communities where continued learning is valued, support teachers in leadership roles, link to the educational system, and adapt to ensure positive impact.

In addition to the previous mentioned seven features of effective PD, Guskey (2000) has suggested that there are four main principles of effective PD. These are 1) a focus on learning and learners, particularly the students; 2) an emphasis on both individual and organizational change; 3) the inclusion of small, manageable change guided by a grand vision; 4) the continuous, embedding of PD in all aspects of a teacher's' work. By combining the seven features of effective PD and the four main principles of effective PD, teachers and students will profit from a stronger program based on the needs of the individual school district.

Teacher desire and willingness to improve classroom instruction is also a factor for successful change in teacher instruction. The *Effects of Professional Development on Science Teaching Practices and Classroom Culture* study conducted by Supovitz and Turner in 2000 also supports the historical science education research. Their study

indicated that teachers who participate in more than 160 hours of PD reported more growth than the average teacher.

Note the word “time” or references to devoting extra teacher time often appears in the research presented on successful PD. One such study, similar to Loucks-Horsley, et al. 2003 book: *Designing Professional Development for Teachers of Science and Mathematics*, is Gess-Newsome’s research for her chapter in *Professional Development: Planning and Design (2001)*, states there are several factors within PD learning opportunities that affect the outcome of teachers who participate, these factors should be present: 1) sustained support, 2) designed by and for the individual, 3) connected to classroom practice, 4) having teachers learn science in new ways, 5) challenges pedagogical beliefs and practices, 5) promote incremental change, 6) provide collaboration. A collaborative effort among teachers was the highlighted point being made in the 1995 Darling-Hammond and McLaughlin report.

More recently, Garet et al. (2001) streamlined the elements of positive PD by requiring the following aspects: the PD must focus on CK, provide opportunities for active learning, connect to or interact in a coherent way with other activities, engage teachers in reform-based PD, promote collective participation of teachers, and provide an adequate amount of time for participation. These same researchers also used literature-based best practices to study a national sample of teachers who participated in PD program/s funded by the Eisenhower, Title II grant from the Elementary and Secondary Education Act. They concluded that for PD to be most effective and have a lasting impact, the program/s need to be sustained and intensive. Program/s that focus on developing the CK of the participating teachers and offer opportunities for real-world

interactions are easily integrated into the daily life of the school and are more likely to produce a positive effect.

Ingvarson, Meiers, and Beavis's (2005) Australian study found that PD programs are most effective when they offer opportunities for teachers to:

1. focus on what student were to learn and how to deal with the problems student may have in learning that subject matter,
2. focus on the standards that students should achieve by collaboration with others to examine student work,
3. actively reflect on their practices as it relates to the research-based best practices, their student needs, and the educational standards, and
4. plan and practice new teaching strategies, especially when they can receive feedback and/or coaching from colleagues (2005, p. 15).

Additional research by Johnson, Kahle, & Fargo (2007) indicates that teachers who participated in whole-school PD were linked had a positive impact on student achievement in:

Whole-school involvement insures that students will have continuous opportunities to experience standards-based instruction. Whole-school, sustained professional development provides the opportunity for collaboration of teachers over time which creates a community of learners and enables professional growth, even outside the realm of the program (p. 785).

Finally, Penuel et al. (2007) identified the following elements of successful PD: it must discuss alignment with local, state, and national standards, engage teachers in aligning activities with standards, emphasize the content of a particular curriculum, provide

ongoing and consistent support, and connect to reform-based practices. Regardless of the list to which one subscribes, successful PD is designed to support teacher efforts and ultimately improve student outcomes.

The effects of a PD program follow a logical chain of events: first, it improves teacher's knowledge, skills, and motivation; second, it allows teachers to enhance their classroom teaching by applying these newly enhanced skills; and finally, it raises student achievement in turn. Yoon et al. (2008) reviewed 1,300 studies and found that only nine mixed content-area studies met the "What Works" Clearinghouse evidence standards. The "What Works" standards refer to the PD in terms of "planning, designing, implementing, and allocating resource" (p.2), along with "attesting to the paucity of rigorous studies that directly examine the effect of in-service teacher professional development on student achievement in the core subjects" (p. 7). These nine studies employed best practices in regards to the total number of contact hours (ranged from 5-100 hours with 14 hours showing a positive and significant effect), duration (2 months to 1 year) and intensity.

In 2011, Heller, Daehler, Wong, Shinohara & Miratrix's study of three PD interventions (Teaching Cases, Looking at Student Work & Metacognitive Analysis) showed that teachers who have time to process and implement what was emphasized during the PD—two years, in the case of this study—generated significant increases in both teacher and student CK. The researchers state that:

This study provided strong evidence of efficacy for the three professional development courses tested in that all produced significant increases in teacher and student outcomes...Furthermore, the powerful treatment effects were

maintained in the school year following the study year, when both intervention teachers and their next cohort of students showed gain scores significantly greater than those of controls (based on the study year control scores) (p. 351).

The implication of this study supports “professional development that emphasizes analysis of student learning, pedagogy, and content, rather than focusing on general pedagogy or purely on content” (Heller et al., 2012, p. 356). Programs of this nature have a considerable and longer-lasting influence on teaching and learning in elementary school.

At the completion of a review of the empirical literature, Capps, Crawford, and Conostas (2012) aligned the literature they examined to the following categories or critical features of effective PD: structural features, which include total time, extended support, and authentic experience, and core features, which include coherency, developed lessons, modeled inquiry, reflection, transference, CK. The subsequent research findings fall into the following areas:

1. Enhanced teacher knowledge,
2. Change in teacher beliefs,
3. Change in teacher practice, and finally,
4. Enhanced student knowledge.

Research has found that PD programs that “run for a week or more may be an adequate length of time to help teachers understand aspects of inquiry” (p. 299). It notes that giving “teachers a chance to ask questions and interact with professional developers and their colleagues outside of the workshop, and giving the teacher the opportunity to

receive feedback on new teaching strategies after using them in their classrooms (Garet et al. 2001) is important.

Dubner et al. (2001) stated that “If teachers are expected to enact inquiry-based instruction, engagement in authentic inquiry experience may be a necessary intervention in schools...it is predicted that teachers who experience authentic inquiry, similar to that which they will later enact in their classrooms, will be better able to translate their experiences and related concepts to their students (p. 300). They continue with an analysis of the main findings of the study of the core features of PD programs: “teachers will be more likely to enact a curriculum or changes in their teaching if they see it as relevant to their everyday work” (p. 301); teachers that go beyond simply implementing a prepared inquiry-based lesson plan and enact one that they developed will “benefit from PD experience grounded in the same pedagogical principles (Loucks-Horsley et al. 1999; NRC, 1996)” (p. 301) that they are trying to model. Reflection should be valued just as much as the overall PD experience: “programs that provide explicit time for reflection may encourage teachers to be more metacognitive about what they know, how they know it, and what they do” (p. 302). Context is everything; allowing teachers to explicitly discuss PD materials and experiences will “ensure that teachers will feel comfortable enacting the reform-based curriculum in their classrooms. Additionally, discussions on transference allow the teacher to consider how enactment may look in their classroom” (p. 302). The teacher must develop adequate CK, and failure to do so will result in a teacher that “will likely be uncomfortable with the material they teach and have difficulties when they attempt to teach the material” (p. 302) if CK is not the vehicle in which the reform-based curriculum is delivered.

In the process of completing an empirical literature review, Capps et al. (2012) found that issues concerning teacher's CK, "studies that actively assessed teacher understanding before and after the PD intervention or used multiple methods to verify findings appeared more robust" (p. 303). In examining teachers' beliefs about change, "first, it appears that very few studies systematically assessed teacher beliefs. Second, evaluating teacher beliefs is a difficult endeavor. Further, determining the change in a teacher's beliefs is not necessarily indicative of a change in this teacher's practice. Finally, additional research should focus on alternative ways to assess teacher beliefs beyond primarily using teacher self-reports" (p. 304). When measuring teachers' classroom practices, "it would be useful to conduct pre- and post-observations of teacher classroom practice... these observations can help to serve as a reference point, in addition to lesson plans, interviews, and other data sources, when attempting to characterize a teacher's practice" (p. 304). The researchers found that "it was not possible to determine if the teachers' involvement in the PD affected their students' achievement" (p. 305).

Penuel et al., (2007) conducted a study using a pre-made curriculum, i.e. GLOBE and illustrated the meaning of PD as a way to support the implementation of curriculum material that are aligned to standards. PD is also classified as last less than one day or up to several days over a span of several months. Penuel et al. (2007) incorporate the role of context within teacher's learning, thus, the researcher will be looking a one particular curricular innovation as 1) reform vs. traditional PD, 2) duration and time span, 3) role of colleagues, 4) focus of PD, 5) active learning, 6) coherence, and 7) local supports and barriers. The team had both the GLOBE PD provider and participant complete

instruments, which measured several aspects, for this paper I will be focusing on the changes in teacher knowledge and practice with questions adapting questions from the theoretical framework. When analyzing the data, at the teacher level, the researchers used the theoretical framework to design several independent variables. Some of which were reform-like PD, coherence, and collective participation. It was shown that the more teachers were exposed to PD programs the more the PCK and CK were used in the classroom. It should be noted that there was no statistical significance concerning an increase in teacher's CK or PCK, only to how much the content changes were used.

Borko (2004, cited in Desimone 2009) description of PD because it most accurately depicted what PD programs should strive to attain:

For teachers, learning occurs in many different aspects of practice, including their classrooms, their school communities, and professional development courses or workshops. It can happen in a brief hallway conversation with a colleague, or after school when counseling a troubled child. To understand teacher learning, we must study it within these multiple contexts, taking into account both the individual teacher-learners and the social systems in which they are participants (p. 182).

A study completed by van der Valk and de Jong (2009) emphasized school-based PD Trajectory (PDT), focusing on using Vygotsky's sociocultural notion of the "zone of proximal development" (ZPD). "This zone reflects the distance between the actual development level of the learner as determined by activities that can be performed without assistance and the potential development level of the learner as determined by performance of tasks under guidance of a more capable person," written by van der Valk & de Jong (p. 5). They go on to say:

In our experience, open-inquiry by scaffolding is difficult to carry out as the teachers are not prepared for the role of giving students space, as well as, structure, and they do not see this role exemplified by their colleagues at school. This underscores the need to support teachers who want to implement open-inquiry settings in guiding students by scaffolding (van der Valk & de Jong, 2009, p. 6).

During this project, a community of practice was established between the secondary-school science teachers and science teacher educators for this PDT. “The secondary school teachers’ contribution to the community included preparing and reporting about guiding their students’ open-inquiry learning, whereas contributions by the teacher educators included preparing and scaffolding the teachers in taking on their new roles” (van der Valk & de Jong, 2009, p. 2). The PDT consisted of four parts: orientation, preparation, enacting, and evaluation. The researchers’ findings support the idea that scaffolding is not only known to be effective for students but is also an effective strategy for use in science teacher PD. They conclude that “[PDT] innovations should focus on active, autonomous learning and promote communication about science among students and between students and their teacher(s)” (van der Valk & de Jong, 2009, p. 22).

In summary, the literature emphasizes the importance of the characteristics of PD programs themselves including; (a) improve teacher’s knowledge and skills, (b) focus on the standards by using reform-based practices, (c) provide collaboration through ongoing and consistent support, (d) help teachers apply the newly enhanced skills in order to impact student achievement. In light of this, the present study pays specific attention to the PD outcome related survey questions found on the PDEI questionnaire. The

participants were asked to rate how much a PD component was emphasized during the PD session, including but not limited, to (1) improving content knowledge, (2) using inquiry-based/ problem-centered teaching, (3) implementing activities in the classroom.

Characteristics of Participants

Teacher Qualifications. In addition to considering PD characteristics, as outlined above, research has also focused on teacher qualifications. Geo & Stickler (2008) define teacher qualifications as

the credentials, knowledge, and experience that teachers bring with them when they enter the classroom, such as coursework, grades, subject-matter education, degrees, test scores, experience, certifications), and evidence of participations in continued learning (e.g. internships, inductions, supplemental training, and professional development) (p. 2).

With these factors in mind, it is important to remind ourselves about the link between teacher qualification and student achievement. It should come as no surprise that the teacher quality is related to the qualifications the teacher brings to the classroom and this level of expertise can be influenced by the type and quality of the PD program the teacher attends.

Content Knowledge and Pedagogical Content Knowledge. Chval, Abell, Pareja, Musikul and Ritzka (2008) PD “must consider teachers as learners, extensive opportunities to develop knowledge and skills in both content and teaching via community-centered, knowledge-centered, learner-centered and assessment-centered learning environments...[and] provide opportunities for feedback, revision, and success” (p. 32). Kennedy (1998, cited in Chval et al., 2008) noted that professional development

experiences focused on subject matter knowledge, and knowledge of students were more likely to have a greater impact on student learning than professional development focused on teaching behavior” (p. 32) was also mentioned by this group of researchers. This study supported the effectiveness of PD program/s in increasing teacher CK and PCK. This study also quantified the amount of programming needed to be at 35 hours or less. Additionally, it was noted that rural teachers network less and, therefore, need PD opportunities more.

The Kanter and Konstantopoulos (2010) study focuses on PD that focused on ways to increase teacher’s CK and PCK through “practice-based” PD providers. Practice based PD aims to “use any of a variety of learning activities to support teachers in applying what they learned to their own practice, to resolving problems they were experiencing in their own classrooms” (p. 859). During this study, the teachers participated in a for-credit graduate-level course, three hours a week for ten weeks. The researcher administered student pre-and posttest with items of cognitive questions, bloom's taxonomy emphasized. The teacher’s degree of CK and PCK was measured using an instrument like a content assessment thus providing a pre-and post CK scores while PCK used written analysis and coding of the teacher’s videotaped session of the participant teaching. Statistical analyzes via looking for changes in student’s science achievement, attitudes, and plans using the curriculum, as well as, the effect size of CK and PCK. The researchers found that PD could improve both CK and PCK of the teacher who attended the program.

Timperley & Alton-Lee (2008) took an additional step with using PCK as a framework they incorporated responsiveness-to-diversity. This article encompasses a

review of 97 empirical studies; in regards to what PD means it is the very of learning opportunities that teachers can, are being provided. One example is the teacher-as-good-employee view teacher can learn and can do so in a short burst of delivered knowledge from superiors, i.e. single workday workshops. While another give teachers a little more credit and “engages” them in opportunities to learn. “Black & William (1998) reminds us that there is no direct relationship between a particular act of teaching and what students learn” (p. 340). The research team does take a closer look at the content of PD opportunities via the 97 studies. Using Shulman’s idea of PCK, the researchers added a third attribute to “qualify” for their review, PD need to combine a “deepening of curriculum CK with particular teaching approaches” (p. 342). The researchers go on to unpack the learning process of the teachers during the studies being examined. “The knowledge and the skills teachers acquire through participating in the professional learning experience and the learning process engaged provided the strongest explanation for differential impact of students” (p. 344). Identifying four learning processes 1) cueing and retrieving prior knowledge with the outcome of consolidating it or alternatively, examining it for its adequacy, 2) becoming aware of new information or skills and integrating them into current values and belief systems, 3) creating dissonance with current beliefs, attitudes, or knowledge of effective practice, and 4) acknowledgment of the importance of social situations of learning and judge one’s own work through self-regulation. Timperley & Alton-Lee (2008) “when coding the presence or absence of any of these attributes in the analysis...simultaneously considered the depth to which the content was addressed” (p. 344) these “components formed a theoretical map against which the empirical studies were analyzed” (p.345). “Each attribute was treated as neutral

until it was tested against the evidence thus helped to identify what kinds of teacher knowledge and the circumstances under which it was acquired were associated with benefits to students” (p. 346) more specifically the range and mean effect sizes for all effects for example the categories of attitudes toward: subject, self-efficacy, and social outcomes: cognitive processing. The researcher went on to infer the learning processes from the descriptions provided by the provider this “interplay between developing knowledge and the learning process” (p. 351) was difficult. In this study, it was shown that PD is an effective way to improve teacher CK and PCK across several factors in a review of several studies.

Classroom Experience. Experience in the teaching field would seem to be an important element in the success of student test score improvement, but research has shown this not to be the case. When experience was discussed, it usually pertains to the number of years used by the state to determine a teacher’s salary (Clotfelter et al., 2007a, p. 20). When studies focus on how teaching experience could lead to success teaching it is important that a clear definition of “experience” is obtained. Some research goes on to further define a beginning teacher as a teacher with up to two years’ classroom experience and a veteran or career teacher with five or more years (Croninger, Rice, Rathbun, & Nishio, 2007; Tschannen-Moran & Hoy, 2007).

Unfortunately, research has found “the years of teaching experience is not statistically significant in any subject area” (Goldhaber & Brewer, 1996, p. 205). Additionally, it was found when elementary school students, all of whom received instruction from their self-contained teacher in both reading and math, standardized test scores were matched at the student teacher level “the first two years [of teacher

experience] appear to raise scores significantly in [mathematical] computation. However, subsequent years' lower test scores. There is no statistically significant relationship between teaching experience and math concepts scores" (Rockoff, 2004, p. 250). This was also the conclusion of research by Darling-Hammond et al., (2001). Fortunately, though, as teachers advance in experience and PD in the areas of inquiry-based instruction, students' test results increase (Roehrig, Kruse, & Anne Kern, 2007, p. 886). It can be inferred, then, that what makes a difference is the PD training and how to present the material that one knows.

While one would assume that experience is a sound factor to use by researchers, those same researchers need to realize that several contributing factors can make using experience as a variable in their study hard to interpret. Reviews of literature such as that by Wayne and Young (2003) also include the characteristic of experiences. Generalization could take into account teacher shortages or surplus, teacher motivation to complete PD based on whether they had children that dependent on them at home, even if they participate in a PD program and then choose to leave the profession. Jacob (2007) concurs with this by adding students with teachers who are beyond the first few years are no worse off than more experienced, advanced degrees or certified teachers. However, inexperienced urban teachers "may be less effective at raising student achievement...[and] lack of traditional certification probably does not make them less effective" (p. 139).

Degrees and Coursework. Degrees can be defined a bachelor in their subject area or a graduate degree of any type such as a master's, a Ph.D. or other (Clotfelter et al., 2007). While researchers like Moyer-Packenham et al. (2008) refer to the subject matter

knowledge, a teacher holds and how this knowledge is obtained. This knowledge can be derived from holding a subject specific degree; “whether the teacher is certified in their subject area, and whether the teacher has a BA or Masters (MA) degree in his or her subject area” (Goldhaber & Brewer, 1996, p. 206) or comes from graduate coursework (Monk, 1994).

While investigating the areas of degree level and coursework level mainly in Math and Science, conflicting data was found. After years of experience, degree level is most commonly used as a variable to measure the effectiveness of PD program/s over coursework level. Studies are referring to the educational level of the program participant. Bachelor’s degree, Master’s degree, or some other level of education can show how well the subject of the development program will be assimilated by educators and, in turn, used in the classroom. As can be expected, there are several differences in education and educational level when trying to measure this variable.

Fullan (1996, cited in Jeanpierre, Oberhauser et al. 2005) argued “you cannot improve student learning for all or most students without improving teacher learning for all or most teachers (p.41)””; Jeanpierre, Oberhauser et al. (2005) went on to say teacher and student learning are inextricably linked” (p. 669). As shown science and math teachers must have a content specific knowledge and training to effectively teach. As Wright and Wright (2000) pointed out in their research, “One cannot teach, model or support what one does not know, feel or accept” (p. 137).

Supovitz and Turner (2000) reveals, even more, support of the relationship between teacher knowledge and student success:

The most powerful individual influences on both teaching practices and investigative culture where teachers' content preparation and attitudes towards reform. Each standard deviation of increased content preparation a teacher reported was associated with a 20% increase in the use of both investigative teaching practice and investigative classroom culture. (p. 974)

The results of the research evaluating the need for specific training in a content area for student knowledge improvement are evident and would indicate middle and high school level science and math students will achieve at a higher level if the instructors have continuing specific subject PD. However, this research applies to middle and high school only. An alternative study that draws on math and reading achievement score of 6th-grade rural students, who are taught by the same teacher in both subjects and only have one classroom per grade, have been found to a significant effect of teacher subject knowledge and student achievement. A "one-standard-deviation increase in teacher subject knowledge raises student achievement by about 10 percent of a standard deviation" (Metzler & Woessmann, 2010, p. 20).

Croninger et al., (2007) examined the existing evidence of elementary teacher degree level of student achievement reporting it to be "mixed and inclusive" (p. 314), and that this may be due to the fact that "subject-specific degrees are relatively rare at the elementary level" (p. 316). Once again when PD providers align the needs of their participants within the area of subject matter knowledge research has noted "professional development experiences...were more likely to have a greater impact on student learning than PD focused on teaching behaviors" (Chval et al., 2008, p. 33).

Certification Status. For the purpose of this review the operational definition of teacher certification falls to Moyer-Packenham et al., (2008) who refers certification as a “type of teaching certificate one holds (e.g. secondary mathematics certification, algebra endorsement, or physical science certification)” (p. 566). While states can define licenses into three categories: regular (both initial and continuing), lateral or alternative, and other (e.g. provisional, temporary, and emergency) (Clotfelter, Ladd, & Vigdor, 2010; Croninger et al., 2007) some state can provide the alternative process referred to as High, Objective, Uniform State Standards of Evaluation (HOUSSE) to become “highly qualified”.

It must be noted that certification can mean a teacher is Nationally Board certified by completing a series of exercise and activities designed to test CK via a portfolio (National Board for Professional Teaching Standards, 2009). A review of how manipulating this certification variable is to the effectiveness of PD program/s will be presented.

In Rockoff (2004) research, “raising teacher quality may be a key instrument in improving student outcomes.” In addition to Rockoff (2004) research, Clotfelter et al., (2007b) “shows the effects of certification by subject. Relative to the base case of no certification, being certified in the subject (regardless of the specific subject) is predictive of higher achievement than being certified in a related subject” (p.25). As an example of the above information, the authors go on to state that:

The results for teachers of the two math courses, algebra, and geometry, stand out. Being certified in math increases student achievement in a math course on average by about 0.12 standard deviations, and being certified in any field also

raises achievement in algebra or geometry but by the smaller amount of about 0.05 standard deviations. Certification also matters for biology and [economic, legal and political systems] ELP, but interestingly, the relevant certification apparently does not need to be in the specific field. (p. 26)

Wayne and Youngs (2003) research then asserts that “certification mirror those for degree can be coursework...subject-specific measures matter” (p. 106).

In summary, important teacher qualifications include content and pedagogical content knowledge, degrees, and coursework, and certification status. Yet, how PD providers define and take these into account as variables in studying PD outcomes is important.

Chapter Summary

Chapter two summarized the literature related how teacher quality is highly correlated with student achievement and how PD is an effective means of updating teachers' knowledge and skills thus affecting teacher quality. Improving teacher quality is important and PD programs can have a meaningful impact on teacher knowledge and skills that help determine the quality of student learning experiences. Researchers have found that there is a statistically significant link between the teacher quality and the PD programs in which they participate.

So, if what we are striving to improve are student outcomes and employing quality teachers and providing them quality PD programs to improve their skills is the best path to these goals, then deciding what factors improve PD outcomes becomes paramount. The literature provides strong evidence to guide the design of programs to this effect. First, PD programs must utilize elements that are known to be effective. The

PD must engage teachers in the daily concrete tasks of teaching in their classroom. Any PD program must help the teachers connect to or be coherent with the teacher's current classroom. PD must help build the teacher's PCK and CK over an extended period of time. A PD program must provide follow-up to the initial PD, which helps the teacher to continue to be engaged with the inquiry, reflection, and experimentation of material provided during the PD. Finally, the PD program must encourage collaboration between participants and/or PD program providers.

When research moves beyond identifying only the important elements that affect the outcomes of PD, then the characteristics of the participants within the PD program can also be highlighted as the second factor that needs to be considered when the overall goal is to improve student achievement. Research suggests that PD programs may achieve optimal outcomes when they take into consideration the following participant characteristics: 1) teacher qualifications, 2) content knowledge and pedagogical content knowledge, 3) experience, 4) degrees and coursework, and 5) certification status.

Building on this literature, chapter three presents the research methods and procedure, research questions and hypothesis, and a discussion of the instruments and the data collection and analysis for the present study.

Chapter 3: Research and Method

The purpose of the quantitative correlation study was to explore possible relationships between factors related to teacher qualifications, school context, and the reported PD outcomes. The study utilized archived instrument data gathered in 2006-2007 from the ITQG evaluation project of a Midwestern University using the Teacher Participant Data Questionnaire (TPD) and the Professional Development Evaluation end-of-summer and end-of program instruments (PDEI). A quantitative correlation study research design was employed to investigate factors of the teacher qualifications, school context to support the importance of PD role in the process of Improving Teacher Quality. Chapter three presents the specific research methods appropriate for the research study.

The federal government supports teacher PD to improve teacher quality by providing funding at the national level as well as through ‘trickle down’ funding to states. One promising funding source for statewide PD programs is the Improving Teacher Quality State Grant (ITQG):

The purpose of the program is to increase academic achievement by improving teacher and principal quality. This program is carried out by: increasing the number of highly qualified teachers in classrooms; increasing the number of highly qualified principals and assistant principals in schools; and increasing the effectiveness of teachers and principals by holding LEAs [local education agency] and schools accountable for improvements in student academic achievement (Academic Improvement and Teacher Quality Programs, 2009).

Statewide PD programs, once funded, can be tailored to the needs of the state. These programs can be offered across a vast geographic region to draw teachers from both rural and urban settings. So, within a diverse population of teachers' PD programs need to account for the factors that can affect the PD outcomes. That is where this study can come into play.

Research Design and Rationale

A quantitative correlation study was employed to understand emergent themes in the analysis of the archived data from Cycle A ITQG. The archived instrument data, which entails both quantitative and qualitative information, allowed for the analysis responses related to the teacher qualifications, teacher characteristic, and school context. According to Ary, Jacobs, Sorensen, & Walker (2013) correlational research studies are useful to “1) assess relationships and patterns of relationship among variables in a single group of subjects, 2) correlation can be used to measure consistency (or lack thereof) in a wide variety of cases, and finally, 3) if you find that two variables are correlated, then you can use one variable to predict the other. The higher the correlation, the more accurate the prediction” (p. 370). Using this approach allows the researcher to make knowledge claims based on the post-positivist paradigm. This paradigm limits a study to identifying and measuring variables. The isolation of these variables removes subjective bias and allows the researcher to detect statistical trends (Pedhazur, 1997). By utilizing the data collected from the ITQG PD program's science teacher participants, all results, findings, and analysis can be considered when designing future PD program/s.

Methodology

The correlation research design was appropriate for the current study since the data collected in 2006 from the ITQG instruments was quantitative in nature thus the correlational method was selected. In particular, 16 forced-choice items from the demographic based questions on the TPD questionnaire and the 55-identical force-response items of the PDEI end-of-summer and end-of-program instruments questions supplied data in order to determine whether, and to what degree a relationship exists between two or more quantifiable variables. Responses to these Likert scale on-line pre-and/or post-instrument questions were used to explore, identify, and critically analyze implications of factors related to teacher qualifications and school context to the reported PD outcomes (see Appendix A-C).

Ary et al., (2013) explained that “various considerations need to be taken into account when evaluating the practical utility of a correlation. The importance of the numerical value of a particular correlation may be evaluated in four ways: (1) considering the nature of its population and the shape of its distribution, (2) its relation to other correlations of the same or similar variables, (3) according to its absolute size and its predictive validity, or (4) in terms of its statistical significance” (p. 374). With this in mind, this study plans to draw random samples of equal numbers from each subgroup to assess the influence of such variables as gender and the impact a variable, like gender, will influence on the studies correlation of interest.

Population and Sampling

The target population of this study is teachers who have completed one of seven ITQG science PD projects, specifically those who participated in the summer institute

and follow-up sessions during the preceding academic year. All teachers had a chance to respond to the TPD and the PDEI instruments. This pool of possible research participants included 180 teachers from Cycle A. As noted in Table 2, however, not all 180 teachers provided responses to all instruments.

Table 2

Survey Responses from Cycle A Participants

Project	# Teacher participants ^a	Teacher participant data	Professional development evaluation instrument	
		T ₁	T ₂	T ₃
B	31	30	23	12
D	24	23	21	13
E	24	24	23	19
J	19	19	8	3
K	31	30	28	17
M	24	24	16	8
N	27	27	24	17
Totals	180	177	143	89

Note. T₁: Completed by participants at the beginning of the PD projects; T₂: Completed by participants at the end of the summer institutes; T₃: Completed by participants at the end of the PD projects.

^a Total teacher participants for each project were reported based on data from the Project Participant Data Forms;

Sampling Method

The data used for the study were archived by the external evaluation team assigned to the cycle's ITQG PD programs. For this study, the purposive sampling

techniques were selected since the intent was to focus on particular teacher qualifications of a population that are of interest, more specifically this study used homogenous sampling, which implies intentionally selecting “incidents, slices of life, time periods, or people on the basis of their potential manifestation or representation of important theoretical constructs” (Patton, 1990, p. 177). The use of archived research data was considered as a bounded system because they represented a purposeful sample of teacher participants in Cycle A’s ITQG science PD programs (Patton, 1990). All responses to the two instruments, the TPD and the PDEI, from teacher participants were collected for the purposeful sample. The teacher participants will be selected based on the following criteria which was located in the TPD questionnaire: (a) declared their major was in science education, any science major or other education degree (e.g., elementary education), (b) declared how many years they have taught science at the elementary school, middle/junior high school, or high school level, (c) declared that during the upcoming school year they would be teaching science, and (d) have completed the voluntary instrument questions from within the PDEI.

Informed Consent

Since the quantitative correlation study utilized archived instrument data maintained by the external evaluation team permission to use the participants’ results was secured from each participant at the time they completed the instrument. The evaluation team informed the teacher participants upon login that “the informed consent form provides important information about our data collection activities and your rights as a participant in the evaluation process. We have prepared a single informed consent form that covers all of the evaluation questionnaires we plan to administer. You only need to

provide informed consent one time. If you agree to participate in the evaluation, you should, click the yes radio button, select the Next button, enter identifying information, click the Submit your responses button. If you choose not to participate, in the evaluation, click the no radio button, click the next button, select your PD project from the list, but leave the rest of the ID information blank, click the submit your responses button” (Abell, Arbaugh, Ehlert, Lannin, & Marra, 2006).

Confidentiality

Stringent protocols were followed to ensure instrument respondent confidentiality. The study data and documentation were secured on a secure hard drive through the university and only accessible to those who had verifiable access to the external hard drive. The confidentiality of the participant who responded to the 2006 instrument conducted by external evaluation team was maintained.

Archival Data

The TPD and PDEI instruments were developed by the Mid-western university external evaluator team in 2001 and continued to be administered to teacher participations during Cycle A. The PDEI was developed to measure the perceived improvement in teacher content knowledge after the implementation of a PD project. The TPD was developed to collect background or demographic information related to the teacher qualifications.

Instrumentation

The PDEI consisted of an on-line, pre-and post-instrument that contained 55 identical force-response items. The pre-instrument included questions that were designed to elicit; content addressed during the PD, participant’s perception of content knowledge

change due to the PD, the perceived and anticipated change in teaching practices due to the PD, the participants perceived confidence in this content knowledge and ability to teach the content, and the overall rating of the PD. The post-instrument also included additional items about the nature and perceived benefit of academic PD activities, the perceived impact of the PD on student learning, and the perceived benefit of the PD on the participant's professional practices. The post-instrument also allowed the participants to include open-ended responses or comments.

The TDP was an online questionnaire that contained 22 forced-response items with 2 additional questions that asked the teachers to identify characteristics that make PD useful or effective and why they chose to participate in this project. The forced-choice items ranged from asking the teacher to identify a specific response (i.e. gender as male or female) or to select from the list provided (i.e. how many years have you taught, 0 years, 1-5 years, 6-10 years, 11-25 years or 26+ years).

Data Analysis Plan

All statistical analyses of the quantitative results were conducted with the help of Statistical Package for Social Sciences software (SPSS), version 23. The information presented in this section is based on three data sources—reports submitted to the MDHE by PD project directors, responses to the external review team's Teacher Participant Data Questionnaire (TPD). The data are presented in two sections: 1) characteristics of participants, and 2) characteristics of school districts.

The primary purpose of the study is to examine teacher qualifications and their relationship to PD outcomes. Therefore the first objective is to answer the following research question (RQ):

1. What are the reported teacher qualifications, repeat ITQG participant, and school context on the TPD questionnaire?

2. How do self-reported PDEI PD outcomes differ at the end-of-summer institute across teacher qualifications, repeat ITQG participant, and school context?

H₀₁- There is no significant difference between end-of-summer institute and end-of-program on the PDEI instruments results of PD outcomes.

3. Are self-reported PD outcomes from PDEI at the end-of-summer different than outcomes reported at the end-of-program? Does this vary based on participant's demographics?

H₀₂- There is no significant difference between the self-reported PD outcomes between early career teachers (0-5 yrs.) and beyond (6+ yrs.)?

H₀₃- There is no significant difference between the self-reported PD outcomes between reported education levels of the participants (Bachelors+ or Masters +).

H₀₄- There is no significant difference between the self-reported PD outcomes between participants who have a science or science education degree and participants who hold any other reported degree?

H₀₅- There is no significant difference between the self-reported PD outcomes between participants from high needs school districts (HNSD) and those that do not teach in a HNSD?

H₀₆- There is no significant difference between the self-reported PD outcomes between repeat PD program participants and non-repeat PD program participants?

RQ 1: reported teacher qualification and school context. Demographic

characteristics of instrument participants and other nominal-level data were also analyzed

using descriptive statistics that can include the measure of central tendencies (e.g., frequency, mean, mode, median, variance, range, and standard deviation). These being teacher qualifications (total years of experience, education level, science/science and education major), repeat ITQG participant, and their school context (HNSD).

RQ 2: self-reported PDEI PD outcomes differ at the end-of-summer institute across teacher qualifications, repeat ITQG participant, and school context. MANOVA analysis were used to address research question two using SPSS. Research question two utilized the end-of-summer PDEI instrument which asked participants to rate questions, “rate the following statements based on your experiences in this PD project as they relate to your teaching assignment.” Teachers responded on a four-point scale: “not at all,” to “very much”. The second part of research question also investigated PDEI statements included: “I am more confident in my science/math knowledge needed to be an effective teacher” and “Confidence in my ability to teach has improved” by running a Chi-square.

RQ 3: self-reported PD outcomes from PDEI at the end-of- summer different than outcomes reported at the end-of-program. Does this vary based on participant’s demographics? Due to the nature of the data, MANOVA was employed using SPSS. This analysis will use the teacher qualifications factors (total years of experience, education level, science/science and education major), if they were a repeat participant, and finally the school context (HNSD) in which they teach.

Assumptions for the study

This study makes the following assumptions:

1. The data for the dependent variable will be normally distributed within groups.
2. There is homogeneity of the variance and covariance.
3. There is a linear relationship among all pairs of dependent variables, all pairs of

covariates, and all dependent variables.

Limitations of the Study

Following is a list of limitations of the study:

1. The study was limited to a non-experimental design (Creswell, 2009). The design weakness was further accentuated by lack of treatment and a control group.
2. The data collections are from an archived source. Researchers do have to be aware of the concern when using archival data; as Rudestam and Newton (2007) state, “archival data sets often suffer from missing, incomplete, or compromised data” (p. 101).
3. Results of study were reflective of data gathered during the PD program’s summer institutes and following academic school year (July- May) and could not be generalized to other time frames.
4. Selection of the instrument responses (TPD or PDEI) may have been influenced by participants’ self-reporting, since the participants may report what they believe the PIs expect or what reflects positively on their own abilities, knowledge, or opinions.
5. The researcher is part of the evaluation team that utilized the instruments during later cycles of the ITQG program in this Midwestern state employed. Researcher bias was probable due to pre-existing tacit knowledge of PD programs.

Validity and Reliability

In quantitative research, ensuring the reliability and validity of the instruments are of paramount importance in the decreasing of errors that might arise from measurement problems in the research study. Reliability refers to the accuracy of the measurement

procedure and validity refers to the measure describing what it purports to describe (Plano Clark, Garrett, & Leslie-Pelecky, 2010). Results from the PDEI instruments will be expressed by the “Pearson r coefficient” (Pedhazur, 1997). PDEI’s content validity by aligning the instrument items with commonly cited components of effective PD from the RFP and the research literature. As part of the PDEI instrument, the study asked teachers to indicate the degree to which they perceived improvement in their instructional practices as a result of their experience in the ITQG Program. The study examined this instructional improvement in five categories: (a) instructional materials, (b) collaboration, (c) assessment, (d) pedagogy, and (e) content knowledge. These categories were reduced for both the end-of-summer and end-of-program PDEI instrument to two factors using a factor analysis Cronbach’s alpha was calculated based on the two-factor areas of teaching knowledge and skills, and classroom activities and materials, Tables 3 and 4.

Table 3

Perceived Improvement in Teaching Practice PDEI End-of-Summer

Factors	Items	Cronbach’s alpha
Teaching knowledge and skills	5	.839
Classroom activities and materials	6	.866

Table 4

Perceived Improvement in Teaching Practice PDEI End-of-Program

Factors	Items	Cronbach's alpha
Teaching knowledge and skills	4	.878
Classroom activities and materials	7	.867

Chapter Summary

Chapter three presented the purpose and goals of the study and the appropriateness of utilizing a quantitative correlation study design. The correlation study utilized archived data from a cycle A's ITQG instrument conducted by the Midwestern University's external evaluation team for the department of Higher Education related to 2006 teacher participants' PD program outcomes. Moreover, the study design allowed for the examination of relationships between teacher qualification and school context factors related to the PD outcomes from instrument data collected around categories contributions of PD aspect to professional practices (i.e., content knowledge, pedagogy, instructional material, assessment, and communication and collaboration), and teacher confidence in subject matter and teaching knowledge (Creswell, 2009). The chapter also described the population under investigation, sampling framework, and data collection and analysis methods to be used. An explanation of the instrument, and the study reliability and validity was also provided. Chapter four presents the study results.

Chapter 4: Results

The most recent NCLB Act of 2001 mandated that schools hire only “highly qualified” teachers beginning in the 2005 school year (U.S. Department of Education, 2002). The point to supporting a PD program is to improve teacher quality and effectiveness, thereby improving student outcomes. Funding for statewide PD programs, therefore, represent a school district’s commitment to student success. One such funding source for statewide PD programs is the ITQG.

The purpose of the program is to increase academic achievement by improving teacher and principal quality. This program is carried out by: increasing the number of highly qualified teachers in classrooms; increasing the number of highly qualified principals and assistant principals in schools; and increasing the effectiveness of teachers and principals by holding LEAs and schools accountable for improvements in student academic achievement (Academic Improvement and Teacher Quality Programs, 2009).

The success of a PD program in achieving its intended outcomes, however, is influenced by a variety of factors. The purpose of this study was to explore possible relationships between factors related to teacher qualifications, school context, and the reported PD outcomes from a statewide PD initiative. The study used archived instrument data gathered during Cycle A ITQG PD programs. Descriptive and correlation analyses were used to explore possible relationships between factors related to teacher qualifications, school context, and the reported PD outcomes by addressing the study research questions:

1. What are the reported teacher qualifications, repeat ITQG participant, and school context on the TPD questionnaire?

2. How do self-reported PDEI PD outcomes differ at the end-of-summer institute across teacher qualifications, repeat ITQG participant, and school context?
3. Are self-reported PD outcomes from PDEI at the end-of-summer different than outcomes reported at the end-of-program? Does this vary based on participant's demographics?

Data Collection Procedures

The archived quantitative instrument data were gathered by the external review team for MDHE during the fourth cycle of the state ITQG PD summer and post academic sessions. All statistical analysis of the quantitative results was conducted with the help of Statistical Package for Social Sciences software (SPSS), version 23. In particular, 16 forced-choice items from the demographic based questions on the TPD questionnaire and the 55-identical force-response items of the PDEI end-of-summer and end-of-summer instruments questions supplied data in order to determine whether, and to what degree a relationship exists between two or more quantifiable variables. Responses to these Likert scale on-line pre- and/or post-instrument questions were used to explore, identify, and critically analyze implications of factors related to teacher qualifications and school context to the reported PD outcomes (Appendix A-C). The nominal and numeric data were then analyzed to determine frequencies of the following demographic characteristics (a) ethnicity and gender; (b) certification status; (c) years of teaching experience; (d) teaching assignment; (e) PD experience; and (f) overall characteristics of participating schools.

The information presented in this section is based on two data sources—reports submitted to the MDHE by PD project directors, responses to the external review team's

TPD. The TDP data is presented in two sections: 1) characteristics of participants, and 2) characteristics of school districts.

Research Question One Results

Characteristics of Project Participants

Ethnicity and Gender. The Cycle A PD science projects served a total of 192 participants, including 182 teachers, 10 categorized as other (this includes paraprofessionals, counselors, and administrators). Three individuals attended two projects. Of the 192 responses to the ethnicity item on the TPD, there were two main groups represented—76.6% described themselves as White and 21.4% described themselves as African American (Figure 1). Of the 192 participants who responded to the gender item, 84.2% were women (Figure 2).

Figure 1: Participant Ethnicity (n=192).

Figure 2: Participant Gender ($n=177$).

Educational Attainment of Participants. Almost all of the responding participants in Cycle A PD science projects held a university degree (except for the 2 participants whom were either pre-service teachers or paraprofessionals); 44.0% held a Bachelor's degree as their highest degree and 53.9% held a Master's degree as their highest degree (see Figure 3).

Figure 4 describes the majors of the respondents' first Bachelor's and highest degrees. The majority of the participants majored in education (other than science education) in their first Bachelor's degree (58.0%) and in their highest degree (69.4%). There were 5 participants (2.6%) with their highest degree in Science, while 21 (10.9%) in Science Education.

Certification Status of Participants. The majority of Cycle A responding participants held regular teaching certification in the state of Mid-Western; others held provisional certifications ($n=18$) or Temporary Authorization Certificates ($n=7$) (see Table 5). The majority of teachers with regular certification held elementary ($n=133$) and/or middle level certification ($n=94$). (Note that some respondents held more than one

certification). It makes sense that the majority of certificates are from elementary and middle levels given that the Cycle A RFP specifically targeted teachers in grades 4-8. However, respondents also held 11 regular high school certifications.

Figure 3: Highest Degree of Participants (n=193)

Figure 4: Major of Participants' First Bachelor's and Highest Degree

Table 5

Certification Status of Participants

Subject and Level	Regular	Provisional	Temporary
Elementary/Early Childhood	133	3	1
Biology			
Middle/junior high school	12	1	0
High School	2	0	1
Both	10	0	0
Chemistry			
Middle/junior high school	9	1	0
High School	2	0	0
Both	5	1	0
Earth Science			
Middle/junior high school	20	1	1
High School	4	0	0
Both	9	1	0
Physics			
Middle/junior high school	6	1	0
High School	1	0	0
Both	4	0	0
General Science			
Middle/junior high school	47	4	4
High School	2	0	0
Both	14	1	0

Participant Teaching Experience. Out of 192 respondents, 48 had been teaching for 1-5 years at the start of Cycle A science projects, 50 for 6-10 years, 66 for 11-15 years, and 20 for 26 or more years (Figure 5). However, in terms of experience at their

current school or school district, 85 had been in their current school for 1-5 years and 69 had been in their current district for 1-5 years prior to Cycle A.

Participants had the most experience teaching at the elementary and middle school levels (Figure 6), which is consistent with their certification (Table 5) and the Cycle A targeted grade levels. In terms of experience teaching science, the trend is the same, with the most years of experience at the elementary level (Figure 7).

Figure 5: Teaching Experience of Participants

Note: Number of responses < 5 not labeled for readability

Figure 6: Teaching Experience of Participants by Grade Level

Figure 7: Science Teaching Experience of Participants by Grade Level

Teaching Assignments. During the school year following the Cycle A summer institutes (2006-2007) most of the responding participants were assigned as elementary and/or middle level teachers (Figure 8), consistent with the Cycle A RFP focus on grades 4-8.

Figures 9 and 10 illustrate teaching assignments by grade level and subject area in the year prior to participants' Cycle A PD involvement and the year following the PD summer institute. One interesting trend is that, at the beginning of Cycle A, 29.2% of respondents were in teaching assignments other than mathematics or science, and by the end-of-program this figure had dropped a little more than half to 16.4%. This might indicate that some teachers got involved in Cycle A because their teaching assignment was going to change to include more teaching. This trend corresponds to an increase from 26.9% to 38.2% of respondents who reported a teaching assignment related to "science only."

Note: Number of responses < 5 not labeled for readability.

Figure 8: Participants' Teaching Assignment for 2006-2007

Figure 9: Teaching Assignment in Current Position at the Beginning of the Project ($n=260$)

Figure 10: Teaching Assignment in Current Position at the End of the Project ($n=110$)

Participant Professional Development Experience. In Cycle A, the instrument questions asked teachers to comment on their previous experience with PD within and outside of the ITQG Program. In the year prior to Cycle A, 66.1% of teachers participated in some form of PD (Figure 11). When asked about participation in district-sponsored PD in the year prior to Cycle A, 83 participants reported participating in 36 or more hours of PD (Figure 12). However, 60 reported 0 hours in science-specific PD. Thus, most of the district-sponsored PD that teachers received was around general pedagogical issues, not about science education. When asked about previous ITQG sponsored PD, 80 responses indicated participation in a previous cycle—the majority in a prior year of their current project (Figure 13). In all, 57.9% reported no enrollment in previous ITQG projects, while 42.1% had participated in previous cycle ITQG project (Figure 14).

Participants were asked to rate the importance of various components of PD (content knowledge, content standards, instructional materials and methods, learning principles, assessment, hands-on activities, and collaboration with other teachers) based on their prior experiences with PD (Figure 15). Most components were rated by the majority of participants as very important. Content standards, instructional materials, and hands-on activities received the highest ratings. Learning principles, assessment, and instructional methods received lower relative ratings, but were still rated “somewhat” to “very” useful by the majority of participants.

Figure 11: Professional Development Participation in Previous Year (n=189)

Note: Number of responses < 5 not labeled for readability.

Figure 12: District-Sponsored Professional Development Hours Completed in Previous Year

Figure 13: Cycle A Participant Enrollment in Previous ITQG Projects

Figure 14: Cycle A Participant Enrollment in Previous ITQG Projects (n=190)

Note: Number of responses ≤ 10 not labeled for readability.

Figure 15: Participant Rating of Importance of Selected Professional Development Characteristics

Characteristics of Participating Schools

Cycle A PD participants came from 64 Mid-Western school districts, two private schools, and three charter schools (plus two pre-service teachers who were not teaching). The Cycle A RFP stated that “MDHE, in consultation with DESE and the U.S. Department of Education (USDE), has made a strategic decision to use Mid-Western’s Cycle A ITQG funds to improve mathematics and/or science achievement in Mid-Western’s high-need school districts” (p. 4). However, fewer than 38.0% of Cycle A participants were from the high-need districts specified in the RFP (Figure 16). Based on reports by the PD directors, the 7 Cycle A science projects directly impacted 18,052 students. Figure 17 describes the number of students directly impacted by each Cycle A project.

Figure 16: Percent of Cycle A Participants from High-Need Districts* (n=194)
 *As defined by MDHE of Cycle A Request for Proposals.

Note. *Because no student data were reported by the project M, number of students impacted is an estimate based on the following assumptions: 20 students per elementary teacher, 80 students per middle level teacher, and 100 students per secondary teacher.

Figure 17: Students Directly Impacted through Teacher Participation in Cycle A Professional Development Projects

Statistical Findings for Research Questions 1 and 2

The purpose of the quantitative correlation study was to explore possible relationships between factors related to teacher qualifications, school context, and the reported PD outcomes. In preparation for data analysis, descriptive statistics and factor analysis were produced for several groups of instrument questions from the end-of-summer and the end-of-program PDEI using SPSS. Following are the results of the analyses.

Descriptive analysis. The second and third research questions sought to explore the factors related to teacher qualifications, school context, and the reported PD outcomes. Using descriptive statistics, the PDEI instruments were analyzed. The PDEI instrument asked teachers to self-report their level of knowledge on the content targeted in their PD projects. Table 6 presents a summary of teachers' responses to these general prompts on content knowledge. The first comparison is from the first instrument administered in most projects at the end of the summer institute, in which the teachers were asked to report their level of knowledge prior to the PD instruction and after the summer institute. Responses to the science knowledge prompts suggested a gain of 2.9 scale points (on an overall 11-point scale). Interestingly, the mean response to the end-of-summer prompt was around 7.4, which was lower than at the end-of-summer institute. However, caution should be exercised when interpreting the data in Table 6, because all teachers who responded at the end-of-summer did not respond at the end-of-program.

The PDEI Instrument asked teachers if they felt more confident in their science "knowledge needed to be an effective teacher" at the end-of-summer institute and at the

end-of-program. The majority of science respondents indicated “very much” confidence at both points in time (see Table 7).

The study also asked teacher participants to indicate the relevance of perceived gains in content knowledge to their teaching assignments. In general, participating teachers reported that most of their improved knowledge was relevant to their teaching assignments (Table 8). This rating did decline over time.

Table 6

Perceived Level of Project-focused Content Knowledge on the PDEI

	End-of-summer			End-of-program		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Science	124	7.8	1.2	72	7.4	1.2

Note. 0=knew nothing -- 10=knew it all (teachers respond within the range of 0-10);

Table 7

Frequency and Descriptive Statistics of Confidence in Content Knowledge on the PDEI

Confidence	End-of-summer (n= 125)							End-of-program (n= 74)						
	0	1	2	3	n/a	<i>M</i>	<i>SD</i>	0	1	2	3	n/a	<i>M</i>	<i>SD</i>
In my science knowledge needed to be an effective teacher	0	1	44	76	4	2.8	1.2	1	4	42	78	0	2.8	1.4
In my ability to teach improved	1	5	18	47	3	2.6	0.6	2	8	24	40	0	2.4	0.8

Note. 0=not at all; 1=a little; 2=moderate; 3=very much; n/a=not applicable (n/a responses were not included in the descriptive statistics).

Table 8

Frequency and Descriptive Statistics Improvement in Content Knowledge Relevant to Teaching Assignment on the PDEI

	End-of-summer (n = 124)									End-of-program (n = 73)								
Content	0	1	2	3	4	5	n/a	M	SD	0	1	2	3	4	5	n/a	M	SD
Science	0	1	2	21	47	53	0	4.2	.8	1	1	1	17	29	24	0	4.0	1.0

Note. 0=No gain in content knowledge; 1=None of the gain was relevant to my teaching assignment; 2=Very little was relevant; 3=A Moderate amount was relevant; 4=Most of the gain was relevant; 5=All of the gain was relevant; n/a=I have no teaching assignment (n/a responses were not included in the descriptive statistics).

At the end of Cycle A, as part of the PDEI instrument, the study asked teachers to indicate the degree to which they perceived improvement in their instructional practices as a result of their experience in the ITQG Program. The study examined this instructional improvement in five categories: (a) instructional materials, (b) collaboration, (c) assessment, (d) pedagogy, and (e) content knowledge. Table 9 summarizes the results for both times the instrument was administered, between 56.8% and 59.2 % of teachers responded to the end-of-program PDEI instrument. All items received average ratings between 2.2 and 2.8, indicating a moderate to more substantial perceived improvement in instructional practice. Teachers identified the most improvement in using inquiry-based. Statements associated with “analyzing student data” and the “use of technology to enhance teaching” received the lowest ratings in relation to impact on practice.

Table 9
Perceived Improvement in Teaching Practice on PEDI

Subject area	End of Summer Institute						End of PD Program					
	Factor		Descriptive Statistics				Factor		Descriptive Statistics			
	1	2	<i>n</i>	<i>M</i>	<i>SD</i>	<i>A</i>	1	2	<i>n</i>	<i>M</i>	<i>SD</i>	<i>A</i>
Improving my content knowledge	X		125	2.5	0.6	.84	X		74	2.3	0.7	.88
Creating lessons aligned with GLE's	X		125	2.6	0.6	.84	X		73	2.3	0.8	.88
Assessing student learning	X		125	2.3	0.7	.84	X		71	2.3	0.7	.88
Increasing student motivation	X		125	2.6	0.7	.84		X	72	2.6	0.6	.87
Analyzing student performance data	X		125	2.2	0.8	.84	X		72	2.2	0.7	.88
Using inquiry-based / problem-centered teaching		X	125	2.8	0.5	.87		X	73	2.7	0.5	.87
Collaborating with other teachers		X	123	2.4	0.8	.87		X	73	2.4	0.7	.87
Using technology effectively to enhance your teaching		X	124	2.3	0.8	.87		X	73	2.2	0.9	.87
Participating in classroom activities as your students would		X	125	2.7	0.6	.87		X	73	2.6	0.7	.87
Implementing activities in your classroom		X	125	2.7	0.6	.87		X	74	2.6	0.5	.87
Developing materials for use with your students		X	125	2.6	0.6	.87		X	74	2.6	0.5	.87
Managing inquiry-based / problem-centered classrooms		X	124	2.5	0.7	.87		X	73	2.5	0.6	.87

Note. Factor 1 is teaching knowledge and skills; Factor 2 is classroom activities and materials; more information about the Factors can be found in Table 3 and 4.

Table 10 summarizes teachers' perceptions of how their PD experiences improved student learning. Teachers rated PD emphases "increasing student motivation" and "using inquiry centered instructional practices" as the components with the most impact on student learning.

More than half of responding teachers reported a high degree of impact from both items. Other items rated greater than 2.0 (indicating at least a moderate impact on student

learning) included “improving content knowledge” and other PD activities that are directly related to day-to-day teaching responsibilities, e.g., “creating lessons” and “assessing student learning.”

Interestingly, many PD components that teachers rated favorably as emphasis areas and/or that they suggested were important to high quality PD experiences were not rated as having significant impacts on student learning. Teacher collaboration, participating in activities as students would, and designing activities and materials all received average ratings of less than 2.0, suggesting that teachers perceived these components as having only a small impact on student learning.

To examine research questions two and three, a MANOVA will be conducted to assess if mean differences exist. The MANOVA is an appropriate statistical analysis when the purpose of research is to assess if mean differences exist on more than one continuous dependent variable by one or more discrete independent variables.

For research question two, the continuous dependent variables are contribution of PD aspect to professional practices, impact on teaching practices, and confidence in subject matter; the independent variable have the following groups (experience (yrs.) vs. degree level vs. science major vs. HNSD vs. repeat participants). The third research question sought to explore relationships between PD outcomes among teachers who have participated in both the end-of-summer and the end-of-program PDEI instrument. It was hypothesized that measures of PD outcomes collected on the end-of-summer PDEI instrument did not differ than outcomes reported on the end-of-summer PDEI instrument. More specifically, the measures do not vary by the participant's set of demographics [experience (yrs.) vs. degree level vs. science major vs. HNSD vs. repeat participants].

Table 10

Teacher Perceptions of PD Components that Improved Student Learning

PD components or emphasis	End-of-program							
	Frequencies					Descriptive Statistics		
	0	1	2	3	4	<i>M</i>	<i>SD</i>	
Improving my content knowledge	0	4	32	32	1	73	2.51	.974
Creating lessons aligned with GLE’s	2	7	32	30	2	73	2.45	1.33
Assessing student learning	1	3	43	34	2	73	2.45	1.26
Increasing student motivation	0	3	28	30	0	74	2.54	.578
Analyzing student performance data	0	5	43	24	3	74	2.53	1.46
Using inquiry-based/problem-centered teaching	0	1	22	43	1	74	2.76	.888
Collaborating with other teachers	11	29	33	23	1	74	1.41	1.15
Using technology effectively to enhance your teaching	13	28	31	50	2	74	1.46	1.47
Participating in classroom activities as your students would	1	23	47	0	2	73	1.85	1.31
Implementing activities in your classroom	0	25	48	0	1	74	1.76	.977
Developing materials for use with your students	0	33	38	0	1	72	1.64	1.01
Managing inquiry-based/problem-centered classrooms	3	28	41	0	2	74	1.73	1.35

Note. 0=none; 1=a little; 2= moderate; 3=high; 4=no improvement in my practice.

MANOVA assesses whether mean differences among groups on a combination of dependent variables are likely to have occurred by chance. The MANOVA creates a linear combination of the dependent variables to create a grand mean and assesses whether there are group differences on the set of dependent variables. The MANOVA uses the *F* test; the ratio of two independent variances estimates of the same population variance. The *F*-test allows researchers to make the overall comparison on whether group means differ. If the obtained *F* is larger than the critical *F*, the null hypothesis is rejected.

The assumptions of normality and homogeneity of variance/covariance matrices were assessed. Normality assumes that the scores are normally distributed (bell shaped) and will be assessed using the one sample Kolmogorov Smirnov test. Homogeneity of variance assumes that both groups have equal error variances and will be assessed using Levene's test.

MANOVA Analyses

The second research question sought to explore relationships between PD outcomes (impact on teaching practices, and confidence in subject matter) and teacher qualification and school context (experience (yrs.) vs. degree level vs. science major; HNSD vs. repeat participant). It was hypothesized that measures of PD outcomes would not be systematically related to a teacher qualification and school context (experience (yrs.) vs. degree level vs. science major; HNSD vs. repeat participant).

Teaching experience was consolidated to two groups, designated as "0-5 years" and "6+ years" were created by utilizing the 1 nominal question indicating if the teacher had a certain amount (zero years; 1-5; 6-10; 11-25; and 26+), of years of teaching experience coming into the PD program. Participants were assigned to each group according to base on indicating if they have 0-5 years or 6+ years teaching experience. In that the variables of PD outcomes are likely to be highly correlated--and that the effect for the sum of variables was desired a MANOVA was conducted on these variables across the groups of 0-5 years or 6+ years teaching experience.

Highest level of educational degree was consolidated to three groups, designated as "BS and BS plus;" "Master;" and "beyond Masters" were by utilizing the 1 nominal question indicating the highest degree level (less than bachelors; bachelor degree only;

credits beyond bachelor degree; MA/MS/MEd; EdS; and PhD/EdD), coming into the PD program. Participants were assigned to each group according to base on indicating if they have BS and BS plus, Masters, or beyond Masters. In that the variables of PD outcomes are likely to be highly correlated--and that the effect for the sum of variables was desired a MANOVA was conducted on these variables across the groups of BS and BS plus, Masters, or beyond Masters.

Majors the participants reported was consolidated to two groups, designated as “science education or science major;” and “other major” were by utilizing the 2-nominal question indicating the major of degree (mathematics education; mathematics or statistics; science education; any science major; and other education degree), coming into the PD program. Participants were assigned to each group according to base on indicating if they had a science education/ science major or did not hold a science education/ science major. In that the variables of PD outcomes are likely to be highly correlated--and that the effect for the sum of variables was desired a MANOVA was conducted on these variables across the groups of science education/ science major or did not hold a science education/ science major.

In regard to school context the PD program providers had to identify HNSD in which they were going to recruit teachers from in order to participate in their PD program. The teachers then identified their school district and building within the PDEI end-of-summer instrument. This was consolidated to two groups, designated as HNSD and Non-HNSD were created by utilizing the two-open ended nominal questions indicating the name of the district and building the teacher expected to work in during the academic year. Participants were assigned to each group (HNSD) base on indicating if

their school district was on the Mid-Western DESE HNSD list. In that the variables of PD outcomes are likely to be highly correlated and that the effect for the sum of variables was desired a MANOVA was conducted on these variables across the groups of HNSD.

Repeated PD program participants was consolidated to two groups, designated as “repeated” and “non-repeated” were created by utilizing the 1 open-ended nominal question indicating if the teacher had a participated in other ITQG projects in the past few years (yes or no), of years of teaching experience coming into the PD program. Participants were assigned to each group base on whether they have participated in an ITQG PD program before. In that the variables of PD outcomes are likely to be highly correlated--and that the effect for the sum of variables was desired a MANOVA was conducted on these variables across the groups of repeated vs. non-repeated participants.

Research Question Two Results

Multivariate Analysis of Variance

Introduction. A MANOVA was conducted to assess if there were significant differences in the linear combination of end-of-summer PDEI Teaching Knowledge and Skills factors and classroom activities and materials factors based between the levels of:

- Experience (yrs.) were independent. There were 2 levels in Experience (yrs.): 0- 5 years and 6+ years (experienced).
- Degree level held were independent. There were 2 levels in Degree held: B.S.Ed. or BSED plus hours and Masters and beyond.
- Repeat ITQG participant were independent. There were 2 levels in Repeat ITQG participant: yes, has participated before in ITQG PD program and no other participation in ITQ PD program.

- High needs school district (HNSD) were independent. There were 2 levels in HNSD: does not teach in HNSD and does teach in HNSD.
- Science or science education major were independent. There were 2 levels in Science or science education major: holds a science or science education major and all other major.

Absence of multicollinearity. A correlation matrix was calculated to examine multicollinearity between the dependent variables. All variable combinations had correlations less than .9 in absolute value, indicating the results are unlikely to be significantly influenced by multicollinearity. The correlation matrix is presented in Table 11.

Table 11

Correlations between PDEI Factors for Years of Experience

PDEI factors	1	2
1. Teaching Knowledge and Skills	-	
2. Classroom activities and materials	0.53	-

Homogeneity of covariance matrices. To examine the assumption of homogeneity of covariance matrices, Box's *M* test was conducted. The results were not significant, $\chi^2(3) = 7.38, p = .061$, indicating that the covariance matrices for each group of Experiences (years) were similar to one another and that the assumption was met. The results were not significant, $\chi^2(3) = 0.85, p = .837$, indicating that the covariance matrices for each group of Repeat participant in ITQG PD were similar to one another and that the assumption was met. The results were not significant, $\chi^2(3) = 4.82, p = .186$, indicating that the covariance matrices for each group of High needs school district(HNSD) were

similar to one another and that the assumption was met. The results were not significant, $\chi^2(3) = 6.49, p = .090$, indicating that the covariance matrices for each group of Science or science education major were similar to one another and that the assumption was met.

Results. The main effect for Experience (yrs.) was not significant, $F(2, 120) = 1.66, p = .195$, Partial $\eta^2 = 0.03$. The main effect for repeat participant was not significant, $F(2, 119) = 0.68, p = .510$, Partial $\eta^2 = 0.01$. The main effect for HNSD was not significant, $F(2, 121) = 0.62, p = .542$, Partial $\eta^2 = 0.01$.). The main effect for Science major was not significant, $F(2, 119) = 0.89, p = .413$, Partial $\eta^2 = 0.01$. All suggesting the linear combination of end-of-summer PDEI Teaching Knowledge and Skills factors and classroom activities and materials factors based was similar for each level for repeat participant in ITQG PD, HNSD, and science major (Table 12). To further examine the effects on end-of-summer PDEI Teaching Knowledge and Skills factors and classroom activities and materials factors, an Analysis of Variance was conducted for each dependent variable.

Table 12

MANOVA Results for End-of-Summer PDEI Teaching Knowledge/Skills and Classroom activities/materials Factors

Variable	<i>Pillai</i>	<i>F</i>	<i>df</i>	<i>Residual df</i>	<i>p</i>	η^2_p
Experience (yrs.)	0.03	1.66	2	120	.195	.03
Repeat participant	0.01	0.68	2	119	.510	0.01
HNSD	0.01	0.62	2	121	.542	0.01
Science major	0.01	0.89	2	119	.413	0.01

Analysis of Variance

First the ANOVA that was conducted to determine whether there were significant differences in teaching knowledge and skills factor by each of the independent variables. Prior to the analysis, ANOVA assumptions were examined. The result of Levene's test was not significant, $F(1, 121) = 1.19, p = .278$, indicating that the assumption of homogeneity of variance was met for Experience (yrs.); $F(1, 120) = 0.03, p = .866$, indicating that the assumption of homogeneity of variance was met for repeat participant; $F(1, 122) = 0.00, p = .956$, indicating that the assumption of homogeneity of variance was met for high needs school district; $F(1, 120) = 1.06, p = .305$, indicating that the assumption of homogeneity of variance was met for science or science education major.

The results of the end-of-summer teaching knowledge and skills factor ANOVA (Table 13) were not significant, $F(1, 121) = 1.60, p = .209$, indicating the differences in teaching knowledge and skills among the levels of experience (yrs.) were all similar. The main effect, experience (yrs.) was not significant at the 95% confidence level, $F(1, 121) = 1.60, p = .209$; levels of repeat participant ANOVA were not significant, $F(1, 120) = 1.34, p = .249$. The main effect, repeat participant in ITQG PD was not significant at the 95% confidence level, $F(1, 120) = 1.34, p = .249$; levels of HNSD ANOVA were not significant, $F(1, 122) = 0.53, p = .468$. The main effect, HNSD was not significant at the 95% confidence level, $F(1, 122) = 0.53, p = .468$. The results of the levels of science major ANOVA were not significant, $F(1, 120) = 1.69, p = .197$. The main effect, science major was not significant at the 95% confidence level, $F(1, 120) = 1.69, p = .197$, indicating there were no significant differences of teaching knowledge and skills by any

independent variable's levels. The means and standard deviations are presented in Table 14.

There were no significant effects in the model. As a result, posthoc comparisons were not conducted. Second, an ANOVA that was conducted to determine whether there were significant differences in end-of-summer PDEI classroom activities and materials factors by each of the independent variables. Prior to the analysis, ANOVA assumptions were examined. The result of Levene's test was significant, $F(1, 121) = 5.72, p = .018$, indicating that the assumption of homogeneity of variance was violated for experience (yrs.). Consequently, the results may not be reliable or generalizable. The result of Levene's test was not significant, $F(1, 120) = 0.10, p = .757$, indicating that the assumption of homogeneity of variance was met for repeat participant; $F(1, 122) = 1.35, p = .248$, indicating that the assumption of homogeneity of variance was met for high needs school district; $F(1, 120) = 0.04, p = .843$, indicating that the assumption of homogeneity of variance was met for science or science education major.

Table 13

Analysis of Variance Table for Teaching Knowledge and Skills by Teacher Qualification

Teacher qualification	<i>SS</i>	<i>df</i>	<i>F</i>	<i>p</i>	η^2_p
Experience (yrs.)	0.38	1	1.60	.209	0.01
Residuals	28.83	121			
Repeat participant	0.32	1	1.34	.249	0.01
Residuals	28.50	120			
HNSD	0.13	1	0.53	.468	0.00
Residuals	29.09	122			
Science major	0.39	1	1.69	.197	0.01
Residuals	27.96	120			

Table 14

Means, Standard Deviations, and Sample Size for Teaching Knowledge and Skills by Teacher Qualification

Teacher qualification	<i>M</i>	<i>SD</i>	<i>n</i>
Experience (yrs.)			
0-5	2.33	0.51	32
6+	2.45	0.48	91
Repeat participant			
Yes	2.37	0.48	67
No	2.47	0.49	55
HNSD			
No	2.45	0.48	73
Yes	2.38	0.49	51
Science major			
Science or science education	2.53	0.44	30
Other degree	2.40	0.50	92

The results of the end-of-summer Classroom activities and materials factor ANOVA (Table 15) were not significant, $F(1, 121) = 3.20$, $p = .076$, indicating the differences in activity based among the levels of experience (yrs.) were all similar. The main effect, experience (yrs.) was not significant at the 95% confidence level, $F(1, 121) = 3.20$, $p = .076$; levels of repeat participant ANOVA (were not significant, $F(1, 120) =$

0.23, $p = .630$. The main effect, repeat participant was not significant at the 95% confidence level, $F(1, 120) = 0.23, p = .630$; levels of HNSD ANOVA were not significant, $F(1, 122) = 0.10, p = .747$, indicating the differences in activity based among the were all similar. The main effect, HNSD was not significant at the 95% confidence level, $F(1, 122) = 0.10, p = .747$; levels of science major ANOVA were not significant, $F(1, 120) = 0.17, p = .685$, the main effect, science major was not significant at the 95% confidence level, $F(1, 120) = 0.17, p = .685$, indicating there were no significant differences of activity based by any of the independent variable's levels. All the means and standard deviations are presented in Table 16. There were no significant effects in the model. As a result, posthoc comparisons were not conducted.

Table 15

Analysis of Variance Table for Classroom Activities and Materials Factor by Teacher Qualification

Teacher qualification	<i>SS</i>	<i>df</i>	<i>F</i>	<i>p</i>	η^2_p
Experience (yrs.)	0.29	1	3.20	.076	0.03
Residuals	11.05	121			
Repeat participant	0.02	1	0.23	.630	0.00
Residuals	11.35	120			
HNSD	0.01	1	0.10	.747	0.00
Residuals	11.50	122			
Science major	0.02	1	0.17	.685	0.00
Residuals	11.37	120			

Table 16

Means, Standard Deviations, and Sample Size for Teaching Knowledge and Skills by Teacher Qualification

Teacher qualification	<i>M</i>	<i>SD</i>	<i>n</i>
Experience (yrs.)			
0-5	2.66	0.38	32
6+	2.77	0.27	91
Repeat participant			
Yes	2.72	0.31	67
No	2.75	0.30	55
HNSD			
No	2.73	0.32	73
Yes	2.75	0.28	51
Science major			
Science or science education	2.76	0.34	30
Other major	2.73	0.30	92

Chi-Square Test of Independence

Introduction. A Chi-Square Test of Independence was conducted to examine whether level of reported confidence at the end-of-summer, there were 2 levels in confidence in science knowledge to be an effective teacher: not at all or a little and moderate or very much, and:

- Experience (yrs.)
- Degree level
- Repeat participant
- HNSD
- Science major

Results. The results of the Chi-square test were not significant, $\chi^2(1) = 0.07$, $p = .797$, suggesting that Level of reported confidence at the end-of-summer and experience (yrs.) could be independent of one another. The results of the Chi-square test were not significant, $\chi^2(1) = 0.35$, $p = .554$, suggesting that Level of reported confidence at the end-of-summer and degree level held could be independent of one another. The results of the Chi-square test were not significant, $\chi^2(1) = 0.22$, $p = .642$, suggesting that Level of reported confidence at the end-of-summer and repeat ITQG participant could be independent of one another. The results of the Chi-square test were not significant, $\chi^2(1) = 0.95$, $p = .331$, suggesting that Level of reported confidence at the end-of-summer and HNSD could be independent of one another. The results of the Chi-square test were not significant, $\chi^2(1) = 0.65$, $p = .421$, suggesting that Level of reported confidence at the end-of-summer and science or science education major could be independent of one

another. This implies that the observed frequencies were not significantly different than the expected frequencies. Table 17 presents the results of the Chi-square test.

Table 17

Observed and Expected Frequencies by Level of Reported Confidence at the End-of-Summer for each Teacher Qualification

Confidence	Experience (yrs.)	
	0- 5 years	6+ years
not at all or a little	1 [0.80]	4 [4.20]
moderate or very much	10 [10.20]	54 [53.80]
Confidence	Degree level held	
	B.S.Ed.+	Masters +
not at all or a little	1 [1.59]	4 [3.41]
moderate or very much	21 [20.41]	43 [43.59]
Confidence	Repeat participant	
	Yes	No
not at all or a little	3 [2.50]	2 [2.50]
moderate or very much	31 [31.50]	32 [31.50]
Confidence	HNSD	
	Yes	No
not at all or a little	4 [2.97]	1 [2.03]
moderate or very much	37 [38.03]	27 [25.97]
Confidence	Science major	
	Yes	Other
not at all or a little	3 [3.75]	2 [1.25]
moderate or very much	48 [47.25]	15 [15.75]

Note. Items in brackets represent expected cell frequencies.

Research Question Three Results

Multivariate Analysis of Variance

Introduction. To help explain what may be responsible for the significant differences between end-of-summer classroom activities and materials factor and end-of-program classroom activities and materials factor results addition testing was utilized. First, a MANOVA were ran for each previously used independent variable against the end-of-summer and end-of-program classroom activities and materials factor.

Results. The interaction effect between degree level and science major was not significant, $F(2, 53) = 0.68, p = .511$, Partial $\eta^2 = 0.02$; the interaction effect between degree level and experience (yrs.) was not significant, $F(2, 53) = 0.39, p = .677$, Partial $\eta^2 = 0.01$; the interaction effect between degree level and HNSD was not significant, $F(2, 53) = 1.41, p = .253$, Partial $\eta^2 = 0.05$; the interaction effect between degree level and repeat participant was not significant, $F(2, 53) = 0.38, p = .689$, Partial $\eta^2 = 0.01$; the interaction effect between science major and HNSD was not significant, $F(2, 53) = 0.53, p = .593$, Partial $\eta^2 = 0.02$; the interaction effect between science major and repeat participant was not significant, $F(2, 53) = 0.55, p = .581$, Partial $\eta^2 = 0.02$.

The interaction effect between experience (yrs.) and HNSD was not significant, $F(2, 53) = 0.24, p = .785$, Partial $\eta^2 = 0.01$; the interaction effect between experience (yrs.) and repeat participant was not significant, $F(2, 53) = 1.30, p = .280$, Partial $\eta^2 = 0.05$; the interaction effect between HNSD and repeat participant was not significant, $F(2, 53) = 1.29, p = .283$, Partial $\eta^2 = 0.05$; all suggesting the linear combination of end-of-summer classroom activities and materials factor and end-of-program classroom activities and materials factor was similar for each factor level combination.

The interaction effect between science major and experience (yrs.) was significant, $F(2, 53) = 4.52, p = .015$, Partial $\eta^2 = 0.15$, suggesting the linear combination of end-of-summer classroom activities and materials factor and end-of-program classroom activities and materials factor was significantly different between the factor level combinations of science major and experience (yrs.). These interactions will be further explored with additional tests. Table 18 presents the results of the MANOVA of the end-of-summer and end-of-program classroom activities and materials factor.

Table 18

MANOVA Results for End-of-Summer and End-of-Program Classroom Activities and Materials Factor by Degree Level, Science Major, Experience (yrs.), HNSD and Repeat Participant

Variable	<i>Pillai</i>	<i>F</i>	<i>df</i>	<i>Residual df</i>	<i>p</i>	η^2_p
Degree level	0.01	0.24	2	53	.791	0.01
Science major	0.02	0.49	2	53	.613	0.02
Experience (yrs.)	0.02	0.53	2	53	.590	0.02
HNSD	0.01	0.27	2	53	.763	0.01
Repeat participant	0.01	0.34	2	53	.713	0.01
Degree level:Science major	0.02	0.68	2	53	.511	0.02
Degree level:Experience (yrs.)	0.01	0.39	2	53	.677	0.01
Degree level:HNSD	0.05	1.41	2	53	.253	0.05
Degree level:Repeat participant	0.01	0.38	2	53	.689	0.01
Science major:Experience (yrs.)	0.15	4.52	2	53	.015*	0.15
Science major:HNSD	0.02	0.53	2	53	.593	0.02
Science major:Repeat participant	0.02	0.55	2	53	.581	0.02
Experience (yrs.):HNSD	0.01	0.24	2	53	.785	0.01
Experience (yrs.):Repeat participant	0.05	1.30	2	53	.280	0.05
HNSD:Repeat participant	0.05	1.29	2	53	.283	0.05

* $p < .05$

The main effect for degree level was not significant, $F(2, 53) = 0.24, p = .791$, Partial $\eta^2 = 0.01$; the main effect for science major was not significant, $F(2, 53) = 0.49, p = .613$, Partial $\eta^2 = 0.02$; the main effect for experience (yrs.) was not significant, $F(2, 53) = 0.53, p = .590$, Partial $\eta^2 = 0.02$; the main effect for HNSD was not significant, $F(2, 53) = 0.27, p = .763$, Partial $\eta^2 = 0.01$; the main effect for repeat participant was not significant, $F(2, 53) = 0.34, p = .713$, Partial $\eta^2 = 0.01$, suggesting the linear combination of end-of-summer classroom activities and materials factor and end-of-program classroom activities and materials factor was similar for each level of degree level (Table 21).

To further examine the effects of degree level, science major, experience (yrs.), HNSD and repeat participant on end-of-summer classroom activities and materials factor and end-of-program classroom activities and materials factor, an Analysis of Variance was conducted for each dependent variable.

The results of the end-of-summer ANOVA were not significant, $F(15, 54) = 1.32, p = .224$, indicating the differences in end-of-summer among the levels of degree level, science major, experience (yrs.), HNSD, and repeat participant were all similar (Table 22). The main effect, degree level was not significant at the 95% confidence level, $F(1, 54) = 0.00, p = .969$; science major was not significant at the 95% confidence level, $F(1, 54) = 0.69, p = .409$; experience (yrs.) was not significant at the 95% confidence level, $F(1, 54) = 1.06, p = .309$; HNSD was not significant at the 95% confidence level, $F(1, 54) = 0.43, p = .515$; repeat participant was not significant at the 95% confidence level,

$F(1, 54) = 0.25, p = .619$, indicating there were no significant differences of end-of-summer by independent variable's levels.

The interaction between degree level and science major was not significant at the 95% confidence level, $F(1, 54) = 0.31, p = .579$; between degree level and experience (yrs.) was not significant at the 95% confidence level, $F(1, 54) = 0.04, p = .834$; between degree level and HNSD was not significant at the 95% confidence level, $F(1, 54) = 2.87, p = .096$; degree level and repeat participant was not significant at the 95% confidence level, $F(1, 54) = 0.43, p = .516$; between science major and HNSD was not significant at the 95% confidence level, $F(1, 54) = 1.05, p = .311$; between science major and repeat participant was not significant at the 95% confidence level, $F(1, 54) = 1.07, p = .305$; between experience (yrs.) and HNSD was not significant at the 95% confidence level, $F(1, 54) = 0.35, p = .555$; between experience (yrs.) and repeat participant was not significant at the 95% confidence level, $F(1, 54) = 2.65, p = .110$; between HNSD and repeat participant was not significant at the 95% confidence level, $F(1, 54) = 2.63, p = .110$, indicating there were no significant differences of end-of-summer by the values of the independent variable's level with interaction of another independent variable term.

The interaction between science major and experience (yrs.) was significant at the 95% confidence level, $F(1, 54) = 9.07, p = .004$, indicating there were significant differences of end-of-summer by the values of the science major:experience (yrs.) interaction term. The means and standard deviations are presented in Table 19.

Table 19

*Analysis of Variance Table for End-of-Summer Classroom Activities and Materials
Factor by Degree Level, Science Major, Experience (yrs.), HNSD and Repeat Participant*

Term	SS	df	F	p	η^2_p
Degree level	0.00	1	0.00	.969	0.00
Science major	0.06	1	0.69	.409	0.01
Experience (yrs.)	0.10	1	1.06	.309	0.02
HNSD	0.04	1	0.43	.515	0.01
Repeat participant	0.02	1	0.25	.619	0.00
Degree level:Science major	0.03	1	0.31	.579	0.01
Degree level:Experience (yrs.)	0.00	1	0.04	.834	0.00
Degree level:HNSD	0.26	1	2.87	.096	0.05
Degree level:Repeat participant	0.04	1	0.43	.516	0.01
Science major :Experience (yrs.)	0.83	1	9.07	.004**	0.14
Science major :HNSD	0.10	1	1.05	.311	0.02
Science major :Repeat participant	0.10	1	1.07	.305	0.02
Experience (yrs.):HNSD	0.03	1	0.35	.555	0.01
Experience (yrs.):Repeat participant	0.24	1	2.65	.110	0.05
HNSD:Repeat participant	0.24	1	2.63	.110	0.05
Residuals	4.95	54			

** p < .01

The results of the end-of-program ANOVA were not significant, $F(15, 54) = 0.69$, $p = .779$, indicating the differences in end-of-program among the levels of degree level, science major, experience (yrs.), HNSD, and repeat participant were all similar (Table 20). The main effect, degree level was not significant at the 95% confidence level, $F(1, 54) = 0.47$, $p = .496$; science major was not significant at the 95% confidence level, $F(1, 54) = 0.50$, $p = .484$; experience (yrs.) was not significant at the 95% confidence level, $F(1, 54) = 0.13$, $p = .718$; HNSD was not significant at the 95% confidence level, $F(1,$

54) = 0.05, $p = .822$; repeat participant was not significant at the 95% confidence level, $F(1, 54) = 0.31$, $p = .577$, indicating there were no significant differences of end-of-program by independent variable's levels.

The interaction between degree level and science major was not significant at the 95% confidence level, $F(1, 54) = 0.83$, $p = .365$; between degree level and experience (yrs.) was not significant at the 95% confidence level, $F(1, 54) = 0.80$, $p = .376$; between degree level and experience (yrs.) was not significant at the 95% confidence level, $F(1, 54) = 0.80$, $p = .376$; degree level and HNSD was not significant at the 95% confidence level, $F(1, 54) = 0.16$, $p = .688$; between degree level and repeat participant was not significant at the 95% confidence level, $F(1, 54) = 0.48$, $p = .49$; between science major and experience (yrs.) was not significant at the 95% confidence level, $F(1, 54) = 0.84$, $p = .362$; between science major and HNSD was not significant at the 95% confidence level, $F(1, 54) = 0.00$, $p = .981$; between science major and repeat participant was not significant at the 95% confidence level, $F(1, 54) = 0.16$, $p = .693$; between experience (yrs.) and HNSD was not significant at the 95% confidence level, $F(1, 54) = 0.23$, $p = .631$; between experience (yrs.) and repeat participant was not significant at the 95% confidence level, $F(1, 54) = 0.04$, $p = .839$; and between HNSD and repeat participant was not significant at the 95% confidence level, $F(1, 54) = 0.11$, $p = .737$, indicating there were no significant differences of end-of-program by the values of the independent variables and the interaction. As a result, posthoc comparisons were not conducted. The means and standard deviations are presented in Table 23.

Table 20

*Analysis of Variance Table for End-of-Program Classroom Activities and Materials
Factor by Degree Level, Science Major, Experience (yrs.), HNSD and Repeat Participant*

Term	<i>SS</i>	<i>df</i>	<i>F</i>	<i>p</i>	η^2_p
Degree level	0.09	1	0.47	.496	0.01
Science major	0.10	1	0.50	.484	0.01
Experience (yrs.)	0.03	1	0.13	.718	0.00
HNSD	0.01	1	0.05	.822	0.00
Repeat participant	0.06	1	0.31	.577	0.01
Degree level:Science major	0.17	1	0.83	.365	0.02
Degree level:Experience (yrs.)	0.16	1	0.80	.376	0.01
Degree level:HNSD	0.03	1	0.16	.688	0.00
Degree level:Repeat participant	0.10	1	0.48	.491	0.01
Science major:Experience (yrs.)	0.17	1	0.84	.362	0.02
Science major:HNSD	0.00	1	0.00	.981	0.00
Science major:Repeat participant	0.03	1	0.16	.693	0.00
Experience (yrs.):HNSD	0.05	1	0.23	.631	0.00
Experience (yrs.):Repeat participant	0.01	1	0.04	.839	0.00
HNSD:Repeat participant	0.02	1	0.11	.737	0.00
Residuals	10.89	54			

Since the end-of-summer and end-of-program MANOVA reported a significance between science major and experience (yrs.) to further examine the differences among the variables, *t*-tests were calculated between each pair of measurements. Tukey pairwise comparisons were conducted for all significant effects. For the interaction effect between science major and experience (yrs.), the mean of end-of-summer classroom activities and materials factor for the combination of science major and 0-5 yrs. ($M = 2.81$, $SD = 0.33$) was significantly larger than for other major and 0-5 yrs. ($M = 2.33$, $SD = 0.59$). While

the interaction of the other major and 0-5 yrs. was significantly smaller than for science major and 6+ yrs. ($M = 2.75$, $SD = 0.29$). While the interaction of the other major and 0-5 yrs. was significantly smaller than for other major and 6+ yrs. ($M = 2.89$, $SD = 0.14$). No other significant effects were found (Table 21).

Table 21

Means, Standard Deviations, and Sample Size for End-of-Summer Classroom Activities and Materials Factor by Science Major and Experience (yrs.)

Science major	Experience (yrs.)	<i>M</i>	<i>SD</i>	<i>n</i>
Science major	0-5	2.81	0.33	9
	6+	2.75	0.29	44
Other major	0-5	2.33	0.59	4
	6+	2.89	0.14	14

To focus just on the interaction effect between science major and experience (yrs.) more testing was used Table 22 presents the results of the interactions. Interaction effect between science major and experience (yrs.) was significant, $F(2, 66) = 5.27$, $p = .008$, Partial $\eta^2 = 0.14$, suggesting the linear combination of end-of-summer classroom activities and materials factor and end-of-program classroom activities and materials factor was significantly different between the factor level combinations of science major and experience (yrs.). The main effect for both the science major, $F(2, 66) = 1.54$, $p = .222$, Partial $\eta^2 = 0.04$ and experience (yrs.), $F(2, 66) = 3.06$, $p = .054$, Partial $\eta^2 = 0.08$, were not significant, suggesting the linear combination of end-of-summer classroom activities and materials factor and end-of-program classroom activities and materials factor was similar for each level of science major . To further examine the effects of science major and experience (yrs.) on end-of-summer classroom activities and materials

factor and end-of-program classroom activities and materials factor, an Analysis of Variance was conducted for each dependent variable.

Table 22

MANOVA Results for End-of-Summer and End-of-Program Classroom Activities and Materials Factor by Science Major and Experience (yrs.)

Variable	<i>Pillai</i>	<i>F</i>	<i>df</i>	<i>Residual df</i>	<i>p</i>	η^2_p
Science major	0.04	1.54	2	66	.222	0.04
Experience (yrs.)	0.08	3.06	2	66	.054*	0.08
Science major:Experience (yrs.)	0.14	5.27	2	66	.008**	0.14

* $p < .05$; ** $p < .01$

Analysis of Variance

An ANOVA was conducted to determine whether there were significant differences in end-of-summer classroom activities and materials factor by science major and experience (yrs.) including all two-way interactions. Prior to the analysis, ANOVA assumptions were examined.

The results of the end-of-summer ANOVA were significant, $F(3, 67) = 3.87, p = .013$, indicating there were significant differences in end-of-summer classroom activities and materials factor among the levels of science major and experience (yrs.) (Table 23). The main effect, science major was not significant at the 95% confidence level, $F(1, 67) = 2.91, p = .093$, indicating there were no significant differences of end-of-summer classroom activities and materials factor by science major levels. The main effect, experience (yrs.) was significant at the 95% confidence level, $F(1, 67) = 6.20, p = .015$, Partial $\eta^2 = 0.08$, indicating there were significant differences in end-of-summer classroom activities and materials factor by experience (yrs.) levels. The interaction

between science major and experience (yrs.) was significant at the 95% confidence level, $F(1, 67) = 9.88, p = .002$, indicating there were significant differences of end-of-summer classroom activities and materials factor by the values of the science major:experience (yrs.) interaction term (Table 24). The means and standard deviations are presented in Table 25.

Table 23

Analysis of Variance Table for End-of-Summer Classroom Activities and Materials Factor by Science Major and Experience (yrs.)

Term	SS	df	F	p	η^2_p
Science major	0.25	1	2.91	.093	0.04
Experience (yrs.)	0.54	1	6.20	.015*	0.08
Science major:Experience (yrs.)	0.86	1	9.88	.002**	0.13
Residuals	5.81	67			

* $p < .05$; ** $p < .01$

Table 24

Means, Standard Deviations, and Sample Size for End-of-Summer Classroom Activities and Materials Factor by Experience (yrs.)

Experience (yrs.)	n	M	SD	SE	95% Confidence Interval for Mean	
					Lower	Upper
0-5	13	2.667	0.46	.086	2.495	2.838
6+	59	2.788	0.26	.040	2.708	2.869

An ANOVA was also conducted to determine whether there were significant differences in end-of-program classroom activities and materials factor by science major

and experience (yrs.) including all two-way interactions. Prior to the analysis, ANOVA assumptions were examined.

Table 25

Means, Standard Deviations, and Sample Size for Interaction of End-of-Summer Classroom Activities and Materials Factor by Science Major and Experience (yrs.)

Science major	Experience (yrs.)	n	M	SD	SE	95% Confidence Interval for Mean	
						Lower	Upper
Science major	0-5	4	2.33	0.59	.147	2.039	2.627
	6+	14	2.89	0.14	.098	2.619	3.011
Other major	0-5	9	2.81	0.33	.079	2.736	3.050
	6+	44	2.75	0.29	.044	2.661	2.839

The results of the end-of-program ANOVA were not significant, $F(3, 67) = 0.72$, $p = .546$, indicating the differences in end-of-program classroom activities and materials factor among the levels of Science major and Experience (yrs.) were all similar (Table 26). The main effect, Science major was not significant at the 95% confidence level, $F(1, 67) = 0.60$, $p = .442$ neither was Experience (yrs.), $F(1, 67) = 0.29$, $p = .594$, indicating there were no significant differences of end-of-program classroom activities and materials factor by science major levels. The interaction between science major and experience (yrs.) was not significant at the 95% confidence level, $F(1, 67) = 2.13$, $p = .149$, indicating there were no significant differences of end-of-program classroom activities and materials factor by the values of the science major :experience (yrs.) interaction term. The means and standard deviations are presented in Table 27. There

was no significant effect in the model. As a result, posthoc comparisons were not conducted.

Table 26

Analysis of Variance Table for End-of-Program Classroom Activities and Materials Factor by Science Major and Experience (yrs.)

Teacher qualifications	<i>SS</i>	<i>df</i>	<i>F</i>	<i>p</i>	η^2_p
Science major	0.11	1	0.60	.442	0.01
Experience (yrs.)	0.05	1	0.29	.594	0.00
Science major:Experience (yrs.)	0.40	1	2.13	.149	0.03
Residuals	12.69	67			

Table 27

Means, Standard Deviations, and Sample Size for Interaction End-of-Program Classroom Activities and Materials Factor by Science Major and Experience (yrs.)

						95% Confidence Interval for Mean	
Science major	Experience (yrs.)	<i>n</i>	<i>M</i>	<i>SD</i>	<i>SE</i>	Lower	Upper
Science major	0-5	2.45	0.64	4	.218	2.016	2.884
	6+	2.74	0.32	14	.145	2.488	3.067
Other major	0-5	2.78	0.21	9	.116	2.511	2.975
	6+	2.64	0.48	44	.066	2.511	2.773

Chapter Summary

The purpose of the quantitative study was to explore possible relationships between factors related to teacher qualifications, school context, and the reported PD outcomes. The study findings were drawn from archived instrument data gathered during Cycle A ITQG PD programs. The self-reported PD outcomes for ITQG participants were described. Results were attained using descriptive and correlation analyses were used to explore possible relationships between factors related to teacher qualifications, school context, and the reported PD outcomes by addressing the study research questions:

1. What are the reported teacher qualifications, repeat ITQG participant, and school context on the TPD questionnaire?
2. How do self-reported PDEI PD outcomes differ at the end-of-summer institute across teacher qualifications, repeat ITQG participant, and school context?
3. Are self-reported PD outcomes from PDEI at the end-of-summer different than outcomes reported at the end-of-Program? Does this vary based on participant's demographics?

These three research questions were studied to explore the possible relationships between PD outcomes and teacher qualifications, confidence, and school context. The first research question focused on the participant's reported qualifications, school context, and whether or not they had participated in ITQG PD programs before. The results were demographic in nature and the study supplied the overall descriptive statistical context where only one hypothesis was accepted.

The second research question was to gain insight into whether PD outcomes differ at the end-of-summer institute across teacher qualifications, repeat ITQG participant, and

school context. The hypothesis for research question two was accepted, specifically that there would be no significant difference between end-of-summer teaching knowledge and skills and classroom activities and materials factors on the PDEI instruments results of PD outcomes. Even with the null hypothesis being accepted, it is worth noting that in the reported ANOVA for end-of-summer data revealed that experience (yrs.) had one of the lowest $p = .076$ ($p < .05$), while not significant for research question two this may indicate why research question three hypotheses were rejected.

The third research question was to gain insight into whether self-reported PD outcomes from PDEI at the end-of-summer different than outcomes reported at the end-of-program and if the PD outcomes vary is it based on participants' demographics. There were five hypotheses for research question three, each related to the reported teacher qualifications, whether the participant has repeat attendance in an ITQG PD programs, and their school context. Three of the five null hypotheses were accepted; there is no significant difference between the self-reported PD outcomes between reported education levels of the participants (Bachelors+ or Masters +); between PD program participants who teaching in a high needs school districts (HNSD) and those that do not teach in a HNSD; between the self-reported PD outcomes between repeat PD programs participants and non-repeat PD programs participants. The other two null hypotheses were rejected based on the MANOVA there was a difference between end-of-summer classroom activities and materials factor and end-of-program classroom activities and materials factor that were found to have an impact on end-of-summer/ end-of-program classroom activities and materials factor difference ($p = .043$, $p < .05$) but not a difference for teaching knowledge and skills factor of end-of-summer nor the end-of-program.

An MANOVA identified significant difference for end-of-summer and end-of-program for the classroom activities and materials factor due to the interaction between science major and experience (yrs.) $p = .015$ ($p < .05$), the main effects were not significant nor any other interaction. Thus, an ANOVA was utilized to pin point that it was the end-of-summer classroom activities and materials interaction between science major and experience (yrs.) with a $p = .004$, ($p < .05$) and not the end-of-program classroom activities and materials factor the explained the difference in PD outcome means. Thus, the interaction needed to be examined further with its own MANOVA. The results of that test showed significance at the $p = .054$ ($p < 0.5$) for experience (yrs.) and not the science major. The interaction of the two variables was reported at $p = .008$ ($p < 0.5$). Which resulted in the follow up ANOVA with experience (yrs.) reported a significant p level of $.015$ ($p < 0.5$) and interaction with science major at $p = .002$ ($p < 0.5$). Resulting is rejecting both the null hypothesis, there is no significant difference between the self-reported PD outcomes between early career teachers (0-5 yrs.) and beyond (6+ yrs.) and there is no significant difference between the self-reported PD outcomes between participants who have a science or science education degree and participants who hold any other reported degree.

The study conclusions and recommendations are presented in Chapter five.

Chapter 5: Discussion, Conclusions, and Implications

The purpose of this quantitative study was to explore the possible relationships between factors related to teacher qualifications, school context, and the reported PD outcomes. This study used archived instrument data gathered during Cycle A ITQG PD programs to analyze the PD outcomes of the ITQG participants. The study relied on data from a survey (PDEI) that asked teachers to indicate the degree to which they perceived improvement in their instructional practices as a result of their experience in the ITQG Program. The PDEI consisted of an on-line, pre-and post-instrument that contained 55 identical force-response items.

The present study utilized two sets of PDEI questions, the first related to the participant's perception of content knowledge change due to the PD ($n=12$) in five categories: (a) instructional materials, (b) collaboration, (c) assessment, (d) pedagogy, and (e) content knowledge. The second set related to the participants' perceived confidence in their content knowledge. The participants were asked to respond on a four-point scale: "not at all," to "very much" on both sets of PDEI questions. Both PDEI end-of-summer and end-of-project surveys were found to be highly reliable with Cronbach's alphas scores between $\alpha = .84$ - $.88$. Thus it was established that the items on the PDEI surveys are reliable measures for the two factors 1) teaching knowledge and skills and 2) the classroom activities and materials.

The research questions asked include 1) What are the reported teacher qualifications, repeat ITQG participant, and school context on the TPD questionnaire? 2) How do self-reported PEDI PD outcomes differ at the end-of-summer institute across teacher qualifications, repeat ITQG participant, and school context? and 3) Are self-

reported PD outcomes from PEDI at the end-of-summer different than outcomes reported at the end-of-school year? Does this vary based on participant's demographics? The study was designed to further our understanding of how factors related to the participants may account for variation in PD outcomes that could ultimately affect student achievement.

Interpretation of Findings

The study sought to explore relationships between PD outcomes (impact on teaching practices, and confidence in subject matter) at the end-of-summer institute and teacher qualification and school context (experience vs. degree level vs. science major vs. repeat participant vs. HNSD). It was hypothesized that measures of PD outcomes would not be systematically related to a teacher qualification and school context (experience vs. degree vs. science degree vs. HNSD). This was found to be the case, in that there was no significant difference in mean scores for teachers who completed the end-of-summer PDEI survey when comparing their teacher qualification and their school context. A MANOVA was used to analyze the PD outcomes and did show that the teacher qualification of experience (yrs.) did have the smallest p value of the group, $p = .195$. When the ANOVA was examined the p value for just the teaching knowledge and skills factor was found to have the lowest value, $p = .076$, even though it was not statistically significant. The perceived confidence in content knowledge survey questions on the PDEI was analyzed using a Chi-square and did not find significance when comparing their teacher qualification and their school context.

The study also sought to explore the change in PDEI PD responses from the end-of-summer to the end-of-program. PD outcomes for the same teacher qualification and school context (experience vs. degree level vs. science major vs. repeat participant vs.

HNSD) were analyzed to see if there was variation. I found no significant difference for the teacher qualifications of degree level, repeat participant, or HNSD. The MANOVA did reveal statistical significance for the interaction of experience (yrs.) and science major, $p = .015$ for the classroom activities and materials factor for the end-of-summer and end-of-program on the PDEI survey. The ANOVA narrowed the finding of significance to the end-of-summer classroom activities and materials factor with a p value of $.004$ for the interaction of experience (yrs.) and science major. This was confirmed by a Turkey pairwise comparison that substantiated PD programs had a statistically significant greater impact on teacher participants who held a science degree or who were science education majors and who had more than six years of experience compared to those teacher participants who held a major other than science and had fewer than six years of experience teaching.

The results of this study corroborate the findings of several other studies related to how PD may influence teachers differently based on factors such as career stage and degree. For example, Coldwell found that "...professional development at different stages of the teacher's life interacts with other factors to influence teacher resilience and commitment to the profession (2017, p. 190). Specifically, Coldwell's study reported PD influenced teachers' career progression by allowing the teachers to: 1) demonstrate their skills and attributes, 2) PD move into different subject areas in the future, and 3) increase in confidence that had come from taking part in the PD.

While self-reported outcomes suggest some teachers in this study benefited more than others from the PD programs, it is not clear that these teacher outcomes translate directly to student learning outcomes. For example, Rivkin et al., (2005) that found that

the interaction between a teacher's experience and the major of their degree might not be the only factors that affect student achievement as an outcome of PD. More specifically, the study found that teachers' gain from experience in the first few years of teaching were the most significant. (Rivkin et al.,2005). In the present study, it was found that the more experience teachers (6+ yrs.) had a higher mean score for the end-of-summer PDEI self-reported survey questions than the beginning teachers (0-5 yrs.). Specifically, experience teachers who hold a science or science education degree verses the teachers who hold another type of content or education degree.

Limitation of the Study

There are limitations to the present study that must be acknowledged in interpreting these findings. The Improving Teacher Quality Grant program for Cycle A, 2006-2007, main focus was to provide PD to high-needs schools that focused on science and mathematics for fourth through eighth grades by providing the participants with research-based instructional strategies. There was a total of 14 funded PD programs during Cycle A. Seven of these PD programs targeted only science and seven programs targeted both science and mathematics. The overall objectives of the PD programs were to improve student achievement in math/science, increase teachers' content knowledge, and improves teachers' pedagogical knowledge and skills. The RFP for Cycle A specifically mentioned providing participants with the opportunity to reflect on their practices and to give the district feedback on the effectiveness of participants in this activity/experience. The PD programs were designed to deliver year-long sustainability PD, using a multi-year PD programs with post-project meeting, through the use of school year call back and other school-based activities.

There were three main limitations to using the data from this source and therefore, for this study in general. First, this study was not designed to be a random sample. Participants were selected from the science PD programs and the sample size varied from a total of 124 participants for most retro pre-summer institute instruments to only a total of 72 participants by the Post end-of-program instrument. This is the second limitation. The failure to have full participation in the pre- and post- instruments would limit the conclusions that could be made from the data. Finally, as the all the responses were self-report, the study relies on the accuracy and subjectivity of these responses.

To exemplify these limitations, one has to look at what the current study did not find statically significant. The results related to teacher's confidence with their ability to teach science was not found to be significant as related to school context (HNSD). Needless to say, the author of the current study still finds school context important to consider as related to PD programs' outcomes. For example, Sandholtz and Ringstaff (2011) found that when teachers increased their content knowledge and their confidence in teaching science, this resulted in them spending more instructional time teaching science and utilizing different instructional strategies within their science classrooms. When educators participate in a yearlong PD program, there is evidence that PD can benefit teachers in HNSD and can serve as an effective means to improve teacher quality. Since this, in turn, should lead to improvements in student learning, it demonstrates the value of PD programs for this particular group of teachers. Their study helps illustrate how teachers from HNSD, to a greater extent than other teachers, used reform-based practices after participating in PD. Fischer, Fishman, Levey, Eisenkraft, Dede, Lawrenz and McCoy (2016) stated that

High-poverty schools might suffer from substantially lower district expenditures, poorly equipped classrooms, higher student–teacher ratios, more out-of-field teaching, difficulties to recruit and retain highly qualified teachers, and infrequent implementations of effective teaching (Biddle & Berliner, 2003; Boyd, Lankford, Loeb, Ronfeldt, & Wyckoff, 2011; Goldhaber, Lavery, & Theobald, 2015; Hill, Guin, & Celio, 2003; Ingersoll, 1999; Isenberg et al., 2013) which illustrates underlying conditions that contribute to existing opportunity gaps (p. 5-6).

This was not found to be the case in the current study, which could be due to the limitations mentioned above. The goal of the State’s RFP was for the PD providers to engage at least one high needs school district in their PD program. A total of 194 teachers responded to the demographic survey (TDP) indicating that they did or did not teacher in a HNSD. 38 % from HNSD with 62 % of the respondents indicated that they taught in a non-HNSD. The second factor that could affect why significant was not found related to the HNSD variable has to do with the number of surveys completed by a participant at two points in the PD program. Of those teachers who completed the PDEI survey, only 51 respondents indicated that they taught in a HNSD on the end-of-summer PDEI survey and a total of 30 respondents indicated that they taught in a HNSD the end-of-program PDEI survey. This resulted in a lower percent overall of respondents that taught in a HNSD, 40.5 % to be precise.

Implications and Recommendations

The present study explored the possible relationships between factors related to teacher qualification, school content, and the reported PD outcomes. The findings from the study, which showed an interaction between major and years of teaching experience,

may shed light on potential changes that need to be made to existing PD programs to better reach the needs of the PD participants. This study supports the idea that experience matters when teachers engage in PD, and outcomes from the same program may differ for beginners vs. veterans. Thus, the PD needs of teachers are different at different career stages. Implications for PD providers and the design of PD programs might include tailoring the PD program to the audience, or targeting specific majors/career stages for participation in PD programs in order to enhance outcomes. That is, differentiating PD for teachers. Taylor, Yates, Meyer & Kinsella (2011) mention that differentiated PD (based on experience level) is an alternative to one-size-fits-all PD. Borko (2004) points out, however, that despite calls for professional development across the career stages, little is known about PD for experienced teachers, specifically. Thus, questions for further investigation remains—specifically, *In what ways should programs be designed for the beginner vs. experienced teacher or for teachers who are majors vs. non-majors to enhance PD outcomes?*

The findings of this study also might inform grants administrators/district administrators who control access to and funding for PD. Newmann, King, and Young (2000) emphasized that how PD funding is used makes a difference. Funding programs that want to maximize the return on investment in terms of PD outcomes should expect that outcomes will differ for different groups, and tailor their RFP to reflect that. However, recommendations for how the PD should be designed for specific groups is beyond the scope of this dissertation, and further research is needed.

This study found teachers reported higher perceived outcomes from the PD based on their experience and major. This suggests that particular groups of teachers may be

benefiting more from the PD programs they attended, or perhaps they feel better able to capitalize on PD experiences to enact change in their classrooms. Additional analyses of the qualitative data gathered in the PDEI survey could help clarify why the results for the beginner vs. veterans and the majors vs. non-majors were significant while other teacher qualifications were not found to be significant. Furthermore, instead of running analyses of items as clusters (i.e, teaching knowledge and skills subscale and the classroom activities and materials subscale) conducting an analysis of items individually could help identify specific areas that contributed to the significance observed.

APPENDIX

Teacher Participant Data Questionnaire (taken online)

Directions: Your answers on this survey will provide us with information about the backgrounds of teachers who are participating in professional development projects sponsored by the Missouri Department of Higher Education. The survey should take about 15 minutes or less to complete.

Use the "Next!" button in the bottom right corner to proceed to the next screen. If you would like to view a previous screen, use the "previous" button in the bottom left corner. Do not use your browser's "back" or "forward" buttons.

When you have completed the final screen, click on the "submit your responses" button in the bottom right corner to finalize your submission.

For best viewing, please maximize your browser. If using Internet Explorer, close the "favorites" panel and set "text size" (under "view") to smaller.

Your first name:

Your last name:

Please indicate the Professional Development project in which you are enrolled.

1. Your gender:

☐ Male ☐ Female

2. Are you (check all that apply):

- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Hispanic or Latino
- ☐ Native Hawaiian or other Pacific Islander
- ☐ White
- ☐ Other

3. What is your highest level of education?

- ☐ Less than bachelors
- ☐ Bachelors degree only
- ☐ Credits beyond bachelors degree
- ☐ MA/MS/MEd
- ☐ EdS
- ☐ PhD/EdD
- ☐ Other: _____

3a. What year did you graduate with this degree?

3b. What was your major for this highest degree?

- ☐ Mathematics education
- ☐ Mathematics or statistics
- ☐ Science education
- ☐ Any science major
- ☐ Other education degree
- ☐ Other: _____

3c. In what state did you graduate with this degree?

4. Please tell us about your FIRST BACHELOR'S DEGREE.

4a. What year did you graduate?

4b. What was your major for this degree?

- ☐ Mathematics education
- ☐ Mathematics or statistics
- ☐ Science education
- ☐ Any science major
- ☐ Other education degree
- ☐ Other: _____

4c. In what state did you graduate with this degree?

5. Please rate how well your formal college education prepared you to be a teacher.

5a. Subject knowledge

☐ learned too little ☐ learned what I needed to know ☐ learned more than I needed to know

5b. Teaching skills (e.g., lesson planning, classroom man, assessing student progress, etc)

☐ learned too little ☐ learned what I needed to know ☐ learned more than I needed to know

6. Please indicate the certifications or endorsements you have for each area below.

6a. Are you certified in Elementary/Early Childhood Education?

☐ Yes ☐ No

6a1. If yes, what type of certification/endorsement?

☐ regular ☐ provisional ☐ temporary authorization

6b. Are you certified in middle/junior high school mathematics?

☐ Yes ☐ No

6b1. If yes, what type of certification/endorsement?

☐ regular ☐ provisional ☐ temporary authorization

6c. Are you certified in biology?

☐ Yes ☐ No

6c1. If yes, what level?

☐ Middle/junior high school ☐ High School ☐ Both

6c2. If yes, what type of certification/endorsement?

☐ regular ☐ provisional ☐ temporary authorization

6d. Are you certified in chemistry?

☐ Yes ☐ No

6d1. If yes, what level?

☐ Middle/junior high school ☐ High School ☐ Both

6d2. If yes, what type of certification/endorsement?

☐ regular ☐ provisional ☐ temporary authorization

6e. Are you certified in earth science?

☐ Yes ☐ No

6e1. If yes, what level?

☐ Middle/junior high school ☐ High School ☐ Both

6e2. If yes, what type of certification/endorsement?
☐ regular ☐ provisional ☐ temporary authorization

6f. Are you certified in physics?
☐ Yes ☐ No

6f1. If yes, what level?
☐ Middle/Junior high school ☐ High School ☐ Both

6f2. If yes, what type of certification/endorsement?
☐ regular ☐ provisional ☐ temporary authorization

6g. Are you certified in general science?
☐ Yes ☐ No

6g1. If yes, what level?
☐ Middle/Junior high school ☐ High School ☐ Both

6g2. If yes, what type of certification/endorsement?
☐ regular ☐ provisional ☐ temporary authorization

6h. Are you certified in high school mathematics?
☐ Yes ☐ No

6h1. If yes, what type of certification/endorsement?
☐ regular ☐ provisional ☐ temporary authorization

7. How many years have you been a teacher?

8. How many years have you taught ELEMENTARY school??
☐ 0
☐ 1-5
☐ 6-10
☐ 11-25
☐ 26+

9. If you taught at the elementary school level, how many years did you teach:
Mathematics? ☐ 0 ☐ 1-5 ☐ 6-10 ☐ 11-25 ☐ 26+
Science? ☐ 0 ☐ 1-5 ☐ 6-10 ☐ 11-25 ☐ 26+

10. How many years did you teach MIDDLE/JUNIOR HIGH school?
☐ 0
☐ 1-5
☐ 6-10
☐ 11-25
☐ 26+

11. If you taught at the Middle/Junior high school level, how many years did you teach:

Mathematics? ☐ 0 ☐ 1-5 ☐ 6-10 ☐ 11-25 ☐ 26+

Science? ☐ 0 ☐ 1-5 ☐ 6-10 ☐ 11-25 ☐ 26+

12. How many years did you teach HIGH SCHOOL?

☐ 0
☐ 1-5
☐ 6-10
☐ 11-25
☐ 26+

13. If you taught at the HIGH school level, how many years did you teach:

Mathematics? ☐ 0 ☐ 1-5 ☐ 6-10 ☐ 11-25 ☐ 26+

Science? ☐ 0 ☐ 1-5 ☐ 6-10 ☐ 11-25 ☐ 26+

14. What is the name of the school DISTRICT where you expect to teach in 2006/07?

14a. How many years have you taught in that district?

☐ 0
☐ 1-5
☐ 6-10
☐ 11-25
☐ 26+

15. What is the name of the school BUILDING where you expect to teach in 2006/07?

15a. How many years have you taught in that building?

☐ 0
☐ 1-5
☐ 6-10
☐ 11-25
☐ 26+

16. Please indicate the primary position you will hold during the coming school year.

☐ teacher aid ☐ teacher ☐ counselor ☐ building administrator ☐ district admin ☐ other

17. Please provide information about the subjects you anticipate teaching during the coming year.

☐ I will not teach any subjects this year (please skip to q18)

Mathematics

☐ Will not teach ☐ Elementary ☐ Middle/Jr. High ☐ High School

Biology

☐ Will not teach ☐ Elementary ☐ Middle/Jr. High ☐ High School

Chemistry

☐ Will not teach ☐ Elementary ☐ Middle/Jr. High ☐ High School

Earth science

☐ Will not teach ☐ Elementary ☐ Middle/Jr. High ☐ High School

Physical science

☐ Will not teach ☐ Elementary ☐ Middle/Jr. High ☐ High School

Physics

☐ Will not teach ☐ Elementary ☐ Middle/Jr. High ☐ High School

General science

☐ Will not teach ☐ Elementary ☐ Middle/Jr. High ☐ High School

Other science subjects

☐ Will not teach ☐ Elementary ☐ Middle/Jr. High ☐ High School

Other subjects

☐ Will not teach ☐ Elementary ☐ Middle/Jr. High ☐ High School

18. Last year, how many hours did you participate in district sponsored professional development?

Total hours of PD last year

Of the total hours, how many were devoted to math?

Of the total hours, how many were devoted to science?

19. How useful are the following PD characteristics to improving your teaching practice?
Developing or enhancing your content knowledge.

☐ not at all useful ☐ minimally useful ☐ somewhat useful ☐ very useful

Developing lessons aligned to content standards

☐ not at all useful ☐ minimally useful ☐ somewhat useful ☐ very useful

Developing instructional materials for use in your classroom.

☐ not at all useful ☐ minimally useful ☐ somewhat useful ☐ very useful

Focus on instructional methods

☐ not at all useful ☐ minimally useful ☐ somewhat useful ☐ very useful

Student learning principles

☐ not at all useful ☐ minimally useful ☐ somewhat useful ☐ very useful

Focus on assessing student learning

☐ not at all useful ☐ minimally useful ☐ somewhat useful ☐ very useful

Provide opportunities to engage in hands-on activities

☐ not at all useful ☐ minimally useful ☐ somewhat useful ☐ very useful

Require collaboration with other teachers

☐ not at all useful ☐ minimally useful ☐ somewhat useful ☐ very useful

20. Please list or describe other characteristics of professional development that you believe are very important.

21. The project you are currently participating in is an Improving Teacher Quality (ITQ) project sponsored by the MO Department of Higher Education. Have you participated in other ITQ projects in the past few years?

☐ Yes ☐ No

21a. If yes, please indicate which ones.
2003-04

2004-05

2005-06

22. Other than Improving Teacher Quality PD projects and District sponsored PD, were there other professional development you participated in last year?

☒ Yes ☐ No

23. Why did you choose to participate in this project?

Teachers' Professional Development Evaluation Survey--End-of-Institute (taken online)

Please help us to evaluate the professional development project that you have been participating in this summer by completing this short survey. Your responses will be kept confidential. We appreciate your input on this important project! The survey should take less than 15 minutes to complete.

Use the "Next" button in the bottom right corner to proceed to the next screen. If you would like to view a previous screen, use the "previous" button in the bottom left corner. Do not use your browser's "back" or "forward" buttons.

When you have completed the final screen, click on the "submit your responses" button in the bottom right corner to finalize your submission.

For best viewing, please maximize your browser. If using Internet Explorer, close the "favorites" panel and set "text size" (under "view") to smaller.

Your first name:

Your last name:

1. Did you participate in activities designed to improve mathematics teaching?

☐ Yes ☐ No

If YES, please answer the following. If NO, please skip to question 2 on the next screen.

1a. Think back to the day before the summer institute began and please rate YOUR KNOWLEDGE in each area listed below.

Number and operations:	none	a little	moderate	high
Algebra:	none	a little	moderate	high
Geometric and spatial relationships:	none	a little	moderate	high
Measurement:	none	a little	moderate	high
Data and probability:	none	a little	moderate	high
Inquiry-based / problem-centered instruction:	none	a little	moderate	high

1b1. What was your level of mathematical knowledge of the content focused on in the institute (e.g., geometry, probability, algebra) PRIOR to the summer institute?

0 knew nothing 1 2 3 4 5 6 7 8 9 10 knew it all

1b2. What was your level of mathematical knowledge of the content focused on in the institute (e.g., geometry, probability, algebra) AFTER the summer institute?

0 knew nothing 1 2 3 4 5 6 7 8 9 10 knew it all

1c. How much of the improvement in your math knowledge is relevant to your teaching assignment?

- ☐ I had no gain in math knowledge
- ☐ None of the gain was relevant to my teaching assignment
- ☐ Very little of the gain was relevant to my teaching assignment
- ☐ Moderate amount of the gain was relevant to my teaching assignment
- ☐ Most of the gain was relevant to my teaching assignment
- ☐ All of the gain was relevant to my teaching assignment
- ☐ N/A: I have no teaching assignment

2. Did you participate in activities designed to improve science teaching?

Yes No

If YES, please answer the following. If NO, please skip to question 3 on the next screen.

2a. Think back to the day before the summer institute began and please rate YOUR KNOWLEDGE in each area listed below.

Matter and energy:	none	a little	moderate	high
Force, motion, and mechanical energy:	none	a little	moderate	high
Living organisms:	none	a little	moderate	high
Inquiry approach to science education:	none	a little	moderate	high
Ecosystems and organism/environmental interactions:	none	a little	moderate	high
Earth science:	none	a little	moderate	high
Astronomy:	none	a little	moderate	high
Scientific inquiry:	none	a little	moderate	high
Science and technology and human activities:	none	a little	moderate	high

2b1. What was your level of science knowledge of the content focused on in the institute PRIOR to the summer institute?

0 knew nothing 1 2 3 4 5 6 7 8 9 10 knew it all

2b2. What was your level of science knowledge of the content focused on in the institute AFTER the summer institute?

0 knew nothing 1 2 3 4 5 6 7 8 9 10 knew it all

(2c.) How much of the improvement in your science knowledge is relevant to your teaching assignment?

- ☐ I had no gain in science knowledge
- ☐ None of the gain was relevant to my teaching assignment
- ☐ Very little of the gain was relevant to my teaching assignment
- ☐ Moderate amount of the gain was relevant to my teaching assignment
- ☐ Most of the gain was relevant to my teaching assignment
- ☐ All of the gain was relevant to my teaching assignment
- ☐ N/A: I have no teaching assignment

3. For the components of professional development listed below, please rate how much each was EMPHASIZED during the sessions.

Improving my content knowledge	a little	moderate	high
Creating lessons aligned with GLE's	no emphasis	moderate	high
Assessing student learning	no emphasis	moderate	high
Increasing student motivation	a little	moderate	high
Analyzing student performance data	no emphasis	moderate	high
Using inquiry-based / problem-centered teaching	a little	moderate	high
Collaborating with other teachers	no emphasis	moderate	high
Using technology effectively to enhance your teaching	a little	moderate	high
Participating in classroom activities as your students would	no emphasis	moderate	high
Implementing activities in your classroom	a little	moderate	high
Developing materials for use with your students	no emphasis	moderate	high
Managing inquiry-based / problem-centered classrooms	a little	moderate	high

4. For each component below, please rate how much you think your TEACHING PRACTICE WILL IMPROVE this coming school year as a result of what you learned this summer. **NOTE: If you have NO teaching assignment, please skip to question 6 on screen 7.**

Improving content knowledge	none	a little	moderate	very much
Creating lessons related to content standards	none	a little	moderate	very much
Assessing student learning	none	a little	moderate	very much
Increasing student motivation	none	a little	moderate	very much
Analyzing student performance data	none	a little	moderate	very much
Using inquiry-based / problem-centered teaching	none	a little	moderate	very much
Collaborating with other teachers	none	a little	moderate	very much
Using technology effectively to enhance your teaching	none	a little	moderate	very much
Participate in classroom activities as your students would	none	a little	moderate	very much
How to implement activities	none	a little	moderate	very much
Developing materials for use with your students	none	a little	moderate	very much
Managing inquiry-based / problem-centered classrooms	none	a little	moderate	very much

5. Rate the following statements based on your experiences in this professional development project as they relate to your teaching assignment.

Overall, I am confident in my science knowledge needed to be an effective teacher	not at all	a little	moderate	very much	n/a
Overall, I am confident in my science knowledge needed to be an effective teacher	not at all	a little	moderate	very much	n/a
Confidence in my ability to teach improved	not at all	a little	moderate	very much	
I will use materials and activities from this project in my classes during the coming year	not at all	a little	moderate	very much	
The summer institute was relevant to my teaching assignment for the coming school year	not at all	a little	moderate	very much	

6. Overall ratings of professional development

Quality instruction was delivered in this project	never	<1/2 the time	1/2 the time	>1/2 the time	always
Instructors modeled good practice	never	<1/2 the time	1/2 the time	>1/2 the time	always
Overall, I am satisfied with my experiences in this project	not at all	a little	moderate	very much	

7. In your opinion, what was the MOST VALUABLE part of this professional development experience. Please explain why you believe so.
 8. In your opinion, what was the LEAST VALUABLE part of this professional development experience. Please explain why you believe so.
 9. Please provide any additional comments regarding your experiences at this institute below.

Teachers' Professional Development Evaluation Survey--End-of-Project
(taken online)

Please help us to evaluate the professional development project that you have been participating in by completing this survey. Your responses will be kept confidential. We appreciate your input on this important project! The survey should take less than 15 minutes to complete.

Use the "Next" button in the bottom right corner to proceed to the next screen. If you would like to view a previous screen, use the "previous" button in the bottom left corner. Do not use your browser's "back" or "forward" buttons.

When you have completed the final screen, click on the "submit your responses" button in the bottom right corner to finalize your submission.

For best viewing, please maximize your browser. If using Internet Explorer, close the "favorites" panel and set "text size" (under "view") to smaller.
Your first name:
Your last name:

Please indicate the Professional Development project in which you are enrolled:

1. Did you participate in activities designed to improve mathematics teaching?
Yes
No

If you checked NO, please skip to Question 2 on the next screen by clicking the NEXT button in the lower-right hand corner of this screen.

1a. Please rate the extent to which each subject was EMPHASIZED during this Professional Development (PD) Project.

Number and operations:	none	a little	moderate	high
Algebra:	none	a little	moderate	high
Geometric and spatial relationships:	none	a little	moderate	high
Measurement:	none	a little	moderate	high
Data and probability:	none	a little	moderate	high
Inquiry-based / problem-centered instruction:	none	a little	moderate	high

1b. What is your current level of knowledge of the mathematical content focused on in the PD Project (e.g., geometry, probability, algebra)?

0 know nothing 1 2 3 4 5 6 7 8 9 10 know it all

1c. How much of any improvement in your math knowledge due to participating in this PD Project is relevant to your teaching assignment?

- ☐ I had no gain in math knowledge
- ☐ None of the gain was relevant to my teaching assignment
- ☐ Very little of the gain was relevant to my teaching assignment
- ☐ Moderate amount of the gain was relevant to my teaching assignment
- ☐ Most of the gain was relevant to my teaching assignment
- ☐ All of the gain was relevant to my teaching assignment
- ☐ N/A: I have no teaching assignment

2. Did you participate in activities designed to improve mathematics teaching?

Yes

No

If you checked NO, please skip to Question 3 on the next screen by clicking the NEXT button in the lower-right hand corner of this screen.

2a. Please indicate the extent to which each subject was EMPHASIZED in this PD Project.

Matter and energy:	none	a little	moderate	high
Force, motion, and mechanical energy:	none	a little	moderate	high
Living organisms:	none	a little	moderate	high
Inquiry approach to science education:	none	a little	moderate	high
Ecosystems and organism/environmental interactions:	none	a little	moderate	high
Earth science:	none	a little	moderate	high
Astronomy:	none	a little	moderate	high
Scientific inquiry:	none	a little	moderate	high
Science and technology and human activities:	none	a little	moderate	high

2b. What is your current level of knowledge related to the science content focused on in the PD Project?
 0 know nothing 1 2 3 4 5 6 7 8 9 10 know it all

2c. How much of any improvement in your science knowledge due to participating in this PD Project is relevant to your teaching assignment?

- ☐ I had no gain in science knowledge
- ☐ None of the gain was relevant to my teaching assignment
- ☐ Very little of the gain was relevant to my teaching assignment
- ☐ Moderate amount of the gain was relevant to my teaching assignment
- ☐ Most of the gain was relevant to my teaching assignment
- ☐ All of the gain was relevant to my teaching assignment
- ☐ N/A: I have no teaching assignment

3. For the components of professional development listed below, please rate how much each was EMPHASIZED during the PD Project.

Improving my content knowledge		
no emphasis	a little	moderate
Creating lessons aligned with GLE's		
no emphasis	a little	moderate
Assessing student learning		
no emphasis	a little	moderate
Increasing student motivation		
no emphasis	a little	moderate
Analyzing student performance data		
no emphasis	a little	moderate
Using inquiry-based / problem-centered teaching		
no emphasis	a little	moderate
Collaborating with other teachers		
no emphasis	a little	moderate
Using technology effectively to enhance your teaching		
no emphasis	a little	moderate
Participating in classroom activities as your students would		
no emphasis	a little	moderate
Implementing activities in your classroom		
no emphasis	a little	moderate
Developing materials for use with your students		
no emphasis	a little	moderate
Managing inquiry-based / problem-centered classrooms		
no emphasis	a little	moderate

4. For each component below, please rate how much you think your TEACHING PRACTICE IMPROVED this school year as a result of what you learned from this PD Project. Note: If you had NO teaching assignment, please skip to Question 5 by clicking the NEXT button in the lower, right-hand corner of this screen.

Improving content knowledge		
none	a little	moderate
Creating lessons related to content standards		
none	a little	moderate
Assessing student learning		
none	a little	moderate
Increasing student motivation		
none	a little	moderate
Analyzing student performance data		
none	a little	moderate
		very much
		very much
		very much
		very much

Using inquiry-based / problem-centered teaching	none	a little	moderate	very much
Collaborating with other teachers	none	a little	moderate	very much
Using technology effectively to enhance your teaching	none	a little	moderate	very much
Participating in classroom activities as your students would	none	a little	moderate	very much
Implementing activities in your classroom	none	a little	moderate	very much
Developing materials for use with your students	none	a little	moderate	very much
Managing inquiry-based / problem-centered classrooms	none	a little	moderate	very much

5. Please rate how much your STUDENTS' LEARNING was enhanced based on your improvements in each of the following PD components. If you believe your practice related to a component did NOT improve from participating in the PD Project, please select the "no improvement in my practice" option.

Improving content knowledge	none	a little	moderate	very much	no improvement in my practice
Creating lessons related to content standards	none	a little	moderate	very much	no improvement in my practice
Assessing student learning	none	a little	moderate	very much	no improvement in my practice
Increasing student motivation	none	a little	moderate	very much	no improvement in my practice
Analyzing student performance data	none	a little	moderate	very much	no improvement in my practice
Using inquiry-based / problem-centered teaching	none	a little	moderate	very much	no improvement in my practice
Collaborating with other teachers	none	a little	moderate	very much	no improvement in my practice
Using technology effectively to enhance your teaching	none	a little	moderate	very much	no improvement in my practice
Participating in classroom activities as your students would	none	a little	moderate	very much	no improvement in my practice
Implementing activities in your classroom	none	a little	moderate	very much	no improvement in my practice

Developing materials for use with your students					
none	a little	moderate	very much		no improvement in my practice
Managing inquiry-based / problem-centered classrooms					
none	a little	moderate	very much		no improvement in my practice

6. Please rate the following statements based on your experiences in this professional development project as they relate to your teaching assignment.

Overall, I am more confident in my science knowledge needed to be an effective teacher					
not at all	a little	moderate			n/a
Overall, I am more confident in my science knowledge needed to be an effective teacher					
not at all	a little	moderate			n/a
Confidence in my ability to teach improved					
not at all	a little	moderate			n/a
I used materials and activities from this project in my classes during the coming year					
not at all	a little	moderate			n/a
The PD Project was relevant to my teaching assignment					
not at all	a little	moderate			n/a

7. Please rate how much your experiences in each of the following aspects of the PD project have contributed to your professional practice.

Content knowledge (improving knowledge about science and/or math)					
1 none	2	3	4	5	6
					7
Pedagogy (improving how I teach and interact with students)					
1 none	2	3	4	5	6
					7
Instructional materials (developing or revising lessons and related materials)					
1 none	2	3	4	5	6
					7
Assessment (developing and using methods for gauging students' learning)					
1 none	2	3	4	5	6
					7
Communication/Collaboration/ Professionalism (developing working relationships with other PD teachers, instructors, and/or staff)					
1 none	2	3	4	5	6
					7

8. Overall, how valuable was each of the following activities to your professional growth?

Summer institute (classes you attended last summer)									
0 no value	1	2	3	4	5	6	7	8	9
									10 very valuable
School year call backs (weekend workshops and/or other scheduled GROUP MEETINGS for teachers who participated in the PD project)									
0 no value	1	2	3	4	5	6	7	8	9
									10 very valuable
Other school based activities (times when PD staff visited your school to observe teaching, assist with lessons plans, individual coaching, etc.)									
0 no value	1	2	3	4	5	6	7	8	9
									10 very valuable

10. How many times did you participate in PD activities from this project during the school year? (please enter numbers only)

Quality instruction was delivered in this project

never

<1/2 the time

1/2 the time

>1/2 the time

always

Instructors modeled good practice

never

<1/2 the time

1/2 the time

>1/2 the time

always

Overall, I am satisfied with my experiences in this project

not at all

a little

moderate

very much

10. How many hours did you participate in PD activities from this project during the school year? (please enter numbers only)
Note: "PD activities" are defined as any contact or involvement with PD staff.

11. How many call back sessions did you attend over the course of the school year? (please enter numbers only)
Note: "Call back sessions" are planned group meetings between PD staff and participants.

11a. What were the purposes of those sessions? (text is fine)

12. How many times did PD project staff visit with you individually at your school during the school year? (please enter numbers only)

12a. How many hours did PD project staff spend with you individually at your school during the school year? (please enter numbers only)

12b. What were the purposes of those visits?

13. In your opinion, what was the LEAST VALUABLE part of this professional development experience. Please explain why you believe so.

14. In your opinion, what was the MOST VALUABLE part of this professional development experience. Please explain why you believe so.

15. Please provide any additional comments regarding your experiences in this PD Project below.

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