A Blended and Face-to-Face Comparison of Teacher Professional Development:

What's the Impact?

by

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A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

Approved April, 2014 by the
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ARIZONA STATE UNIVERSITY

May 2014

ABSTRACT

The availability and subsequent expansion in the use of online learning environments has provided a new avenue for teacher professional development: blended learning. While blended learning environments may provide attractive benefits to teachers and school administration, the impact of blended teacher professional development has been largely unexamined in the existing research. This mixed-methods study investigated professional development outcomes for 64 teachers participating in district sponsored teaching professional development, 32 in a blended course and 32 in a face-to-face equivalent of the course. Outcomes of the professional development were measured using pre- and post- instructional belief surveys, participant satisfaction surveys, and interviews measuring retention of instructional beliefs and application of new instructional strategies. Additionally, participants who did not complete the course were interviewed to learn about their experience in the course and reasons for non-completion. The results of this study show similar changes in instructional beliefs for both the blended and face-to-face sections and significantly higher satisfaction with course content, materials, and instructor involvement among blended participants. However, blended participants were less likely to be transitioning to, or practicing new strategies as measured by interviews 12 weeks following course completion. A large number of blended participants showed evidence of their knowledge of new instructional strategies, but were reluctant to apply new strategies in their classrooms. Non-completers primarily cited lack of time for their withdrawal, but expressed an interest in future blended learning courses. The recommendations from this study should inform districts, schools, and teachers about blended learning for teacher professional development.

DEDICATION

This work is dedicated to my mom and dad, Mary Ellen and Don Leake, who have always believed in the importance of education and who provide me with continuous love and support.

ACKNOWLEDGMENTS

My doctoral journey would not have been attainable without the support of several important individuals. To my committee, thank you for your role in this process; each of you has provided unique knowledge and perspectives, guided me with your leadership, and inspired me to produce the best research I possibly can.

To Dr. David Garcia, how lucky I have been to start and end my doctoral work with you, experience the education and culture of Costa Rica with you and my cohort, and cheer you on in your future adventures.

I would like to thank my editor, Michele Mosco, for her help with all the details.

Members of my doctoral cohort, Delta 9, I thank you for your friendship and for continuing to inspire me to impact education. As I look toward the future, the knowledge that each of you are also committed to social justice and the empowerment of our students will fuel my passion to promote equity.

I have been incredibly fortunate to have the tireless support of my dear friends, Ashley, Dianne, and Joel, who always know the words I need to hear.

To my supervisor, friend, and incredible mentor Mark Share, thank you for pushing me and believing in me.

Finally, thank you to Kyle, whose love and encouragement got me through the most challenging days.

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CHAPTER 1

Introduction

In an era when schools must effectively implement a new set of nationally adopted curriculum standards and show continual increases in student achievement to meet federal guidelines, districts must ensure that teachers of highest quality teach in their classrooms. Existing research supports the relationship between high-quality teachers and student achievement, but disagrees on the best method of preparing teachers to provide quality instruction (Darling-Hammond, 1998; Geringer, 2003). Based on the argument that professional development allows teachers to gain instructional knowledge and learn new instructional strategies (Whitehurst, 2002), providing quality professional development is an essential strategy districts use to improve the instructional practices of their teachers with the ultimate goal of improving student learning. Teachers have the opportunity to participate in a variety of professional development activities, such as informal learning teams, district workshops and trainings, conferences, and graduate school courses that focus on teaching and learning. Teachers may be left to determine which of these options meets their individual needs based on their previous training, experience, and personal responsibilities, or districts may mandate professional development activities based on alignment to district initiatives and goals (Darling-Hammond, Wei, Andee, Richardson, & Orphanos, 2009; Archibald, Coggshall, Croft, & Laura, 2011). Unfortunately, the research on professional development shows inconsistencies in the impact of professional development on refining teacher practice and increasing student learning, indicating that not all professional activities yield comparable outcomes (Porter, Garet, Desimone, Yoon, & Birman, 2000).

The rapid expansion of online learning provides teachers with an additional avenue for professional development. One type of online education is blended learning, in which "a student learns at least in part at a supervised brick-and-mortar location away from home and at least in part through online delivery with some element of student control over time, place, path, and/or pace" (Staker, 2011, p. 3). Blended learning may arguably provide teachers with a flexible format to engage in professional development. Teachers, already overburdened by professional responsibilities, may be attracted to the flexibility of online learning environments for participating in professional development opportunities. Districts may be attracted to the decreased impact online and blended models have on instructional time and the increase in course offerings they are able to provide. However, to determine the extent to which online environments are an effective medium for professional development, it is essential to understand how online and blended learning environments provide instruction compared to face-to-face courses within the context of the desired outcomes of teacher professional development. Teachers, wishing to make informed decisions about the quality of professional development they receive, may benefit from research that illuminates the relationship between the course environment and learning outcomes. Understanding the relationship between course environments and learning outcomes may help districts decide whether online and blended offerings will have an equal or greater impact on instructional decisions compared to traditional, face-to-face courses.

Purpose of Study/Research Question

The relationship between high-quality teacher professional development and student achievement has been well-documented in research (Blank, de la Alas, & Smith, 2008; Borko, 2004; Darling-Hammond et al., 2009; Desimone, 2009; Garet, Porter, Desimone, Birman, & Suk Yoon, 2001; Smylie, 1989; Supovitz & Turner, 2000; Wilson & Berne, 1999). Historically, professional development, in the form of in-service seminars and single session workshops, have been criticized as ineffective in changing teacher instructional beliefs and practice by both its participants and those evaluating impact on student learning (Smylie, 1989). Professional learning activities are often critiqued as being disconnected from the practice of teaching and from current school improvement initiatives resulting in few instructional improvements (Cohen & Hill, 2000; Kennedy, 1998). For example, Gardner (1996) found that 31 K-12 teachers who attended a 6-day workshop only used 3 out of 18 new concepts and modified their existing instructional practices, rather than changing their instructional beliefs. However, specific characteristics of professional development programs have been linked to student outcomes, informing decisions about which professional development activities have the greatest impact. Professional development programs that are associated with increased student achievement tend to share the characteristics of being sustained over time, include active learning strategies, and focus on the content area in which the teacher instructs (Desimone, 2009; Darling-Hammond et al., 2009). Research has also indicated that more rigorous methods of professional development evaluation that go beyond simple satisfaction surveys are necessary to determine the impact on the primary goal of student learning (Guskey, 2000).

The sophistication of tools available in Web 2.0 environments and the proliferation of online and blended course offerings has coincided with research evaluating the relationship between course environment and participant learning outcomes (United States Department of Education, 2010). A number of studies over the last decade have argued there is no significant difference in learner outcome such as student achievement and learner satisfaction between online environments and their face-to-face counterparts at both K-12 and higher education levels (Allen, Mabry, Mattrey, Bourhis, Titsworth, & Burrell, 2004; Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer, 2004; Russel, Carey, Kleiman, & Venable, 2009; United States Department of Education, 2010). As the literature review will argue, much of the no significant difference research and research investigating the relationship between course environments and learner outcomes most commonly uses measurements such as end of course achievement and satisfaction as indicators of online or face-to-face efficacy (Bye, Smith, & Rallis, 2009; Lim, Kim, Chen, & Ryder, 2008; United States Department of Education, 2010). Additional studies have attempted to further analyze the relationship between course environment and learning outcomes by identifying factors in online and blended environments that may contribute to equal or better learning outcomes and participant satisfaction in online learning compared to face-to-face environments (Kirby, Sharpe, Bourgeois, & Greene, 2010; Rabe-Hemp, Woollen, & Humiston, 2009; Summers, Waigandt, & Whittaker, 2005).

While many large meta-analyses focus on the results in K-12 learning and post-secondary courses, fewer have assessed the relationship between environment and outcomes in teacher populations (Cady & Rearden, 2009; Holzer, 2011; Merrero, Woodruff, Schuster, & Ricco, 2010; Owston, Sinclair, & Wideman, 2008; Russel et al., 2009; Silverman, 2012). A common deficiency in these studies is that most measure learning outcomes using pre-and post- assessment and survey data, reports of participant satisfaction, and participants' participation within the course. Although these measurements may give us some understanding of participants' gains in knowledge and engagement, little is known about the ability of participants to transfer their learning in these courses into their teaching practice. For teachers who may participate in online learning to improve teaching practices, it is essential to understand whether or not blended environments yield the same outcomes as traditional face-to-face courses. The study will address the following research question: Do differences in participant satisfaction and changes in teacher beliefs and instructional practices occur based on participation in a face-to-face or blended professional development course?

Statement of Problem

As the literature review will show, while extensive research exists surrounding the use of online environments, little attention has been given to its use with teacher professional development populations. A greater understanding of the relationship of the blended learning environment on teacher learning and its subsequent impact on teacher behavior is needed to determine whether blended teacher professional development is as effective as face-to-face activities. In this sequential mixed-methods study, I assess the extent to which teachers who participate in a blended professional development course learn new skills and integrate them into their instruction compared to teachers participating in a face-to-face professional development course. My research design, influenced by Guskey's (2000) Five-Level Framework for professional development evaluation, incorporates the use of pre- and post-surveys to measure changes in mathematical instructional beliefs and post-surveys to measure participant satisfaction. I then followed with interviews of course participants to assess the extent to which teachers implement their new learning in classroom instruction. I compare changes in instructional beliefs, participant satisfaction, and retention and use of instructional strategies between participants in the blended and face-to-face courses. This mixed-methods design, which combines quantitative measure of changes in teachers' instructional beliefs with interviews regarding classroom behaviors and instructional decisions adds to our understanding about the relationship between learning environments and the possible impact on instructional beliefs and practices.

Significance of the Study

While research in the second half of the 20^{th} century emphasized the importance of teacher knowledge on student outcomes, the current climate of education has prompted significant changes in legislation over recent years increasing the demand for greater transparency in education (ADE, 2011; The White House, 2009). The No Child Left Behind Act of 2001 and the Race to the Top initiative have raised the public's level of concern regarding student achievement, academic rigor, and teacher quality. Each initiative includes requirements that impact educational stakeholders in three significant ways. First, schools must measure and report student achievement to meet annual requirements for student growth (U.S. Department of Education, 2009). Second, schools must implement new curriculum standards defined by the Common Core State Standards (CCSS) that differ from and exceed the academic demands of previous curriculum standards (National Governors Association Center for Best Practices, 2010; Porter, McMaken, Hwang, & Yang, 2011). Finally, measures to ensure teacher quality and effectiveness, such as certification requirements and the implementation of rigorous evaluation models, have transformed the notion of teacher efficacy and performance.

Each of these changes has increased pressure on districts, schools, and teachers as they attempt to adhere to new requirements set forth by state and federal governments.

Research examining the relationship between teacher quality and student achievement has shown that teacher effectiveness promotes student success and school improvement (Darling-Hammond et al., 2009; Stronge, Ward, Tucker, & Hindman, 2007). These studies have argued that teacher quality effectiveness and quality, as measured by instructional practice, teacher-student interaction, and teacher behaviors are correlated with levels of student achievement. Several studies reveal that many of our nation's students may not have access to highly qualified teachers or teachers prepared to teach in the content area in which they are learning (Almy & Theokas, 2010; Clotfelter, Ladd, & Vigdor, 2007). While some survey data suggests that 95% of secondary-level core classes are being taught by highly qualified teachers in 2007- 2008, representing an 8% from 2003-2004, teachers surveyed in the 2007-2008 U.S. Department of Education Schools and Staffing Survey (Almy & Theokas, 2010) expressed that there are actually three times as many teachers placed outside their area of expertise than this figure suggests. The report indicates that, "15.6 percent of secondary core academic classes are taught by a teacher with neither certification nor a major in the subject area taught, an improvement of just over one percent since 2003-2004" (p. 1). Additionally, there is disproportionality between high and low poverty schools, with an average of 25.1% of classes at high-poverty schools staffed by an out-of-field or under-qualified teacher compared to just 10.6% at low-poverty schools (Almy & Theokas, 2010, p. 2). Therefore, our most underserviced and historically low performing students are being taught by those with the least subject knowledge and qualifications. These findings have led to a belief that many teachers are generally under-qualified to effectively improve student learning.

In an effort to improve the quality of education in the United States, the Race to the Top initiative has recognized the relationship between teacher quality and student achievement by including a focus on teacher quality in its five principle areas of reform (The White House, 2009). The federal government promised additional funding to states who adopt legislation requiring state schools to meet Race to the Top requirements. Compliance with Race to the Top funding and its associated state legislation has required many schools and districts to redesign teacher evaluation and performance instruments.

In May of 2010, Arizona Governor Jan Brewer signed Senate Bill 1040 into law, aligning Arizona with the requirements necessary to compete for federal Race to the Top funding. The law mandates the statewide adoption of a model framework that defines teacher and principal evaluation instruments and requires schools to use new instruments by the 2012-2013 school year (ADE, 2011). The evaluation models defined by the Arizona Framework identify specific instructional behaviors that promote student success. Additionally, Arizona Revised Statute 15-977 (2012) requires that by 2014-2015 school districts will award forty percent of the Classroom Site Fund to teachers based on their individual teacher performance. According the revised statute, districts must adopt a compensation system that includes district and school performance, individual teacher performance, measures of academic student progress, and participation in professional development programs. Teacher compensation will no longer be determined solely by years of experience and educational attainment. Instead, evidence of performance as measured by instructional behaviors and student achievement and growth will provide proof of individual teacher quality and affect employment and financial security. Therefore, both schools and individual teachers have significant interest in improving performance and instructional quality.

As schools enact reforms aimed at meeting the goals mandated by federal legislation, teachers may choose to participate in professional development to learn best practices and new instructional strategies. Legislation over the past two decades has also emphasized the need to evaluate the effectiveness of trainings and the ultimate impact on students as one way to ensure improvements in teacher quality. One of the five criteria related to professional development set forth by The No Child Left Behind Act of 2001 is that professional development opportunities be frequently evaluated for impact on teacher effectiveness and student achievement. Despite this, the evaluation of professional development activities is often based on anecdotal descriptions or participant evaluations, which typically measure participant satisfaction as the only measure of training success (Guskey, 2000; Haslam, 2010). Evidence of what knowledge teachers acquire and the extent to which the learning impacts their instruction has been largely unexamined. In order to determine whether teacher professional development activities are likely to improve teacher quality and increase student learning, rigorous research providing evidence supporting the use of specific professional development models is needed.

Although distance learning options have been available in K-12 settings for over a century, the development of Web 2.0 tools, including sophisticated content delivery, collaboration, and assessment tools, has provided institutions with unique opportunities to provide instruction beyond traditional face-to-face courses, potentially increasing access to a wide variety of learners. These changes allow greater flexibility in the use of online learning and have prompted educational institutions to consider the expansion of online and blended learning environments for K-12 students, post-secondary institutions, and professional development. While current research has attempted to document the benefits, challenges, and outcomes of online learning environments (Bye et al., 2009; Bernard et al., 2004; Cavanaugh et al., 2004; Delfino & Persico, 2007; Kirby et al., 2010; Lim et al., 2008; Meyer, 2003; Summers et al., 2005; United States Department of Education, 2010), there is a great deal to learn about the impact of online course environments on participant learning outcomes, particularly for teacher professional development populations.

Numerous reports issued by government, education agencies, and special interest groups, have documented the expansion of online learning opportunities for a variety of populations, targeting K-12 students, post-secondary institutions, professional development, and vocational training (Allen & Seaman, 2007; Allen & Seaman, 2011; Ashby, 2002; Staker, 2011; Project Tomorrow, 2010). According to a 2011 report by the Sloan Consortium, almost 6.1 million students in higher education were taking at least one online course, a 10% increase between fall of 2009 and fall of 2010 There has been an average increase in enrollment of 18.3% each year since 2003 (Allen & Seaman, 2011, p. 11). While the number of students engaged in online learning in post-secondary educational settings has expanded considerably, online learning has recently gained popularity in K-12 education as well. Queen, Lewis, and Coopersmith (2011) reported that in the 2009-2010 school year, 1.8 million K-12 students were participating in partially or fully online classes in the United States. Public educational entities have offered online courses to K-12 students in all 50 states (Watson, Murin, Vashaw, Gemin,

& Rapp, 2012) and states such as Michigan (2006), Alabama (2008), New Mexico (2009), and Indiana (2011) now have online course graduation requirements effective the year indicated in parentheses (Watson et al., 2011). The Florida Virtual School, founded in 1997, boasted an enrollment of 122,000 full time students in 2010-2011, an increase of 110,000 students over ten years (Florida Virtual School, 2011).

While there is little research on the expansion of enrollment in online and blended professional development for teachers, Dede, Jass Ketelhut, Whitehouse, Breit, and McClosky (2009) have provided an extensive review of perceived benefits of online professional development that may become a catalyst for similar expansion of the use of online learning for professional development. An online search of professional development reveals that the private sector has also discovered the potential of distance learning for teacher professional development. Companies such as Scholastic, PBS, Intel, and PD360 are just some of the many companies promising high-quality professional development delivered online. In 2005, the Arkansas legislature passed Act 2318, creating a partnership with the Arkansas Educational Television Network and the Arkansas Department of Education as a means to deliver professional development online, helping state teachers meet the requirement of earning 60 hours of professional development annually.

These trends illustrate the massive growth in online learning throughout the United States and its potential to transform educational opportunity. However, the limited research linking blended learning teacher development to the impact on students precludes the ability to utilize this environment with confidence. This study provides additional information for districts and teachers wishing to utilize professional development to improve teacher quality and student learning.

Limitations and Delimitations

This study focuses on a specific group of teachers from one district enrolled in a blended or face-to-face section of teacher professional development. While the results of the professional development activities may be influenced by the context of their district, their common experience in meeting state and federal requirements for teacher quality and pressure to improve student achievement should allow the reader to generalize the impacts of blended and face-to-face professional development outside of the isolated study. The impetus for learning about best practices in instruction and subsequent changes in instructional behaviors is similar to that for many teachers in the country.

Operational Definitions of Terms

Asynchronous Learning: Communication which occurs in elapsed time. In online environments, this may include the discussion boards (threaded discussion), journals, blogs, wikis, and email.

Blended Learning: Any learning environment that combines the use of supervised face-to-face instruction in a brick-and-mortar location with some online components where students have some control over place, time, and pace; the term may be used interchangeably with hybrid learning. Online components may substitute for some face-to-face sessions or may serve as an enhancement to face-to-face sessions.

Discussion Board: This is an online communication forum which includes successive messages about a topic and used by a group to aid in discussions.

Distance Learning: This is an educational experience when participants, including instructors and students, are separated by space and may be separated by time.

Mediated Learning Environment: This includes a technology platform in which students can access online course content, communication tools, and assessments; it is also referred to as a learning management system (LMS) or course management system.

Online Learning: This is an educational experience that is delivered primarily over the internet; the term may be used interchangeably with the terms virtual learning, cyber learning, and e-learning.

Teacher Professional Development Activity: This includes any activity in which teachers can gain knowledge and skills to use in their instructional practice; it may be in a variety of forms such as trainings, learning teams, workshops, conferences, or curriculum development.

Synchronous Learning: This includes communication that occurs between students interacting at the same time; in an online environment this may include the use of virtual chats or webinars.

Teacher Effectiveness: This is the general quality of a teacher as measured by various indicators, such as knowledge, classroom instructional behaviors, and student achievement.

Summary

This chapter described the importance of evaluating the use of blended learning environments for teacher professional development activities. It discussed the pressures related to improving teacher quality and student achievement at a time when distance learning options appear to be an attractive and growing option.

In forecasting upcoming chapters of this dissertation, Chapter 2 will review the literature in the area of teacher professional development, providing support for rigorous methods of professional development evaluation, connections to activity outcomes, measurements of activity success. It will summarize the findings in blended learning and highlights characteristics of the blended learning environment that may support its use in teacher professional development. Chapter 3 describes the methods used in this mixed-methods study. A presentation of the results of the data collection is included in Chapter 4. Chapter 5 will discuss the conclusions and implications of the study and discuss areas of future research.

CHAPTER 2

Literature Review

A review of the literature in the area of blended teacher development reveals that little is known about the impact of blended teacher professional development. Even fewer studies have provided evidence of blended professional development efficacy through multiple outcomes as measured by changes in instructional beliefs, content knowledge, and instructional practice. In this chapter, I will address three areas of research relevant to understanding teacher professional development in blended environments. First, I will discuss the literature regarding teacher professional development, summarize the outcomes that may indicate professional development success, and review measurements that may be effective in the evaluation of teacher professional development. Second, I will discuss characteristics of blended learning as defined in the literature and summarize findings in blended learning literature. Finally, I will summarize the findings of research illuminating blended teacher professional development. The discussion will identify the limitations and voids in the research surrounding blended teacher professional development, supporting the relevancy and significance of this study.

Teacher Professional Development

A confluence of forces has prompted a call for increased teacher quality and the use of research-based instructional strategies with students. The demand exists for quality teacher professional development as a vehicle to improve instructional practice and the quality of education that students receive (Cohen & Ball, 1990). Determining whether professional development is effective is complicated by the many forms of professional development activities, the various facets that influence professional development activities, and the number of outcomes that may be indicators of professional development impact. The following section will summarize the various forms, facets, and goals of teacher professional development. I will discuss outcome measurements of professional development as defined in the literature and their correlation with student achievement.

Forms of Professional Growth Opportunities.

The challenges in defining effective teacher professional development (TPD) may be related to the broad definition of what TPD is and the numerous ways in which teachers can learn strategies relevant to their profession. Sparks and Loucks-Horsley (1989) identified five models of staff development that are characteristic of professional learning opportunities for continuing teachers that have been widely cited in the literature. The authors assert that staff development and professional learning opportunities can occur in many traditional and non-traditional contexts, such as workshops, trainings, and seminars, as well as self-guided growth via exposure to professional journals and collaboration with colleagues, observation and assessment of instructional practices, and finally involvement in curriculum design and development. These models vary in format, duration, and context creating vastly different learning opportunities to understand. Finally, teacher professional development may be categorized based on the educational focus of the opportunity, such as curriculum content, technology integration, district initiative, and professional standards.

Trainings. While a host of professional growth models exist, studies frequently focus on professional growth trainings. Many educators may equate trainings in the form of workshops and courses as synonymous with teacher professional development as these workshops, conferences, and district-sponsored courses represent the majority of professional development in which teachers participate (Lieberman & Pointer-Mace, 2008). In a 2009 report released by the National Staff Development Council, nine out of ten teachers reported participating in staff development trainings, typically in the form of workshops, conferences, and short term courses (Darling-Hammond et al., 2009, p. 5). Training, which is generally designed around objectives and learning outcomes, is facilitated by someone who is considered an expert in the instructional area. Frequently, training goals include acquisition of a new awareness or knowledge, skill development, changes in attitude about instruction, and the consistent implementation of new knowledge and strategies in the classroom (Sparks & Loucks-Horsley, 1989; Joyce & Showers, 1988). Trainings are often offered by the district employing the teacher and may be characteristically short in duration (Lieberman & Pointer-Mace, 2008).

The belief that staff development is at the core of educational initiatives to improve student learning is historically belied by a lack of confidence in its worth, especially when professional development is delivered in the form of trainings. In a national survey given in 1985, teachers ranked in-service trainings as one of the least effective sources of professional learning opportunities they have (Smylie, 1989). Nearly 25 years later, a meta-analysis by Darling-Hammond et al. (2009) of 13,000 professional development offerings revealed that only 59% of teachers find content-related professional development beneficial and less than half value non content-related professional development opportunities.

This disparity between the use of trainings to initiate educational practice and the long-standing perception that training is often ineffective has been the catalyst for a significant body of literature highlighting professional development, teacher learning, teacher change, and the impact on student outcomes (Blank et al., 2008; Borko, 2004; Darling-Hammond et al., 2009; Desimone, 2009; Garet et al., 2001; Smylie, 1989; Supovitz & Turner, 2000; Wilson & Berne, 1999). This literature includes evaluations on specific professional development efforts, responses from teachers focusing on the experiences and satisfaction of teachers regarding professional development, and definitions of best practices in teacher professional development. Literature often focuses on characteristics inherent in quality professional development, such as context, duration, coherence, and active learning, yet studies directly linking professional development to teacher and student outcomes are sparse (Garet et al., 2001)

Facets of Effective Professional Development.

In response to challenges presented in evaluating professional development, a number of researchers have attempted to define a core set of features of professional development (Desimone, 2009; Garet et al., 2001; Darling-Hammond et al., 2009). This literature does not define forms of professional development that are more effective than others. Instead, it illuminates components of professional development that are frequently correlated with effectiveness. Research in this area suggests that features of professional development such as the duration, coherence to other learning opportunities, emphasis on content knowledge, integration of active learning, collaboration of teachers within a grade-level, subject, or school, and form of activity may have a significant effect on the change in knowledge, skills, and classroom practices of teachers. While the facets identified below will not be measured in this study of teacher professional development, an understanding of the importance of each will help establish the argument for the courses included for comparison in this study and may be relevant in discussing the outcomes in each course environment.

Duration. Research asserts that the length of the professional development opportunity has an impact on effectiveness (Guskey, 2000; Garet et al., 2001; Hawley & Valli, 1999; Sparks & Loucks-Horsley, 1989) arguing that "conventional approaches to professional development, such as one-time workshops, typically do not lead to significant change in teaching methodologies" (Hawley & Valli, 1999). Darling-Hammond et al. (2009) and Garet et al. (2001) illuminate the significance of professional development duration in two meta-analyses synthesizing the results of empirically based studies on professional development outcomes. Duration can be considered in two contexts: length of time spent in activities and participation in the professional development activity over time. First "longer activities are more likely to provide an opportunity for in-depth discussion of content, student conceptions and misconceptions, and pedagogical strategies" (Garet et al., 2001, p. 921-922). Darling-Hammond et al. (2009) found that professional development activities lasting less than 14 hours were correlated with no student achievement gains, while activities of 30 hours or more "showed a positive and significant correlation with student gains" (p. 9). When activities extend over a longer period of time, they are also more likely to impact student achievement by allowing teachers to attempt new instructional practices in their own classrooms, discuss challenges and successes, and obtain feedback about their practice (Garet et al., 2001). Activities spread over multiple months were correlated with student achievement gains when compared to activities of shorter duration such as one day workshops, and activities with greater duration generally resulted in increased application of new skills in teachers' classrooms (Darling-Hammond et al., 2009).

Emphasis on content. Professional development may address a variety of topics related to instruction, such as professional standards, technology, and pedagogical content knowledge. Corcoran (1995) proposes that professional development that focuses on subject matter and the ways in which students learn content may be essential in changing instructional practices. Activities that are concrete, encourage specific improvement to teacher practice, provide a variety of goals for student learning, focus on subject matter, and address the ways in which students learn differently are generally more effective than those that focus on abstract theory fragmented from context (Darling-Hammond et al., 2009). Research has argued that teachers must have understanding about the concepts within the subjects they teach and how concepts connect with one another in order to employ effective instructional strategies related to their content (Ball & Cohen, 1999; Putnam & Borko, 2000).

In addition to promoting effective instructional strategies, content specific professional development has been shown to impact student achievement. Cohen and Hill (1998) found that in schools where teachers had participated in professional development specific to mathematics instruction, student achievement was higher than in schools without similar professional development opportunities. Increased participation in non-content specific professional development failed to yield similar achievement.

Coherence. One challenge in both offering and measuring professional development effectiveness is that districts and schools often initiate multiple reforms at one time making it difficult to allow teachers to focus on one instructional improvement and even more difficult to identify a causal relationship between professional development and student outcomes. Darling-Hammond et al. (2009) conducted a meta-analysis and found that professional development is more effective when it aligns with other district reforms, rather than those that are isolated or contrary to other changes being made at the school level. Putnam and Borko (2000) further contend that not only must teacher professional development be grounded in content, the context in which the teachers learn is essential. Training that promotes ideas or strategies that contradict the context and goals of their school, local community, or legislation may have less impact than those that align with other district goals and education initiatives. Frequently teachers complain that trainings are fragmented and "that learning experiences outside the classroom are too removed from the day-to-day work of teaching to have a meaningful impact" (Putnam & Borko, 2000, p. 6).

Active learning. A fourth facet of professional development activities argued to correlate with impact is the extent to which the activities promote active learning and engagement of its participants. Putnam and Borko (1997) list active learning as one of four essential components of professional development activities, encouraging teachers to construct their own understanding on concepts. Active learning may emerge in a variety of forms such as observation of teaching, planning curriculum and instruction, analyzing student work and practice, leading and participating in class discussions, and engaging in written work or reflections (Garet et al., 2001).

Collaboration. Research suggests that collaboration among teachers and a constructivist oriented learning environment may be highly correlated with high-quality professional development activities (Borko, 2004; Darling-Hammond et al., 2009;

Desimone, 2009; Wilson & Berne, 1999). Constructivism is based on the central notion that knowledge is constructed by an individual or individuals and is not present independent of the learner (Von Glasersfeld, 1989; Vygotsky, 1978). Within this concept, personal constructivism contends that knowledge is constructed within the learner's mind while reorganizing information based on experiences and prior knowledge (Piaget 1972; Von Glasersfeld, 1989), while social constructivism describes the process in which knowledge is constructed through social interaction (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991; Vygotsky, 1978). In teacher professional development activities, social interaction allows teachers to share a variety of educational perspectives and experiences, creating shared understanding and knowledge. Each individual learner can then construct their own meaning within the context of their classroom making knowledge more meaningful.

These core features of professional development become significant when studying learning environments and learner outcomes. If the form of the activity, duration of activity, focus on content, coherence to other learning activities, opportunities for active learning, and collaboration among teachers is consistent between two activities under comparison, will a relationship between course environment and learner outcomes emerge?

Measuring Teacher Professional Development Outcomes.

Before we can evaluate whether a professional development course is effective, we must define the goals of professional development. Certainly, teacher learning from professional development is significant primarily because of the potential impact it has on the teacher's students. However, proving a direct relationship between professional development and increased student achievement is challenging (Borko, 2004; Supovitz, 2001). As Dede et al. (2009) note:

> within the complexity of educational settings, where multiple school change and professional development initiatives may be underway simultaneously and students move from teacher to teacher, it can be difficult to isolate and attribute the contribution of one professional development program on a teacher's development, and even more difficult to gauge the effect of professional development on student achievement or understanding. (p. 5)

Several studies have argued that despite challenges in linking professional development to student achievement, a correlation exists (Cohen & Hill, 1998; Kennedy, 1998; Wenglinsky, 2002; Yoon, Duncan, Wen Yu Lee, Scarloss, & Shapley, 2007). In a meta-analysis evaluating the effects of professional development on student achievement, Yoon et al. (2007) found that the students in an average control group increased their achievement scores by 21 percentile points if their teacher participated in quality professional development compared to students whose teachers did not. Wenglinsky (2002) determined that when teachers participated in professional development that taught them about higher-order thinking skills and methods for instructing special populations of students, there were significant positive impacts on student achievement.

Therefore, despite a desire to understand the impact of professional development on defined outcomes, the debate continues regarding how much we know about the effectiveness. Sparks and Loucks-Horsley (1989) argue that there is considerable research supporting that training can significantly impact teacher beliefs, increase knowledge, and affect the performance of students, provided they have received adequate chances to learn. Borko (2004) agrees that progress in the research in the last two decades has provided evidence that professional development can have a positive impact on instruction and student learning, but cautions that we still have a great deal to discover about what teachers learn in these opportunities and how it impacts classroom practice and student learning. Desimone (2009) and Guskey (2000) contend that years of documenting teacher satisfaction, attitudes towards professional development, and commitment to innovation has been an insufficient response to the need to evaluate professional development and argue that researchers must examine additional outcomes when assessing professional development. These arguments illustrate the general perception that, while teacher professional development can yield results, our attempts to evaluate them through only basic evaluation methods may minimize their significance in teacher improvement.

In the following sections, I identify four outcomes of professional development that may be measured as an indicator of activity success. I will discuss why this outcome is an indicator of professional development impact, the ways in which each outcome may serve as a precursor for the next, and provide evidence from the literature that each outcome is correlated with changes in student achievement. Finally, I will describe methods that have been used to measure these outcomes in the research, highlighting the methods used previously in evaluation of face-to-face Cognitively Guided Instruction professional development courses, which were utilized in this particular study on teacher professional development.

Participant reactions. Professional development evaluations frequently measure participant reaction and satisfaction as an indicator of program effectiveness. Measurements of participant satisfaction may attempt to reveal the extent to which participants liked the professional development, whether they believed their time was well spent, whether they think it will be useful, and whether the facilitator of the professional development activity was knowledgeable and helpful (Guskey, 2000). The National Staff Development Council classifies questions measuring participant satisfaction into three categories: content, process, and context questions (Kirkpatrick & Kirkpatrick, 1994).

While many researchers argue for multiple rigorous outcome measurements to validate efficacy (Desimone, 2009; Guskey, 2000), they also argue that participant satisfaction remains a valuable indicator of program effectiveness and may be correlated with additional desired outcomes. Answers to questions in the categories of content, process, and context can reveal participant perception of opportunities to explore. In addition, opportunities to question and clarify content may help us understand the participants' satisfaction regarding activity format (Guskey, 2000), thus, helping us compare one course environment to another. Reeves and Pedula (2011) asserts that, "satisfaction with PD is as important as its impact, we do assume it represents an important construct in its own right through its afore- mentioned relationship with learning" (p. 3). In other words, the participant's satisfaction with the activity may be related to their perception of value and their intent to use new learning strategies in their teaching. Low levels of satisfaction may indicate a lack of learning, a lack of value on new learning, and predict a lack of use of a new instructional strategy or instructional pedagogy.

Measuring participant satisfaction. Guskey (2000) argues that participant satisfaction can be measured in several ways. Surveys or questionnaires, typically containing rating scale items combined with open-ended questions, are the most widely used and are considered “highly efficient and unobtrusive” (p. 104). Focus groups, interviews, and personal journals or logs can provide detailed data, but require far greater time and resources in collection and analysis. Because surveys and questionnaires can be administered in the absence of the course facilitator or researcher, participants may be more honest in their responses than they would be in face-to-face interviews and focus groups. Survey items may include questions about the perceived level of instructor or facilitator expertise, the perceived clarity of activity objectives, the usefulness of new knowledge and strategies in improving student learning, and the value of course materials. Surveys and questionnaires are most frequently administered at the end of the professional development session or in a few days following the culmination of the activity. While delaying the collection of data, participants may benefit from several days of reflection on the course, the potential for lost information is increased. By administering the instrument immediately, evaluators can ensure high completion rates that typically decrease to 60-70 % when collection is delayed, possibly biasing the results (Guskey, 2000).

Participant learning. Collecting evidence about participant learning can confirm that the intended goals of the professional development activity were actually achieved and may be one of the primary indicators of activity effectiveness. It is also significant because increasing participants’ knowledge and skills is crucial to the subsequent implementation of new instructional practices (Guskey, 2000).

Understanding knowledge gains resulting from professional development may require looking at multiple types of knowledge specific to teaching practice. Unlike a K-12 or postsecondary student whose learning objectives require the mastery of a particular set of concepts in a subject area, teachers must master a new concept in multiple contexts. They must learn and understand the concepts in the subject area, learn and understand the process by which students learn them according to their age and developmental level, understand how to design and deliver the instruction of these concepts, and understand how to assess student mastery of the concepts. To better clarify the level of knowledge teachers possess about a concept, knowledge about the practice of teaching can be categorized into several types and that multiple types of knowledge may be measured when evaluating changes in teacher knowledge following the completion of a professional development activity (Shulman, 1987).

The research has repeatedly emphasized the relationship between teacher knowledge and student learning, arguing that teachers who possess strong content and pedagogical knowledge and understand the content knowledge within the context of the children they teach exhibit quality instructional strategies and are correlated with students who have higher achievement (Konold et al., 2008). Conversely, research suggests that many teachers learned teaching practices during teacher preparation programs that stress the memorization of facts rather than an awareness of content knowledge (Hammerness et al., 2005) and teachers who lack instructional expertise are associated with students with lower achievement (Mendro, 1998). Stronge's meta-reviews of the research (2002; Stronge et al., 2007) reveal that, among the dimensions affecting student achievement, instructional expertise and student assessment practices have a significant impact on student achievement growth.

***Teacher beliefs*.** Research suggests that changes in beliefs about instructional practice and how children learn particular concepts may be an indicator of gains in knowledge following professional development (Fennema, Carpenter, Franke, Levi, Jacobs, & Empson, 1996; Wilson and Berne, 1999; Guskey, 2000, Hammeress, et al. 2005). Schifter and Fosnot's (1993) work supports the argument that as teachers increase their knowledge about instruction, their beliefs about how children learn also change, which impacts their instructional practices to reflect their new pedagogical belief system. Peterson, Fennema, Carpenter, and Loef (1989) and Fennema et al. (1996) conducted extensive research relating instruction to teachers' knowledge and beliefs. Using a belief scale that measures the beliefs of teachers following CGI training and comparing them to the beliefs held by teachers prior to training, the researchers found a significant correlation between change in knowledge about how children learn and understand mathematics as measured by teacher interviews and changes in beliefs about instruction.

Impact of gains in knowledge on instructional practice. Research supports that changes in teachers' knowledge may precipitate significant changes in teaching practices. Schifter and Fosnot (1993) and Schifter and Simon (1992) found that when teachers increased their mathematical knowledge and knowledge about constructivist pedagogy, they understood more about the way their students learned and changed their instructional practices, adopting constructivist strategies. The work of Peterson et al. (1989) and Fennema et al. (1996) confirmed that changes in instructional beliefs were not only positively correlated with changes in classroom practices and use of CGI oriented instruction, but were also related to increased student achievement. Thus, teacher gains in knowledge in the areas of instruction and assessment should both increase the use of quality instructional strategies and produce higher student achievement, possibly presenting a valuable indicator of professional development success.

These findings may be significant when considering the effectiveness of professional development activities. Based on this research, measuring changes in instructional beliefs throughout professional development may be both an indicator of gains in instructional knowledge and a measure of the likelihood the professional development activity may impact instructional practice and student achievement outcomes.

Measuring change in knowledge. A great deal of the literature measuring the outcomes of teacher professional development centers on gains in knowledge following trainings. While used somewhat frequently, it may be argued that some measures of knowledge gains are more valid than others. Evaluations often use surveys that measure participant perception of knowledge gains, pre and post-assessment of knowledge gains, or interviews to assess gains in knowledge associated with TPD participation. Assessments may use a yes/no response format, which simply measures participants' perceptions of learning, or may ask participants to rank their knowledge or skill on a scale (Garet, Porter, Desimone, Birman, & Suk Yoon, 2001; Guskey, 2000). Using a closed-ended assessment may provide limited information, since many instruments rely on participants' perception of learning. This perception may be more reflective of participant satisfaction.

The use of close-ended surveys can, however, be useful when comparing change in knowledge over time (Fennema, Carpenter, Franke, Levi, Jacobs, & Empson, 1996; Guskey, 2000). In these cases, the measurements may examine actual knowledge about the subject area taught or changes in beliefs about instructional pedagogy and be a more accurate indication of growth during the course.

Transfer of knowledge, changes in instructional practice, and use over time. A primary outcome of professional development, regardless of the method of delivery, is the extent to which the completion of professional development impacts pedagogical change in the teacher's classroom instruction. It has been shown that employing quality, research-based instructional practices is often associated with student achievement gains (Archibald, Coggshall, Croft, & Laura, 2011; Darling-Hammond, Wei, Andee, Richardson, & Orphanos, 2009).

An underlying assumption of staff development is that by acquiring knowledge about a new instructional strategy, teachers can easily change their classroom behaviors and replicate the new strategy in their own teaching (Sparks & Loucks-Horsley, 1989). While Joyce and Showers (1983) contend that teachers are excellent learners and can master and implement any new instructional technique following adequate training, others do not believe integration of a new skill is so simple. Borko (2004) argued that while a fundamental reason for providing professional development is to develop and extend teachers' pedagogical and subject knowledge in order to improve teaching strategies, an increase in knowledge does not always result in a transfer of that knowledge into other contexts or changes in instruction.

Transfer of knowledge was once believed to be a result of learning abstract concepts and de-conceptualized concepts (Grabinger, 1996). However, recent research contends that transfer of knowledge can be much more difficult than previously understood, and that people have a greater ability to transfer and apply new knowledge when learning under a constructivist approach (Boud & Walker, 1990; Feldstein & Boothman, 1997) in which learners gain an understanding of abstract concepts within an environment that encourages reflection on experiences and a collaborative construction of understanding through dialogue among learners. Kennedy (1998) identified "the problem of enactment" in her work, arguing that teachers face the challenge of not only learning what teachers should know, but also implementing that knowledge into their practice. Teachers who have a true understanding of how students learn and why an instructional strategy is appropriate for use in a given situation will be more effective than a teacher who simply applies the strategy without understanding the "why" behind it. (Hammerness et al., 2005). However, even when teachers have a strong understanding and foundation of teaching, integrating the skills in practice can be difficult. In determining the effect of learning environment on transfer and use of new learning, it is notable that teachers frequently cite challenges related to learning environment and institutional reforms that conflict with changes in instruction.

The instructional strategies learned must also be sustainable over time to use with many future groups of students. Guskey (2000) discusses the importance of measuring the use of new knowledge and skills after the participant has had time to implement the strategies into the context of their own classroom. By comparing the participants' knowledge at the end of professional development and then again several weeks later, evaluators may learn whether implementing new strategies strengthened the understanding of the concepts or it may reveal gaps in the participants' understanding. He argues that the time appropriate for follow up evaluation may differ across professional development activities, but is necessary in cases where continuous use of new strategies is expected. Few studies discuss multiple measures of knowledge over time, possibly due to the constraints of evaluation funding or limitations on teachers' time. Goldschmidt and

Phelps (2010) evaluated the knowledge of teachers six months following professional development and found that there was a statistically significant decrease in knowledge when compared to the post-test. They suggested that post-activity evaluations of knowledge alone may not be an indicator of retention and use over time. Additionally, teachers who show similar gains in knowledge during professional development may implement new strategies at different rates over time. Fennema, Carpenter, Franke, Levy, Jacobs, and Empson (1996) recognized the need to not only evaluate implementation of new instructional strategies following TPD, but also measure use over time. In a four year longitudinal study, the researchers measured the teachers' changes in beliefs surrounding CGI mathematical instruction and their integration of strategies into the classroom. The researchers found that while the majority of teachers displayed a significant change in instructional beliefs following CGI training, the rate of change for each teacher varied considerably, with some teachers making dramatic changes to instruction within the first year and others changing more slowly over time.

Measuring transfer of knowledge and changes in instructional practice. Change in pedagogy may be measured using self-reported teacher data in the form of logs numerating the frequency of use of a teaching skill in classroom instruction, surveys measuring self-reported use of classroom practices, student interviews about classroom instruction, the analysis of interview data in which teachers reflect on their new instructional practices, and through observation of classroom practices (Guskey, 2000; Garet, Porter, Desimone, Birman, & Suk Yoon, 2001; Supovitz & Turner, 2000). Each method provides benefits to the research design, and each presents its own challenges. Guskey (2000) and Cohen (1990) argue that surveys, which may be relatively easy to administer and analyze when examining large samples, often yield inaccurate levels of use because teachers may misrepresent or overestimate their use of the new instructional skill. Other research has shown high correlations between self-reporting surveys and interviews and observations. Furthermore, due to the anonymity of self-reporting surveys, participants may be more likely to answer honestly rather than in socially desirable ways resulting in bias. However, they argue that surveys can limit the detail and richness of data that can be collected in interviews and observations (Desimone, 2009). Student interviews may have the potential to reveal classroom practices accurately, but may be difficult to obtain depending on the age of the students involved. Observations can be prohibitively time consuming if done correctly. Focused interviews, while requiring a skilled interviewer, may be a convenient and unobtrusive way to learn about teaching practices and has been found to correlate well with behaviors seen in observations (Fennema, Carpenter, Franke, Levi, Jacobs, & Empson, 1996; Carpenter T. P., Fennema, Peterson, Chiang, & Loef, 1989).

In summary, the preceding section of the literature review detailed multiple outcomes of professional development activity success and argued that the use of several measurements provide a richer understanding of the potential impact on student learning. Each level of measurement is not necessarily an indicator of success alone, but is often a precursor to evidence of success in the subsequent level. Furthermore, high levels of participant satisfaction, gains in instructional knowledge, and changes in instructional practice over time are believed to be associated with increased student achievement (Guskey, 2000).

Blended Learning in Education

Education delivered utilizing technology is not a new phenomenon. Innovations in communication technology have expanded the way in which institutions can provide instruction and training to the individuals they support. Blended learning is one type of online learning and is a term that has emerged in the last three to five years to describe the delivery of content through a combination of face-to-face and web-based instruction (Staker, 2011). The effectiveness of distance learning is well-documented in the research, and as technology changes, researchers have attempted to continue to understand the impact of these tools on learning. Numerous studies of online education determined that there was no significant difference between the effectiveness of distance education and traditional face-to-face environments (Allen, Mabry, Mattrey, Bourhis, Titsworth, & Burrell, 2004; Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer, 2004; Russel, Carey, Kleiman, & Venable, 2009; United States Department of Education, 2010). As technology has evolved, newer methods of delivering instruction can provide course content and the potential for groups of students and instructors to interact either synchronously or asynchronously via the Internet. Today, the term "computer mediated learning" encompasses the use of Web 2.0 tools to deliver content, engage students in dialogue through discussion boards, wikis, and blogs, and assess learning without the requirement of receiving all instruction directly from an instructor or teacher. Computer mediated courses deliver instruction in a variety of formats, including online and blended courses. They often utilize a learning management system such as Blackboard, Moodle, or Canvas to house course content. While the majority of the literature focuses on the expansion and efficacy of purely online environments, opportunities to blend traditional instruction with computer mediated instruction have expanded the ability to meet the needs of diverse learners, attempting to maximize satisfaction and learning, and should prompt additional research in student outcomes related to learning environment. Staker (2011) argues that the majority of growth in K-12 online learning is occurring with blended environments and that blended learning has the capacity to transform our current educational system by providing a flexible and personalized method of instruction for all learners. The following sections will provide a detailed definition of blended learning and identify the benefits and challenges associated with blended learning from the literature.

Definitions of Blended Learning.

Literature and media often reference online and blended learning concurrently, as both formats rely on similar technology, such as computer mediated content delivery and collaboration tools such as online discussion boards, blogs, and wikis. As the use of computer mediated environments have expanded, the agencies promoting understanding about the potential benefits and challenges of online learning have worked to provide definitions for types of mediated learning. *The Online Definitions Project* sponsored by the International Association of K-12 Online Learning (iNACOL, 2011) summarizes online learning as “education in which instruction and content are delivered primarily over the Internet” and that may be referred to as elearning, virtual learning, or cyber-learning (p. 7). Blended learning is characterized by learning that takes place partially in a brick-and-mortar classroom and partially online in which the student has limited control over pacing, time, and space and may be used interchangeably with “hybrid” learning (p. 3).

Beyond this simplistic definition, there are many components of blended learning that can impact the learning environment yielding very different learning experiences (Osguthorpe & Graham, 2003). Within the classification of blended learning, there can be many variations in dimensions and delivery that are significant to consider when reviewing the literature. Singh and Reed (2001) offered six possible variations of blended learning based on specific patterns of delivery: (a) the proportion of face-to-face and online learning, (b) being categorized as self-paced, live, or collaborative, (c) the use of structured or unstructured learning activities, (d) the use of custom content versus packaged content, (e) engagement in work versus learning, and (f) the blending of synchronous and asynchronous learning in the physical and online environments. Osgusthorpe and Graham (2003) argue that, just as in traditional face-to-face instruction, instructional goals, student and instructor characteristics, resources, and teaching style can have a significant impact on the learning environment. They argue further that blended environments may prescribe to any of three types of blends: a model in which the same students participate in both online and face-to-face learning activities and instruction, one in which one group of students participates online and another face-to-face, and finally, one in which one instructor or group of instructors teaches the face-to-face components of a class and another instructor teaches the online segment. These variations should be considered when interpreting the existing literature as they could account for differences in outcomes across studies.

It is also important to recognize that blended learning courses may also be defined by the way in which online instruction either serves as an enhancement to traditional instruction or a replacement for traditional instruction. Some blended courses utilize an online environment that supplements a traditional face-to-face course while maintaining seat time in the face-to-face course while others harness online environments to significantly reduce the seat time of a traditional course ((Dzuiban, Hartman, & Moskal, 2004; Allen, Seaman & Garrett 2007). Although Allen and Seaman (2007) with the Sloan Consortium, known for researching the effectiveness of and promoting the utilization of online learning, have attempted to specifically define blended learning as any course in which 20 to 79% of instruction is delivered online, blended learning is not typically defined by the percentage of time students learn in the online environment and only that seat time in face-to-face sessions is significantly reduced (Owston, Sinclair, & Wideman, 2008). In 2011, Staker refined their definitions of blended learning by describing four models of blended learning: rotation model, flex model, self-blend model, and enriched-virtual model. While each model includes instruction in both brick-and-mortar and online environments, the online portion of the course is utilized differently to meet the goals within each model. This distinction is relevant when analyzing current literature on blended learning, as some studies may argue that it is not enough for blended to yield equal outcomes as face-to-face environments, but instead should have superior outcomes if the online environment is supplemental to traditional instruction in nature (United States Department of Education, 2010).

Benefits of Going Blended

Blended courses have experienced increased attention as they may offer unique benefits for student learning by combining components of both face-to face and online learning and mitigating or eliminating the concerns that are commonly reported in purely online courses. The literature often argues that harnessing both environments to deliver instruction may provide the best of both worlds to students (Fook, Kong, Lan, Atan, & Idrus, 2005). Research comparing online and blended learning environments confirms there may be differences in online and blended environments and course outcomes and that blended learning environments may offer benefits not evident in courses delivered completely online.

In this section of the literature review, I will summarize recent research surrounding online and blended learning courses. I will highlight the “no significant difference” phenomenon in the research of distance learning environments and explain its significance to blended learning. I will identify research measuring blended learning and describe the methods used in evaluating the effectiveness of learning environments. Finally, I will review the research examining the use of blended environments in teacher professional development and argue for further research evaluating the use of blended instruction in teacher professional development environments.

No significant difference phenomenon. The “no significant difference phenomenon” references literature which posits that there is no statistically significant difference between mediated learning environments, such as online and blended models, and traditional face-to-face environments. The proliferation of online environments in K-12, post-secondary, and professional development settings has directed the focus of researchers on the use of mediated learning environments and their impact. The studies examining online learning are relevant to arguments regarding blended learning for several reasons. The “no significance phenomenon” is widely cited, dominating the conversation regarding computer-mediated environments, including those about blended learning. Although conversations may relegate both blended and online learning to the same category, the following analysis will argue that the literature shows that while blended environments utilize some of the same tools as online environments, significant differences may exist between online and blended learning. Thus, the application of the "no significant difference" phenomenon would be erroneously applied to blended learning as it assumes consistent learning outcomes between environments.

Numerous studies over recent decades have argued the effectiveness of online and blended environments when compared to face-to-face traditional courses leading to wide acceptance of the "no significant difference" phenomenon. In one of the first, Russell (1999) summarized approximately 355 studies spanning from 1928 and 1998 and published an annotated bibliography of studies showing no difference in learner outcomes when comparing face-to-face and distance education. From this study, the "no significant difference phenomenon" was applied.

Additional meta-analyses released in recent years confirm this argument, maintaining that individual studies may yield statistically significant differences in outcomes, but when synthesized and considered as a whole, the difference between environments disappears (Allen, Mabry, Mattery, Bourhis, Titsworth, & Burell, 2004; Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer, 2004; United States Department of Education, 2010). Cavanaugh et al. (2004) studied 116 effect sizes from 14 web-delivered K-12 classes demonstrating that online learning can have the same impact on student achievement as face-to-face courses for K-12 students. The quantitative, experimental, and quasi-experimental studies analyzed included journals, dissertations, and reports available between 1999 and 2004 that used student achievement, motivation, attitude, retention, or behaviors as outcome variables. Characteristics of the courses varied greatly in areas such as participant interaction, delivery, frequency, instructional features, and content. While the authors argue that the results confirm the "no significant difference phenomenon," they acknowledge that the success of students varies and that disparities in effect sizes among studies may indicate that some instances of distance education may be more effective than traditional instruction while some may be worse. In this study, blended courses were included alongside the purely online courses studied and results were based on the inclusion of both online and blended environments. The study required that the programs evaluated only needed to deliver half of the instruction online and did not disaggregate the studies in the results. Therefore, the results of the analysis may reflect the impact of blended learning as well as online learning with one environment potentially more effective than the other.

In 2010, the United States Department of Education released its own report, a meta-analysis of 99 studies measuring student learning through assessments, course exams, observations, artifacts, portfolios, and supervisor ratings. The meta-analysis considered characteristics of each study included in the meta-analysis, detailing populations, measurements of efficacy, differences in course environments, and the way in which online tools were used in each course. Of the 50 effect sizes identified, "11 were significantly positive, favoring the online or blended condition," while three favored the face-to-face environment (p. xiii). Outcomes varied more significantly in courses where the curriculum materials and instructional approaches differed indicating that differences may result from instructional variables rather than differences in course environment. The report also concluded that blended environments may be more successful than both purely online and face-to-face, finding that courses containing both online and face-to-face instruction, or a blended model, yielded higher achievement than courses that were purely online. The report concluded by stating that:

> In recent experimental and quasi-experimental studies contrasting blends of online and face-to- face instruction with conventional face-to-face classes, blended instruction has been more effective, providing a rationale for the effort required to design and implement blended approaches. When used by itself, online learning appears to be as effective as conventional classroom instruction, but not more so. (p. xviii)

Additionally, a number of researchers have compared student outcomes in blended environments to online and face-to-face environments. These studies reveal that blended learning can yield the same or better achievement when compared to online and face to face learning (Delialioglu & Yilidirim, 2007; Larson & Sung, 2009; Lim, Kim, Chen, & Ryder, 2008; Roscoe, 2012; Twigg, 1999; Zhao, Lei, Yan, Lai, & Tan, 2005) and confirm some of the earlier findings of the large scale meta-analyses. Achievement, as measured through in-course examinations, and post-course assessments frequently support the use of blended environments compared to purely online or face-to-face environments.

While this research does not focus specifically on teacher professional development, they are studies that provide a background for conversations about the capacity of online teacher professional development (Dede, Jass Ketelhut, Whitehouse, Breit, & McClosky, 2009). The authors argue while there has been an increased focus on empirical studies that link student outcomes and instructional changes to online teacher professional development (Fischman, Marx, Best, & Tal, 2003; Masters, de Kramer, O'Dwyer, Dash, & Russell, 2010), much of the existing literature uses measurements of efficacy consistent with online evaluations included in the “no significant difference” studies (Cady & Rearden, 2009; Sujo de Montes & Gonzales, 2000). Furthermore, studies of online teacher professional development were included in the literature search of the U.S. Department of Education's meta-analysis (2010). Ten studies of teacher professional development were included in the analysis, which may indicate that some of the outcomes of the meta-analysis can be generalized to teacher professional development populations.

A closer examination of the results of blended learning studies provide information beyond levels of achievement and student satisfaction and may help to understand the potential of blended learning and its advantages over purely online environments. Themes about learning conditions and learner experiences identified in the "no significant difference phenomenon" literature and other studies on distance learning may support the argument that blended learning provides the best of both environments. The results of these studies expose the various characteristics that can help educators understand the impact of course environment on learners and are summarized in the following discussion.

Constructivist and learner centered. One benefit of blended learning may be its capacity to promote constructivist learning and student self-reflection. Yew Tee and Karney (2010) observed class interactions in discussion boards, interviewed students, and collected course documents to capture the tacit knowledge of course participants. They determined that online course discussions can encourage conditions that allow students to construct shared knowledge. Bye, Smith, and Monghan Rallis (2009) utilized a quasi-experimental design in which the analysis of end-of-semester grades and surveys indicated a significant difference in perception of course objective achievement in favor of online learning and no significant difference in course satisfaction or course grades between students who had participated in weekly online reflection and those who had submitted hardcopies of weekly reflections. The only difference in the courses was the integration of a student reflection component which allowed participants to analyze their performance on course assignments and discuss their thoughts in online forum. Meyer (2003) found that students reported the ability to more deeply reflect on and analyze course content because of the increase in time when utilizing discussion boards. Discussion boards and blogs used in blended courses also allow participants time to formulate introspective discussion posts and process comments and posts of classmates leading to a transformative learning experience (Garrison & Kanuka, 2004). These online discussion forums have been found to shift the focus away from the teacher as the traditional "sage on the stage" and place the focus on student led discussions. Researchers often cite this constructivist atmosphere as an effective environment for students that may aid students in internalizing concepts studied in the course (Allen et al,. 2004; Resta & Laferriere, 2007).

Mitigating feelings of isolation. One consistent criticism cited of online learning is the feeling of isolation often experienced by course participants and instructors who report that they lack a sense of community belonging and that "while student success and high levels of student and instructor satisfaction can be produced consistently in the fully online environment, many faculty and students lament the loss of face-to-face contact" (Dzuiban, Hartman, & Moskal, 2004, p. 3). In one study evaluating online learning, Rabe-Hemp, Woolen, and Humiston (2009) compared student engagement, levels of autonomous learning, and participant interaction between online and traditional face-to-face courses through the analysis of pre- and post-surveys and online and face-to-face discussion using a population of undergraduate students in a university setting. The researchers found that reduced interaction with classmates and instructors may result in lower levels of engagement and lower achievement. These feelings of isolation in online courses have been linked to low course retention, low levels of participant satisfaction, and decreased participation in online classes. Oh and Lim (2005) found in their study of adult learners that online instruction may be limited in its ability to engage learners who are not inherently organized, self-motivated, and active learners, leading to feelings of isolation. They found that a lack of these characteristics may be related to lower levels of course satisfaction and transfer of new learning.

Conversely, research in blended learning often indicates that learners may experience a greater sense of community than they do in online courses due to the integration of face-to-face sessions. Rovai and Jordan (2004) found that students in blended courses reported greater levels of connectedness than those in fully online courses citing face-to-face sessions as essential in helping them to build relationships and promote a feeling of community. The work of So and Brush (2008) revealed that the degree of emotional bonding between participants may encourage participation and collaboration and were linked to higher levels of course satisfaction. Participants cited face-to-face group work as one catalyst for emotional bonding and connectedness. Additionally, they found that face-to-face sessions mitigated misunderstanding about content and expectations as participants felt connected to their instructor and were more likely to ask for clarification and help. Based on this research, it appears that a combination of face-to-face and online sessions allowed for community building and increased connections among participants and between participants and instructors.

Access and flexibility. Research suggests numerous benefits for learning in online environments, such as increased access to experts in a variety of fields and the ability to access content and continue learning at any time and at any location (Swenson & Curtis, 2003). Blended courses may more effectively utilize facilities and instructors, allowing for an increase in the number of courses offered. A classroom that normally houses one section could host two as sections alternate between face-to-face and online meetings (Roscoe, 2012). Blended learning environments offer flexibility and access to content at anytime and anywhere in a manner similar to online courses. This flexibility is attractive to a variety of learners balancing work and family obligations and is frequently cited as one of the primary reasons for choosing blended environments. Students also report that the flexibility allows them to learn at their own pace, spending more time on challenging concepts and less time on concepts that were easy for them to master (Garnham & Kaleta, 2002; Lin, 2008-2009).

Use of multiple discussion formats and student reflection. Blended learning courses can capitalize on the use of multiple discussion techniques. During face-to-face sessions, students can benefit from spontaneous, face-paced discussions aided by non-verbal communication and both faculty and students may report an increased feeling of connectedness with their classmates and instructors (Waddoups & Howell, 2002; Wingard, 2004). Conversely, the expansion of time inherent in online sessions may have additional benefits to class discussions. In purely face-to-face courses, class discussions are often limited to a specified period of time while class is in session, regardless of whether all students have participated or the discussion is complete. Several studies have found that the discussion boards and blogs utilized in blended learning, which expand the time available for communication and encourage reflection, may promote higher levels of critical thinking than face-to-face courses and allow students time to reflect on their ideas and provide less superficial responses to content (Owston et al., 2008). In a study by Larson and Sung (2009), a greater number of participants in blended and online courses reported that the course increased their critical thinking and were more motivated to work to their highest level than in the face-to-face course.

A variety of discussion formats in blended learning may appeal to students of different learning needs. The nature of many online discussions require participation of all students for course credit. Some of these students may not feel comfortable participating and remain reticent in a face-to-face setting, but are encouraged to engage in discussion when they have had additional time to formulate a response. Additionally, students report feeling more connected with other students when their discussions of course content could begin face-to-face and carry over into the online discussion board (Lin, 2008-2009).

Limitations of Blended Learning Research

Multiple limitations exist in the current literature examining blended learning. One limitation relates to the absence of consistent definitions of blended environments and comparisons in meta-analysis. Multiple barriers may exist in identifying blended courses. The ambiguous definition of blended learning may mean that multiple types of blended learning experiences are being used within the same institution. For example, some courses may be utilizing online asynchronous tools to replace face-to-face sessions of the course, while others may be using the same tools to supplement classroom discussions or assess learning mastery. For example, in the U.S. Department of

Education’s 2010 meta-analysis comparing course environment, only ten studies comparing purely online and blended courses met the qualifications for the analysis, and the design of the blended environments varied considerably.

In addition to difference in definitions and models, differences often exist in course content, materials, and assessments across studies**.** While the report released by the U.S. Department of Education in 2010 concluded that blended learning may be more effective than online and face-to-face environments, the report cautioned that the results may be misleading. In many cases, these studies did not compare curriculum materials, pedagogy, and learning time. Therefore, differences in student outcomes may result from instructional variables other than environment.

Finally, several of the studies examining the impact of blended learning on learner outcomes, the researcher also served as the instructor in the course. Larson and Sung (2009) indicated that it was the preference of the author/instructor to teach in online and blended environments. In another study, the author, also the instructor, described the study completely on the first day of class, potentially influencing the reports of the students in the end-of-course questionnaire (Lin, 2008-2009). This dual role as instructor and researcher may produce bias within the study, especially if the researcher has personal interest in the growth of blended learning.

Blended Teacher Professional Development

Numerous researchers have recognized the need to understand the efficacy of online learning environments for teacher professional development (Dede, Breit, Ketelhut, McCloskey, & Whitehouse , 2005; Dede, Jass Ketelhut, Whitehouse, Breit, & McClosky, 2009; Laferriere, Lamon, & Chan, 2006). A review of the literature in 2005

(Dede, Breit, Ketelhut, McCloskey, & Whitehouse, 2005) argues the potential impact that mediated learning environments can offer to teachers and educational institutions charged with providing professional development opportunities. Professional development utilizing online tools may offer teachers many of the same benefits that mediated environments provide to K-12 and post-secondary students, including flexibility, increased access to expanded offerings and facilitators, and participation in constructivist learner-centered environments.

Teachers who often miss instructional time with their students in order to attend professional development opportunities or give up personal time on nights, weekends, or summer break, may benefit from the flexibility inherent in blended courses (Dede, Breit, Ketelhut, McCloskey, & Whitehouse , 2005; Swenson & Curtis, 2003). Rather than attending courses at local schools, teachers can complete some or all portions of courses in the comfort of their home during times that are most convenient, reducing the impact on their families. District and school workshops are frequently offered during the school day, requiring teachers to obtain a substitute teacher, impacting school budgets, student learning, and teacher preparation time. Online learning opportunities can reduce the time teachers spend away from the classroom and reducing the negative impacts on the school as a whole. The increased flexibility online learning provides may reduce scheduling conflicts and allow more teachers access to courses so they may participate in professional development in instructional practices that can have a positive impact on classroom instruction and student learning. Rovai and Jordan (2004) found that flexibility was linked to participant satisfaction and completion with one participant reporting that, “As a teacher, I would never had made it through this semester without the practical guidance of this course along with the freedom of the online component” (p. 10).

Finally, the learner-centered environments characteristic of online and blended learning align with best practices in teacher professional development discussed earlier in this chapter, promoting dialogue and reflection. Rovai and Jordan (2004) found that students were able to process new information better as the online delivery allowed them time to analyze content and apply new knowledge to their existing beliefs before hearing another student’s interpretation. In Matzat’s (2010) comparison of 26 online learning communities for teacher professional development, blended communities were shown to have more actively engaged members than in purely online communities. Thus, blended courses may be more effective in promoting communication and discussion among participants.

Methods of Evaluating Blended Teacher Professional Development.

The few blended teacher professional development studies have primarily followed the research design of other distance learning studies that frequently employ outcome measurements such as end-of-course assessments and participant satisfaction. In studies of post-secondary and K-12 students, these measurements may be sufficient measures of efficacy. However, the literature on teacher professional development, outlined previously in this chapter, argues that a variety of outcomes should be assessed in order to determine teacher professional development course effectiveness. The few studies examining the use of online instruction in teacher professional development have begun to measure outcomes specific to the goals of teacher professional development, such as participant satisfaction, participant perception of learning gains, and self-reported integration of new instructional strategies, but argue for more rigorous methods of evaluation (Desimone, 2009; Guskey, 2000; Wilson & Berne, 1999). In the following discussion, I will summarize the methods that have been used in the current literature to determine blended teacher professional development efficacy, revealing a void in current findings which prompts further research in this area.

Several studies have measured levels of participant satisfaction related to blended learning environments, which is one of the first and most commonly utilized measurements of professional development success. Holmes, Polhemus, and Jennings (2005) examined a professional development training for K-6 teachers focusing on the integration of technology into instructional practice. The study showed that the blended environment provided teachers with time for independent learning and was linked to sustainability of the program. The participants reported mixed levels of satisfaction, citing insufficient time to participate in online sessions of the course. Tan, Hung, and Chai (2003) also measured participant satisfaction of pre-service teachers, finding positive attitudes towards the blended learning environment and the constructivist approach of the course. Measurements included questionnaires about learning activities, the instructional approach, and feelings of the participants. Mouzakis (2008) used a questionnaire, semi-constructed interviews, and a focus group discussion to determine perceived effectiveness and satisfaction of primary and secondary teachers participating in a blended teacher training. He found that the teachers indicated satisfaction with participation in the training and the learning acquired from the training. The study also revealed that teachers valued the face-to-face components of the blended training and wished for more than two face-to-face sessions as a way to increase feelings of belonging to the class community.

Sherman, Byers, and Rapp (2008) included both satisfaction and gains in knowledge in their evaluation comparing a blended and fully online section of a science professional development program for 45 middle school teachers. It is relevant to note that the blended course required that participants engage in the same number of hours of online training and an additional six hours of face-to-face instruction. Despite this difference in time, the participants in the fully online section of the training showed higher gains in knowledge as measured by changes in the pre-and post-survey. Both groups showed statistically significant gains in knowledge between the pre- and post-test. Participants in the blended workshop indicated that the face-to-face sections enhanced their understanding of the concepts.

Only one group of researchers found in the literature search used multiple measures to evaluate blended teacher professional development (Owston, Sinclair, & Wideman, 2008; Owston, Wideman, Murphy, & Lupshenyuk, 2008). Studies of three professional development initiatives examined the learning outcomes of three blended sections of professional development programs for middle school science and math teachers. The goals of the professional development were to improve teacher knowledge, attitudes, and classroom practice, and improve student engagement, attitudes, and achievement in math and science. The researchers, guided by Guskey's (2000) professional development evaluation framework, used semi-structured interviews and focus groups with the participants, transcripts of online discussions, observation of professional development activities, and student surveys to measure program outcomes.

Questionnaires measured changes in knowledge, beliefs, and instructional practices following participation in the professional development. Observations conducted prior to and following the course provided information about changes in the teachers' instructional practices. Student surveys and teacher interviews were used to determine the impact of the professional development on student learning. Participants in each blended section indicated satisfaction with the course and increased levels of confidence and preparedness in teaching their subject. An analysis of responses indicates that teachers emphasized the value of the face-to-face session, but had mixed satisfaction with the online portions of the course, citing a lack of community when online. The principals who were interviewed indicated that participating teacher exhibited more reflection of their teaching practices and increased collaboration with colleagues following training. Teacher survey results suggested that each blended learning environment was correlated with changes in classroom practice; however, classroom observations indicated that only half of the participating teachers designed and implemented stronger lessons and some employed lessons that used new strategies inappropriately. The student surveys and teacher interviews suggest that the blended learning initiatives seem to positively impact student attitudes and engagement to a degree.

Conclusion

The concepts discussed in this chapter describe the importance of employing rigorous evaluation methods when examining online learning and provide insights into the measurements that may accurately assess efficacy. The chapter summarized the findings in online education and highlighted the characteristics of blended learning that may make it a superior environment for learning. Finally, it outlined the limited number of studies evaluating the use of blended learning in professional development. These few studies evaluating blended learning professional development are limited in their measurements and fail to provide a clear understanding about whether blended environments can have an equal or greater impact on learning and instructional practice than face-to-face professional development. The single study evaluating multiple outcome measurements did not offer a comparison of environments limiting our understanding of the benefits of utilizing blended environments. The following chapter will discuss the methods used in this study of blended teacher professional development.

CHAPTER 3

Methods

In this chapter, I will summarize the research problem and research questions of the study. I will then describe the research methodology used in the study, including a discussion of the setting, population, and sample. I will describe the instruments used to collect data, collection procedures, and data analysis procedures.

I approached this study through mixed methodology, employing quantitative methods to measure differences in changes in instructional beliefs of participants and participant satisfaction between blended and face-to-face sections of Cognitively Guided Instruction professional development activities and a qualitative approach to gather information about the implementation of new instructional strategies following the professional development. I will explain my strategy of inquiry and my rationale for using instrumentation.

Restatement of the Problem

Despite the large body of literature in the areas of teacher professional development and blended learning environments, there is a dearth of research that links the use of blended environments in teacher professional development and its relationship to changes in instructional knowledge and instructional practice. The purpose of the study is to illuminate the relationship between course environment and learner outcomes, as measured by changes in participants' instructional beliefs, participant satisfaction, and changes in instructional practice. Specifically, the study measures multiple facets of participant satisfaction based on the instructors' course surveys, changes in teacher beliefs regarding mathematical instructional strategies based on pre- and post-course surveys, and the instructional decisions and instructional behavior of teachers following professional development. The outcomes are compared between course environments to determine the relationship between course environment and learner outcomes.

Setting of the Study

The study was conducted with educators employed in a suburban, middle class K-8 school district consisting of 19 elementary schools and six middle schools, located in a southwestern state. The school district has several departments which offer professional development in areas such as curriculum, exceptional student services, and instructional technology. Professional development is typically offered in the form of trainings after school, during summer break, and sometimes during release time during school hours. Trainings are facilitated by teacher specialists, consultants, and occasionally teachers in the district. Currently, teachers in the district are not mandated to take specific professional development courses, rather they can select from a menu of options throughout the year that are offered based on current best practices and current educational reforms. The district often chooses activities that have been requested across the district by teachers. The vast majority of trainings are offered in face-to-face sessions, with the exception of four classes: two online classes in the instructional technology department on the use of Blackboard for content delivery, one online from the curriculum department using Blackboard and focusing on learners from diverse backgrounds, and one blended course on teacher evaluation practices using Edmodo as a course platform.

The professional development courses evaluated in this study were Level One Cognitively Guided Instruction (CGI) courses. CGI is an instructional practice that advocates for a constructivist approach for math instruction. This course, Cognitively

Guided Instruction Level I, is based on the work of Carpenter et al. (1999) and the previous research of Carpenter et al. (1989). The instructional approach is founded on four mains constructs or beliefs intended to guide instruction and planning. First, CGI proposes that students come to school with prior knowledge that guides their construction of mathematical understanding rather than being receivers of knowledge presented by teachers. Second, CGI argues that instruction should be designed so that students can construct knowledge rather than designed around teacher presentation of knowledge. Third, the sequence of instruction should be designed based on students' current knowledge of mathematics and not on algorithms or mathematical structures. Finally, students should develop understanding of mathematical constructs using word problems and by creating number sense instead of through the use of algorithms or memorization of facts. In general, Cognitively Guided Instruction encourages the use of discovery to construct mathematical knowledge, the acquisition and use of multiple problem solving strategies, student articulation of problem solving, and a student-centered, rather than teacher-centered, classroom.

The instructors for the courses were initially trained by Linda Levi, one of the original researchers and developers of CGI, and have provided training over the past four years to approximately 150 teachers in the district. The curriculum department funded the Cognitively Guided Instruction courses using Title I funding. The curriculum department chose to offer both blended and face-to-face sections of this course concurrently in order to address requests from teachers for more flexible professional development. The department voiced a need to evaluate the efficacy of these course formats in order to determine whether blended formats will be a viable option for professional development in the future. Like all professional development courses in the district, the courses were free of charge to participants. Upon completion of the course participants received recertification hours for each hour of the course and 80 dollars of salary credit each subsequent year of employment for every 15 hours of district professional development, or 112 dollars for this 21 hour course. While the district does not require employees to complete professional development hours each year, teachers must complete 180 hours of recertification hours every eight years in order maintain teaching credentials with the state. There are a variety of ways in which employees can earn these hours, but district professional development remains an attractive option as it is provided free, is locally offered, and allows employees to receive salary credit.

Each CGI course was 21 seat hours long and took place over 14 weeks. Participants in the face-to-face course attended seven, three-hour sessions located at one of the district elementary schools. Participants in the blended course attended one face-to-face session for the first session, completed five online sessions over the course of ten weeks, and then attended one final face-to-face session to complete the course. Each course addressed the same course objectives and utilized the same course materials, videos, assignments, textbook, and discussion questions. Participants in the blended course accessed material and participated in discussions during the online sessions using Blackboard 9.1, an online course management system. One lead instructor designed both courses to ensure congruence in course content and use of resources. An additional instructor assisted in the blended and face-to-face course. In the blended course, the additional instructor assisted in the facilitation of discussion boards and collaborated with the lead instruction in planning for each class. In the face-to face course, a third instructor assisted due to the large number of students in the class. All three instructors have been formally trained as CGI instructors using the prescribed method of teacher training designed by CGI researchers. All three instructors have been teaching CGI courses in the district for at least five years. The lead instructor for both the blended and face-to-face courses was the math curriculum specialist for the district and has taught online undergraduate education classes using Blackboard for Arizona State University for approximately five semesters. The secondary instructor in both courses was a math coach for the district and supports several Title 1 elementary schools. This was his first experience teaching a blended course. The third instructor, who assisted only in the face-to-face course, had no experience teaching online.

Participants

The sample of the study was a convenience sample of teachers self-selecting to participate in district professional development. Participants included a total of 64 teachers from the district: 32 in the blended course and 32 in the face-to-face session. The district advertised the courses using district email newsletters and were listed in the district online professional development course catalog where teachers were able to log in and enroll. Course participants were not assigned to the course environment, rather they self-selected into either the blended or face-to-face course based on preference. Most teachers were elementary classroom teachers, with only one middle school teacher enrolled in the blended course. The study considers the characteristics of the participants, such as gender, years of teaching experience, and experience with online course environments to determine if the sample represents the broader population of teachers who participate in professional development.

Research Design and Procedures

Based on a review of the literature on teacher professional development and blended learning environments and the gap revealed by the literature, I conducted a mixed methods study of teacher professional development comparing blended and face-to-face learning environments.

To determine the relationship between course environment and learner outcomes in teacher professional development activities, I examined the following questions: What are the differences in course completion rates between blended and face-to-face professional development sections of Cognitively Guided Instruction?

- How do the changes in instructional beliefs, as measured by the change in instructional beliefs survey tool, compare between teachers participating in a blended and face-to-face CGI professional development course?
- What are the differences in participant satisfaction, as measured by district end-of-course satisfaction surveys, between teachers participating in blended and face-to-face professional development CGI courses?
- What are the differences in the retention of CGI oriented beliefs and the use of CGI instructional strategies, as measured by the CGI Belief Interview, between blended and face-to-face participants following course completion?

Research Methodology

In order to determine the relationship between course environment and learner outcomes within a teacher professional development setting, the study employed a mixed-method design that utilized multiple evaluation measurements suggested by Guskey (2000). The instrumentation used was based on the literature supporting a relationship between teachers' mathematical instructional beliefs and student learning and achievement in mathematics (Peterson et al., 1989).

Data Collection Methods

Access. Permission to access course documents and data, including pre- and post-survey data, participant satisfaction data, and teacher demographic information was granted by the district's internal review board for research. As an employee of the district, I am not required to receive governing board approval. All data collected was done so in accordance with IRB procedures and upon collection, data was stripped of identifying information, such as teacher name, school, and grade level.

Quantitative. Surveys were the primary quantitative instrumentation used within the courses for multiple reasons. The efficiency of administering surveys and the rapid return of surveys for data analysis was beneficial in collecting information regarding existing teacher beliefs, beliefs following training, and levels of participant satisfaction. Surveys measuring teacher beliefs and participant satisfaction are commonly used within the district during professional development opportunities and have been collected within each course environment by the district. Furthermore, the anonymity of electronic surveys may yield honest responses regarding instructional beliefs and satisfaction.

In the face-to-face and blended sections, participants completed a pre-survey and the post-surveys measuring beliefs and satisfaction electronically. Each survey employed a Likert scale that lends itself to quantitative analysis. In each case, participants completed the district administered surveys during face-to-face sessions of the course to

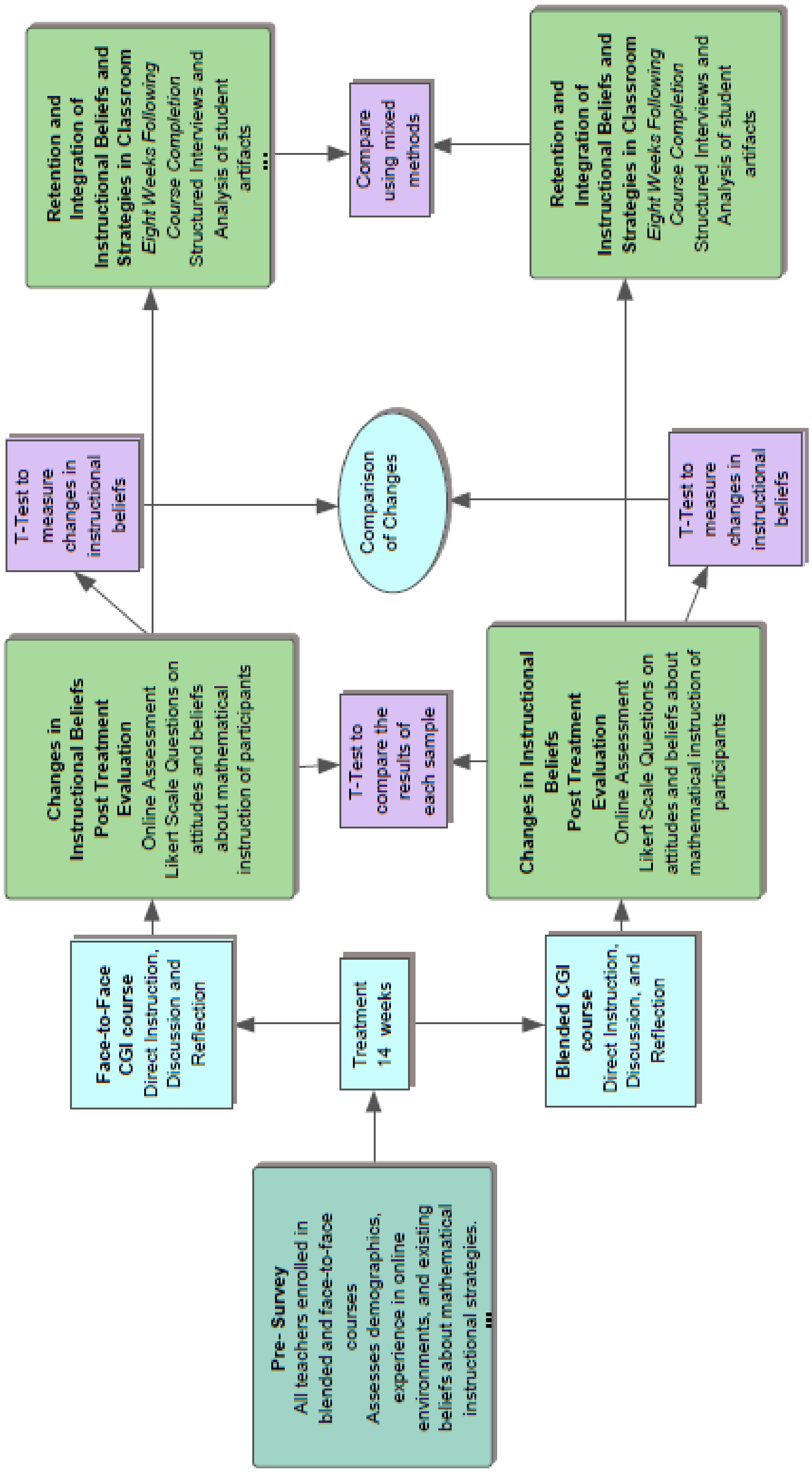

Figure 1. Comparison of outcomes design: Blended versus face-to-face.

ensure high completion rates. All surveys were completed electronically via SurveyMonkey and results were downloaded into SPSS analysis software for analysis.

Mathematics Beliefs Scale Pre- and Post-Survey. The majority of the pre- and post- survey consisted of the CGI belief survey developed Linda Levi and based on the research of Fennema, Carpenter, Franke, Levi, Jacobs, and Empson (1996) and Carpenter, Fennema, Peterson, Chiang, and Loef (1989) prior to and after completion of the course. This 48 item, Likert scale survey measures the instructional beliefs of each teacher and rates the teachers based on their alignment with CGI oriented instruction (see Appendix B, C, and D). The original instrument created by Fennema et al. (1989) consists of four subscales of 12 items each to determine teachers' beliefs about instructional beliefs on four constructs. As the district was trained by Linda Levi, they chose to use her adapted belief scale that includes subscales 1, 2, and 4. The instrument includes 12 additional items not included in subscales. While this instrument did not include items from subscale three of the original belief scale, this construct was evaluated through the use of interviews.

Participants responded to the 48 items on a 1-5 Likert scale. Of the 48 items, half were worded positively, for which a score of 1 indicated less cognitively guided instructional beliefs and a 5 indicated strong cognitively guided instructional beliefs. The remaining items were negatively worded, for which a value of one indicated cognitively guided instructional beliefs and a value of five indicated beliefs contrary to CGI. These negatively worded items were reversed coded once loaded into SPSS, allowing all items to be analyzed together.

The first subscale assesses beliefs about how children learn mathematics. A high score within this construct would show that the teacher believes that children construct their own knowledge based on experience and reflects CGI oriented beliefs, while a low score in this subscale would indicate that the teacher believes that children are the receivers of knowledge. The second subscale reflects beliefs about how mathematical instruction should be planned, a high score indicating that instruction should assist the construction of knowledge, while a low score reflects a belief that instruction should be designed around a teacher's presentation of knowledge. The third subscale reflects teacher beliefs concerning what guides the sequencing of concepts in addition and subtraction. A high score in this subscale demonstrates CGI oriented beliefs that teachers should sequence concepts based on the development and readiness of their students, while a low score demonstrates that sequencing should be planned based on formal mathematics. The final subscale measures beliefs regarding the relationship between students' acquisition of mathematical skills and the ability to problem solve. A high score in this subscale demonstrates CGI oriented beliefs and that computational skills should be taught in conjunction with problem solving, while a low score indicates a belief that skills should be taught in isolation.

Participant Satisfaction. Upon completing the course, participants completed the district post-course survey measuring participant satisfaction (See Appendix C and D). Items included perceptions of instructor knowledge, perceived value of course content and goals, perception of course community, and perception of ability to implement new learning. The first section of the survey was a modified survey of participant course satisfaction based on the work of Moore and Kearsley (1996) and Cassidy and Eachus

(2000). The survey assessed five constructs concerning participant course satisfaction: learner-content interaction, learner-instructor interaction, learner-learner interaction (Moore & Kearsley, 1996), and learner-technology interaction (Cassidy & Eachus, 2000). Questions for the first four constructs were included in the surveys for both blended and face-to-face course participants. Questions for learner-technology interaction construct were included in the survey administered to the blended course participants to obtain information regarding their perception of blended learning environments as a mode of delivery.

Participants responded to the statements using a four-point Likert scale. Descriptive statistics and use of *t*-tests and ANOVAs were used to understand differences in participant satisfaction between the blended and online learning environments. The face-to-face survey also included two questions regarding participants' experience with online courses to determine if there was a relationship between the population and experience in online environments. One open-ended question asking participants their reason for choosing the face-to-face environment was included in the face-to-face survey.

Qualitative. In his description of qualitative research, Stake (2010) argues that a richer understanding of individuals' experiences can be collected through the use of qualitative measurements and that new connections and understanding can be generated through this process. With this belief as a guide, interviews of course completers were conducted to gain a greater understanding of how beliefs are retained following training and the degree of implementation of new strategies in instruction. Non-completers were also interviewed to learn about the reasons for withdrawing from the course.

Mathematical belief interview. Each course participant received a letter requesting their voluntary participation in the study (Appendix A). Individuals who wished to participate in the interviews signed an IRB from indicating their consent. This convenience sample yielded 26 total respondents.

Twelve weeks after the completion of the course, consenting course completers were interviewed to determine retention of CGI oriented beliefs and the level of integration of CGI strategies in their instruction. Interviews lasted 30 to 45 minutes. Participants were given the choice of holding the interview at the location of their choice, on or off of the school campus, yet all participants chose to hold the interview in their classroom on campus. Teacher interviews were conducted by the researcher.

Upon arriving, I introduced myself, and made small talk with each participant to increase his or her level of comfort. Although the participants and I work in the same school district, I do not have contact with the participants in my role and do not supervise or evaluate the participants in any way. The participant selected a location in the room to hold the interview. While I set up the laptop for audio recording, I briefly described the study, explaining that I was interested in understanding the outcomes of teacher professional development and current math instructional practices.

Interviews were structured using the protocol developed by CGI researchers and evaluated each of the four constructs inherent in cognitively guided instruction (Appendix E). The interview was designed to collect information on the instructional strategies that teachers employ in the classroom, the teachers' perceptions of the roles of the teacher and student within the classroom, and to obtain additional information about teachers' beliefs about mathematical instruction and student learning (Peterson, Fennema, Carpenter, & Loef, 1989). The interview included 10 questions with follow-up questions and the protocol encourages probing questions if necessary.

Each interview was recorded using the software “Audacity” and exported into an mp3 file in a password protected folder. The files were later transcribed for coding. At the conclusion of the interview, participants were invited to share any additional thoughts they had throughout the interview or ask questions.

Participants may have used artifacts such as student work, lesson plans, and classroom items such as visual aids and manipulatives to describe and support their use of CGI oriented instructional strategies, if available in the classroom. If participants mentioned instructional resources or student work such as classroom materials, visual aids, student math journals, lessons, assessments, or activities, the researcher asked to see these artifacts of instruction. The researcher collected images of interview artifacts for analysis and to support the participants’ responses, which were stored electronically with the interview audio file.

Course withdrawal. Participants who withdrew during the blended or face-to-face course were contacted two weeks after the course end date. Eight of the 13 non-completers agreed to an interview of 5 to 10 minutes. All participants chose to be interviewed in their classroom.

Upon arriving, I introduced myself, explained that I was conducting research on the outcomes of professional development practices, and that I was interested in learning about their recent experience in the CGI course. The interview questions were framed around the constructs defined by Moore and Kearsley (1996) and were meant to better understand how course content and interaction with the course environment, instructor, materials, and fellow participants may have impacted withdrawing from the course. The interviews were recorded using the software Audacity and the sound files were saved in a password protected file for later transcription and coding. At the conclusion of the interview, participants were asked if there was anything additional they wished to share.

Data Analysis Procedures

Instructional Belief Survey and Participant Satisfaction

The instructional belief survey instrument, both as a whole and within each subscale, yielded high levels of validity and reliability in previous studies (Carpenter et al., 1989; Fennema et al., 1996) indicating that it is an effective measurement of teacher beliefs. To ensure a correlation between items and each subscale, as well as a correlation between each subscale and the survey as a whole, the results were analyzed using bivariate correlation.

Once uploaded into SPSS, negatively worded items were reverse coded so that low values for the items would calculate as a high score, effectively indicating cognitively guided instructional beliefs. Thus, both negatively and positively worded items were able to be analyzed on the same scale.

Descriptive statistics and statistical analysis for the comparison of multiple groups, including frequencies, means, standard deviation, comparison of means, and ANOVAs were used to analyze the results. Frequencies for each item response on the pre- and post-survey were analyzed to look for patterns in response rates for individual items. Frequencies were also analyzed to look for changes in responses on individual items between the administration of the pre- and post-survey. The mean change in scores, or difference in scores, was compared between each class using comparison of means and ANOVAs to determine whether course environment elicited different changes in instructional beliefs. Changes in subscale scores were also compared between sections.

Instructional Belief Interview

The process of coding was guided by the previous research of Franke, Fennema, Carpenter, and Ansell (1992) and Fennema et al. (1996). The original analysis of CGI implementation by Franke et al. (1992) was developed based on the work of Hall (1975) who described levels of use of instructional practices, and Schifter and Fosnot (1993) whose work defined the extent to which a teacher designed instruction based on constructivist belief by creating levels of implementation. Franke et al. (1992) used a cyclical process of defining levels of implementation. They first defined dimensions of instruction characteristic of CGI, then isolated differences in instuction and beliefs within these dimensions, created categories based on the differences, and then used these categories to define the data. The definitions of each level were redefined throughout the data analysis process.

Coding by CGI construct. Interview responses within this study were analyzed using a similar process. First, characteristics of instructional and beliefs associated with each of the four CGI constructs were identified (See Figure 2). These constructs guided the coding as they reflected the course objectives and intended outcomes for the participants. The characteristics were defined using a summary of the literature related to Cognitively Guided Instruction (Fennema et al., 1996).

Construct I: Children construct knowledge rather than receive it.	
<u>Non-CGI practices or beliefs.1</u> - Teachers deliver knowledge. - Teachers should demonstrate the correct strategies to solve problems. - For students to be successful in mathematics, they must receive formal instruction from the teacher.	<u>CGI practices or beliefs</u> - Students come to school with a great deal of prior knowledge about math. - Formal instruction from the teacher is not necessary for students to solve many mathematical problems.
Construct II: Instruction should be designed around students' construction of knowledge versus the teacher's presentation of information	
- Teachers should model the correct way to solve problems, then students should practice to achieve fluency. - Direct instruction is frequently used with teacher modeling and solving algorithms step by step	- Manipulatives and classroom resources used to promote multiple problem solving strategies should be available for students during math instruction. - Instruction should allow for student discovery and investigation. - Multiple students are encouraged to share problem solving strategies with the class, even if strategies are incorrect
Construct III: Children's knowledge should guide instructional sequencing and planning	
- Mathematical structure, textbooks, curriculum guides, etc. are used to inform instructional planning. - Assessments tend to be close-ended with little opportunity for students to explain their thinking. - Problems solutions are assessed on whether they are correct or incorrect without an attempt to learn about the student's thinking.	- Student knowledge primarily informs instructional planning. - Extensive classroom observations, student interviews, mathematical reflections in journals and student sharing are used to gather information -about student mathematical knowledge.
Construct IV: Instruction is designed around the use of word problems rather than algorithms	
- Instruction is structured around the use of algorithms to promote mathematical understanding. - Students are encouraged to memorize facts before concepts are understood.	-Word Problems are used to introduce new mathematical concepts and promote mastery. - Students are not encouraged to memorize facts, rather fluency occurs naturally when concepts are mastered.

Figure 2: Summary of Cognitively Guide Instructional Strategies versus Non-CGI Strategies

Once characteristics of instruction for each construct were identified, interview transcriptions were analyzed for responses. Any response that related to a construct was grouped for each participant in an Excel document. In some cases, responses for individual questions aligned with multiple constructs and were included in both groupings.

Determining level of CGI implementation. After grouping the responses by construct for each participant, the responses as a group were analyzed as a whole. Differences among participants in responses within each construct were used to identify a continuum of implementation and determine the extent to which the concepts and beliefs within the professional developments courses were understood, adopted, and transferred to instructional practices in the classroom and defined the levels of implementation. The four levels of implementation that emerged from interview responses are discussed in detail in chapter 4.

Research Questions	Sources of Data	Data Analysis and Reporting Procedures
What are the differences in course completion rates between blended and face-to-face professional development sections of Cognitively Guided Instruction?	Course records	Comparison of completion rates and attrition percentages for each course
How do the changes in instructional beliefs compare between teachers participating in a blended and face-to-face CGI professional development course?	Belief Scale Pre- and Post- Course Surveys	Descriptive statistics and appropriate statistical analysis for the comparison of multiple groups, which include a comparison of means and ANOVAs
What are the differences in participant satisfaction between teachers participating in blended and face-to-face professional development CGI courses?	Participant Satisfaction post course survey	Descriptive statistics and appropriate statistical analysis for the comparison of multiple groups, which may include a comparison of means and ANOVAs
What are the differences in the retention of CGI oriented beliefs and the use of CGI instructional strategies between blended and face-to-face participants following course completion?	Belief Interview and supporting artifacts	Coding of transcriptions to reveal emerging themes using a priori and en vivo coding strategies.

Figure 3. Summary of data sources and analysis.

CHAPTER 4

Results

Chapter 4 will detail the findings of this mixed-methods study investigating the outcomes of professional development following blended professional development as compared to traditional face-to-face professional development. The results of pre- and post-course surveys on instructional beliefs and participant satisfaction, an analysis of responses from participant interviews, and student artifacts will be discussed. The findings address the following research questions:

- What are the differences in course completion rates between blended and face-to-face professional development sections of Cognitively Guided Instruction (CGI)?
- How do the changes in instructional beliefs, as measured by the instructional beliefs survey tool, compare between teachers participating in a blended and face-to-face CGI professional development course?
- What are the differences in participant satisfaction, as measured by district end-of-course satisfaction surveys, between teachers participating in blended and face-to-face professional development CGI courses?
- What are the differences in the retention of CGI oriented beliefs and the use of CGI instructional strategies, as measured by the CGI Belief Interview, between blended and face-to-face participants following course completion?

Participants

A total of 64 teachers enrolled in three sections of Cognitively Guided Instruction, Level 1 during the 2012-2013 school year. Of the participants, 32 enrolled in the face-to-face section of the course and the remaining 32 enrolled in one of two blended sections of the course, self-selecting into the section they preferred.

An analysis of variance revealed a statistically significant difference in the age of participants who enrolled in each section, where the blended participants were almost six years older than the face-to-face participants ($p = 0.028$). Despite this difference in age, participants in both sections had similar years of experience within the district and in total years of teaching (Table 1). There were no significant differences in district experience ($p = 0.250$) or total experience ($p = 0.310$) between blended and face-to-face sections as determined by an analysis of variance.

Table 1

Participant Demographics by Section Enrollment (Blended Versus Face to Face)

	Blended	Face-to-Face	All
Age			
Mean	41.48	35.6	38.7
Range	21-63	23 - 63	21 - 63
Years of District Experience			
Mean	7	5.07	6.05
Range	1 - 29	1 - 19	1 - 29
Years of Total Teaching Experience			
Mean	8.26	6.60	7.44
Range	1 - 29	1 - 23	1 - 29

There are a total of 25 schools in the district; nineteen schools are elementary schools and six schools are middle schools. Course participants represented 17 schools within the district: 16 elementary schools and one middle school (see Appendix F). In the blended section, participants represented 13 schools, 12 elementary schools and one middle school, and in the face-to-face session, participants represented 13 elementary schools. Five schools represented had just one participant enrolled in the course, ten schools had between two and six participants enrolled in the course, and two schools had over ten participants enrolled in the course.

Participant Online Experience

During the first session of the course, participants were asked to respond to questions about their previous experiences in professional development. In the blended section, 71.9% of participants had previously participated in an online or blended course and 53.1% had previously used Blackboard as either an instructor or as a participant. Face-to-face participants had slightly less experience with online or blended learning environments, with 62.5% reporting that they had participated in an online or blended course in the past and 46.9% reporting that they had used Blackboard as either a student or instructor.

Catalyst for Choosing Course Environment

In the online pre-course survey administered at the beginning of the first class, participants were asked why they chose the blended or face-to-face section of the course and submitted open-ended responses. Responses were then analyzed for themes which included participants' beliefs about their learning styles as well as perceptions of the impact of course format on learner experience and learner outcomes. Both face-to-face and blended participants provided examples of why the format of the course they chose better fit their needs than the other format.

Blended participants. In general, blended participants cited their preference for the blended section as it related to convenience and flexibility. Nineteen participants stated that they enrolled in the blended course because the blended format provided flexibility in when they could learn and complete coursework. These examples included both a desire or preference for flexibility and a perceived need for flexibility. Nine of the participants simply stated that they preferred the flexibility that the blended class provided providing responses such as "I chose to take the blended section of this course because I am usually very busy during the week and I prefer to work at my own pace at my home. This blended class allows me to get the information and work at the time that fits best with my schedule" and "This type of class is convenient because we can use our time effectively." These participants did not indicate that they could not participate in a traditional face-to-face course, only that they liked the opportunity to participate in the course activities at a time and place of their choosing. Ten of the participants stated a need for the flexibility of the blended course. These participants indicated that the conflicts of family engagements, lack of childcare, involvement in other district committees, second jobs, and the demands of teaching make face-to-face professional development too difficult to attend. In other words, these participants stated that they would not be able to commit to a traditional face-to-face course and their schedule required the flexibility that a blended course offers. Typical responses included "I have wanted to take the course but always seem to have scheduling conflicts. This allows me to do the work whenever I can find the time, including Sunday night" and "I have a baby on the way! It will be tough for me to stay late, so I need to limit those days."

Four blended participants chose the blended section based on their perception of superior learning outcomes. They indicated that they preferred blended courses because they learn more effectively in the environment providing responses such as, “I chose the blended section because I like online courses and felt I could learn a lot from watching and/or reading the instruction online” and “I prefer to study and learn on my own schedule. I feel I gain more from the class that way. It is so challenging to attend a class after a full day of work.”

Five of the blended participants were not aware that a face-to-face section was available and indicated they preferred learning in person, believing they learned better in a face-to-face environment. Typical responses favoring face-to-face learning included “I didn't know what Blackboard was all about. If I had known, I probably wouldn't have taken this class. Computers are not my strength!!! Nevertheless, I am glad I am taking it and learning more about computers and about CGI” and “I choose the blended section of this course because it is the only form this class is offered. I would prefer the face-to-face section if it is available. With face-to-face, modeling and questions can be shown and answered right away. Practice and discussion with peers or classmates give me the insight of their thinking and understand the methods they used. With the Blackboard, I have to check it often to see if my questions are answered.”

Face-to-face participants. Face-to-face participants also cited their preference for the format of a face-to-face course, indicating that, for them, the characteristics of a face-to-face format resulted in superior learning. The responses specifically mentioned increased interaction with colleagues, the ability to clarify content with the instructor when needed, and feeling more present and engaged with course content in face-to-face environments. Reponses regarding the perception of superior learning included “I enjoy the personal interaction. I learn better that way,” “I get more out of a class when I'm able to interact and collaborate with other teachers and professionals,” and “I wanted to get the most out of it as possible. I feel that in person offers more than online courses.”

While some participants stated that they felt that the face-to-face course format would have a more positive impact on their learning, others did not feel they would be able to successfully complete a course in a blended format. These participants cited their inability to effectively allocate time to complete the course and self-discipline by stating, “It (face-to-face) required me to be in class certain times, versus leaving the time to work up to me to get done on my own schedule” and “I know I would not be disciplined to do an online class. I do not like to sit and do reading online.”

Perception of increased learning and perceptions of low self-discipline were the primary reasons for face-to-face course selection given by all face-to-face participants.

Course Completion

Rates of Course Completion

To compare course completion rates, enrollment and completion records for each course were requested from the district. Participants who enrolled, but did not show up for the first session of class were excluded from the data. Per the district reports, it is common for up to 25 percent of participants not to show up to classes in which they are enrolled.

The face-to-face section had a higher completion rate at 96.9% completion as compared to a 62.5% completion rate in the blended sections. Only one participant withdrew from the face-to-face section of CGI, while 12 of the 32 blended participants withdrew before course completion. Of the 12 blended participants who withdrew, 83.3% had participated in an online or blended course in the past, and 33.3% had previously used Blackboard as a learning management system, as reported in the pre-survey. Thus, the reason for course withdrawal may not be linked to lack of experience in online and blended environments and may be correlated with other factors.

The age, years of total teaching experience, and years of teaching experience within the district reflected the original enrollment demographics of the blended and face-to-face sections (Table 2). Like the original enrollment, there was a statistically significant difference in age between blended and face-to-face completers ($p = 0.029$) and no significant difference in years of total teaching experience ($p = 0.774$) or in years of district experience ($p = 0.795$).

Table 2

Demographics of Course Completers (Blended Versus Face-to-Face)

	Blended n = 20	Face-to-Face n = 31
Age		
Mean	42.90	35.58
Standard Deviation	11.72	11.09
Years of Total Teaching Experience		
Mean	6.15	6.61
Standard Deviation	4.83	6.02
Years of District Experience		
Mean	4.70	5.13
Standard Deviation	5.01	6.12

Blended course completers had both fewer years teaching in the district (p = 0.008) and fewer total teaching experience than blended participants who withdrew from the course (p = 0.012) as shown in Table 3. There was no significant difference in age between teachers who withdrew from the blended course and those who completed it (p = 0.454). The mean age of blended course completers was 42, while the mean age of those who withdrew from the blended course was 40.

Table 3

Blended Participant Demographics at End of Course (Completers Versus Non-Completers)

	Completers n = 20	Non-Completers n = 12	Total n = 32
Age			
Mean	42.90	40.08	42.03
Standard Deviation	11.72	11.18	11.18
Years of Total Teaching Experience			
Mean	6.15	12.27	8.32
Standard Deviation	4.83	7.95	6.69
Years of District Experience			
Mean	4.70	11.36	7.06
Standard Deviation	5.01	8.07	6.93

Reasons for Course Withdrawal

In addition to collecting completion rates for each section, participants who withdrew from either course were invited to participate in a short interview to learn why they withdrew. Eight of the 13 non completers agreed to an interview, including the one face-to-face participant who withdrew and 7 of the 12 blended participants who withdrew.

For the face-to-face participant who withdrew and for five of the blended participants who withdrew, the biggest challenge reported in completing the class was time. Both the face-to-face participant and two of the blended participants cited unusual circumstances, such as personal or family medical issues and conflicts that prevented them from having the time to complete the coursework, causing them to fall too far behind. Three of the blended participants who withdrew reported that the demands of their jobs left little time to complete coursework, even for those who had successfully complete online classes in the past:

> It’s funny because I completed my whole master’s online, and I usually don’t have a problem. With the responsibilities now with all of our school things, and I also coach, and outside responsibilities, it just was a little too much. I didn’t wanna really spend my whole holiday break just rushing through work to get through work. I really want to get something out of it.

Despite withdrawing from the course, six of the eight blended participants stated that they liked the opportunity to take a blended course and would enroll in online or blended professional development in the future. Several participants attributed their withdrawal to unusual circumstances and reported that both the content of the course and format the course was provided in was positive.

> I actually really did like it. I liked that we originally met in person, and then had an opportunity to do a lot of it on our own online. I am disappointed that I just didn’t have the time personally to devote to it, because it would have worked. I was really happy that they were doing it online, cuz that does make it much easier, I think, for teachers who have kids. We just don’t have the time. Whatever time we have, we wanna spend it in our classrooms getting things ready…It was my first time using Blackboard, so that was a learning curve as well. I like that. I would like to see more classes offered in that format.

Of the remaining three blended participants who interviewed, two attributed their withdrawal to course content, stating that they realized the course was similar to another mathematical instruction professional development course they had completed in the past. Each reported that, while this course would have been redundant for them, they would like to see more blended courses offered in the district in the future.

Only one of the blended participants who withdrew reported the blended format as a reason for withdrawing. In the pre-survey, this participant reported never taking an online or blended course in the past and stated that he would have preferred a face-to-face environment.

> I didn't realize it was a blended class when I enrolled, and I have found the Blackboard process confusing. I have opened each week's lessons only to be stymied about what to do. I would consider taking the course as a sit in class.

This section presented data related to retention in the blended and face-to-face courses. The percentage of non-completers in the blended course was considerably higher than in the face-to-face course, in which only one participant withdrew. There were no differences in age between blended course completers and non-completers; however there was a significant difference in the two groups' total years of teaching experience and years of teaching within the district. The primary reason for leaving the course was time. Participants cited other commitments or unexpected life situations that precluded them from dedicating the time necessary to finish the course. Despite a lack of course completion, the participants made positive comments about the blended format and indicated that they would participate in another blended course.

Change in Instructional Beliefs

In this section, results and analyses of the instructional belief pre-and post-survey are presented. The pre-and post-survey results for each course section were analyzed using descriptive statistics, an analysis of frequencies, a comparison of means, and

ANOVAs. Response data and analysis for pre-and post-surveys are presented to demonstrate any differences in instructional beliefs between blended and face-to-face sections existing at the beginning of the course and/or differences in beliefs following participation in the course. The differences in instructional belief scores between the pre- and post-surveys will then be presented in order to compare outcomes of the face-to-face and blended sections of the course. Complete survey results are reported in Appendix G.

Pre-Survey Instructional Beliefs

Pre-survey results for each course section were analyzed to determine if the starting instructional beliefs of teachers differed between each section (Table 4). Participants in the blended and face-to-face sections of the class generally responded neutrally or positively towards cognitively-guided instructional belief statements. No statistically significant differences were revealed between the face-to-face or blended section within any of the three subscales as determined by an analysis of variance (Subscale I, $p = 0.719$; Subscale II, $p = 0.075$; Subscale IV, $p = 0.106$), or in the total pre-survey score ($p = 0.162$), indicating similar instructional beliefs at the start of the course. Additionally, no statistically significant differences were found on the pre-survey subscales and pre-survey total score between participants who dropped the course and those who completed the course.

Table 4

Comparison of Instructional Belief Pre-Survey Results by Subscale between Environments (Blended Versus Face to Face)

	Blended n = 32	Face-to-Face n = 32	Total n = 64
Subscale I			
Mean	3.60	3.49	3.52
Standard Deviation	0.46	0.39	0.43
Subscale II			
Mean	3.72	3.42	3.57
Standard Deviation	0.58	0.45	0.54
Subscale IV			
Mean	3.87	3.74	3.81
Standard Deviation	0.43	0.34	0.39
Total			
Mean	3.75	3.62	3.69
Standard Deviation	0.38	0.33	0.36

Differences in Beliefs or Growth

Participants in both the blended and face-to-face courses generally responded more positively to cognitively-guided instructional beliefs in the post-survey than in the pre-survey (Table 5). Post-survey scores, as a whole and within each subscale, averaged around a score of “4” or “agree”. No statistically significant difference was found in the total post-survey means or in the individual subscale means of the two sections (Subscale 1, $p = 0.16$; Subscale 2, $p = 0.31$; Subscale 4, $p = 0.15$; Total, $p = 0.08$).

The means of the post-survey scores within each subscale were compared to the means of the corresponding pre-survey scores, creating a “difference” score that indicated change in instructional beliefs between the beginning and the end of the course. Using an analysis of variance, these “difference” scores were compared between each group to determine if either the blended or face-to-face section demonstrated greater change. No statistically significant difference existed between groups within subscales or in mean total scores (Subscale 1, $p = 0.33$; Subscale 2, $p = 0.40$; Subscale 4, $p = 0.94$; Total, $p = 0.41$).

Table 5

Pre- and Post-Survey Results by Subscale (Blended Versus Face-to-Face)

	Pre-Survey Mean	Post-Survey Mean	Difference in Means
Subscale I			
Blended	3.55	3.94	0.40
Face-to-Face	3.49	3.76	0.27
Subscale II			
Blended	3.72	3.93	0.24
Face-to-Face	3.41	3.77	0.34
Subscale IV			
Blended	3.87	4.40	0.48
Face-to-Face	3.74	4.07	0.33
Total Items			
Blended	3.75	4.10	0.37
Face-to-Face	3.62	3.91	0.29

Note: Subscale I: Students construct knowledge versus receive it.
Subscale II: Instruction should be student-centered and constructivist versus teacher-centered
Subscale IV: Instruction should be designed around solving word problems rather than algorithms and mathematical structure.

Participant Satisfaction

In the online course post-survey, participants were asked to respond to four point Likert scale items. The questions, adapted from Moore and Kearsley (1996), were used to understand participant satisfaction with the course, specifically as it relates to the interaction between the learner and course content, the learner and the instructor, and the learner and their classmates. Responses from each section were compared using descriptive statistics and statistical analysis to determine if there was a relationship between course environment and participant satisfaction.

On average, both groups responded positively to survey questions regarding course satisfaction on the four point scale (Table 6), however the ANOVA yielded a statistically significant difference in satisfaction, with blended participants more satisfied than face-to-face participants ($p = .027$).

Table 6

Participant Satisfaction Rating for all Items by Environment (Blended Versus Face-to-Face)

	Count	Mean	Standard Deviation
Blended	20	3.5500	0.44315
Face to Face	31	3.2298	0.51549
Total	51	3.3554	0.50890

An analysis of each of the four subscales within the satisfaction post-survey revealed statistically significant difference in responses for questions related to three of the four subscales, in favor of blended learning participants (Tables 7 through 14). With respect to general course satisfaction, blended participants reported statistically higher levels of course satisfaction in Question 49 ($p = 0.024$) and in their perception of how the course met their learning needs ($p = 0.022$).

Table 7

Responses to Q49 "I Am Very Satisfied With This Course."

	Count	Mean	Standard Deviation
Blended	20	3.60	0.598
Face to Face	31	3.16	0.688
Total	51	3.33	0.683

Table 8

Responses to Q50 "This Course Met my Learning Needs"

	Count	Mean	Standard Deviation
Blended	20	3.60	0.598
Face to Face	31	3.19	0.601
Total	51	3.35	0.627

Learner-Course Content Interaction

Despite the consistency in course materials and assignments between the blended and face-to-face sections, blended participants also reported significantly higher satisfaction on questions related to learner-course content interaction. Blended participants were more satisfied with course materials, such as videos and course readings, than their face-to-face counterpoints ($p = 0.009$) and were more satisfied with weekly assignments ($p = 0.008$).

Table 9

Responses to Q51 "The Course Documents (Lessons, Lecture Notes, or Media) Used in This Class Facilitated my Learning."

	Count	Mean	Standard Deviation
Blended	20	3.65	0.489
Face to Face	31	3.26	0.514
Total	51	3.41	0.536

Table 10

Responses to Q52 "The Assignments in This Course Facilitated my Learning."

	Count	Mean	Standard Deviation
Blended	20	3.60	0.503
Face to Face	31	3.16	0.583
Total	51	3.33	0.589

Learner-Instructor Interaction

Professional development sections were led by the same instructors who intentionally planned consistent discussions, pacing, and instructional objectives for the blended and face-to-face formats. While both groups reported high levels of satisfaction in learner-instructor interaction, blended participants reported higher satisfaction with the instructors' involvement than face-to-face participants. Blended participants perceived the instructor to be a more active member of the course than face-to-face participants ($p = 0.001$) and were more satisfied with the level of help they received from their instructor when needed ($p = 0.000$).

Table 11

Responses to Q53 "In This Class the Instructor Was an Active Member of the Discussion Offering Direction to Comments."

	Count	Mean	Standard Deviation
Blended	20	3.90	0.308
Face to Face	31	3.42	0.564
Total	51	3.61	0.532

Table 12

Responses to Q54 "I Was Able to Get Individualized Attention From my Instructor if Needed."

	Count	Mean	Standard Deviation
Blended	20	3.85	0.366
Face to Face	31	3.26	0.575
Total	51	3.49	0.579

Learner-Classmate Interaction

Two questions were intended to reveal the perception participants had regarding the level of interaction among course members. This was the only subscale in which an ANOVA revealed no significant difference in satisfaction between blended and face-to-face sections. There was no statistically significant difference in participants' perception of community within the course ($p = 0.519$) or in the perception of opportunity to problem solve with other classmates ($p = 0.779$).

Table 13

Responses to Q55 "This Course Created a Sense of Community Among Students."

	Count	Mean	Standard Deviation
Blended	20	3.00	0.858
Face to Face	31	3.13	0.562
Total	51	3.08	0.688

Table 14

Responses to Q56 "In This Class the Discussion Provided Opportunity for Problem Solving With Other Students."

	Count	Mean	Standard Deviation
Blended	20	3.20	0.894
Face to Face	31	3.26	0.575
Total	51	3.24	0.710

Learner-Technology Interaction

In addition to course satisfaction questions asked of both blended and face-to-face sections, the participants in the blended sections were asked to respond to several additional questions about their interaction with technology. On all questions, the majority of participants agreed or strongly agreed with the statement indicating a positive perception of their interaction with technology. Course completers generally had positive perceptions of their technology skills, with 85% agreeing or strongly agreeing that they were confident in their abilities to use a computer and 90% agreeing or strongly agreeing that they could overcome challenges with technology. Ninety percent of course completers reported that they agreed or strongly agreed that they were satisfied with the blended course and that the blended course met their needs. While 75% of completers agreed or strongly agreed they would take another blended course, only 65% believed that blended courses were as effective as face-to-face courses.

Table 15

Responses to Q60 "I Am Very Confident in my Abilities to Use Computers."

	Frequency	Percent	Cumulative Percent
Disagree	3	15.0	15.0
Agree	5	25.0	40.0
Strongly Agree	12	60.0	100.0
Total	20	100.0	

Table 16

Responses to Q61 "I Can Deal With Most Difficulties I Encounter When Using Computers."

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	5.0	5.0
Disagree	1	5.0	10.0
Agree	8	40.0	50.0
Strongly Agree	10	50.0	100.0
Total	20	100.0	

Table 17

Responses to Q62 "I Am Very Satisfied With This Blended Course."

	Frequency	Percent	Cumulative Percent
Strongly Disagree	2	10.0	10.0
Agree	6	30.0	40.0
Strongly Agree	12	60.0	100.0
Total	20	100.0	

Table 18

Responses to Q63 "I Would Like to Take Another Blended Course."

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	5.0	5.0
Disagree	4	20.0	25.0
Agree	4	20.0	45.0
Strongly Agree	11	55.0	100.0
Total	20	100.0	

Table 19

Responses to Q64 "This Blended Course Met my Learning Needs."

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	5.0	5.0
Disagree	1	5.0	10.0
Agree	6	30.0	40.0
Strongly Agree	12	60.0	100.0
Total	20	100.0	

Table 20

Responses to Q65 "I Feel Blended Courses Are as Effective as Face-to-Face Courses."

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	5.0	5.0
Disagree	6	30.0	35.0
Agree	8	40.0	75.0
Strongly Agree	5	25.0	100.0
Total	20	100.0	

The post-course survey responses indicated high levels of participant satisfaction in both blended and face-to-face course environments; however blended participants reported a higher level of course satisfaction in multiple areas. Similar satisfaction was reported regarding interaction and collaboration among course participants. Despite 90% of blended participants reporting that the course met their learning needs, only 65% reported believing that blended courses were as effective as face-to-face courses. This discrepancy may indicate a lower level of confidence in learning and ability to transfer new knowledge to classroom practice.

Impact on Instructional Practices

A total of 26 participants who completed the CGI course were interviewed in order to learn about the use of CGI practices in their instruction in their classroom 3 months after completing the class. Sixteen of the interview participants completed the face-to-face section, and ten completed the blended course. The interview transcripts were analyzed using the four constructs of instructional beliefs described by Peterson et al. (1989) and responses related to constructs were summarized and then coded using a one through four scale representing the level of implementation of CGI practices. The initial scale was guided by the work of Fennema et al. (1996), but as the interviews were analyzed, levels more specific to the context of this study emerged. These revealed an expanded continuum that considered not only the use of CGI strategies, but also how the adoption of CGI beliefs impacted instructional decisions following professional development.

Four distinct levels of instructional implementation emerged from the interview responses (summarized in Figure 4). In the following section, I describe the four general levels of CGI implementation that emerged from interview responses that apply to all four CGI constructs. Then, each construct is discussed specifically, along with examples of interview responses that demonstrate CGI implementation at each level. Finally, I discuss and quantify the differences between CGI implementation between blended and face-to-face participants.

Emergent Levels of Implementation

Level I: Non-practicing. The first level of CGI implementation was characterized by the participant describing instructional beliefs and practices that were contrary to Cognitively Guided Instruction. In this level, teachers did not mention instructional beliefs or strategies associated with CGI, providing no evidence that they had retained beliefs or knowledge from the course. When describing their current instructional practices, these participants explicitly described beliefs and practices that contradict the goals of CGI. If provided, classroom artifacts, such as student work and instructional resources, did not demonstrate the use of CGI strategies.

Level II: Reluctant. In the reluctant level of implementation, participants acknowledged beliefs and instructional strategies associated with Cognitively Guided Instruction, but stated that they either did not ascribe to those beliefs or perceived obstacles that prevented the use of these strategies. The level could have been named the "yes, but" level as participants frequently acknowledged specific CGI beliefs and practices, then followed by saying, "but, I don't do that because…" Occasionally, the participants described a combination of CGI instructional strategies and traditional teacher-centered instruction or an attempt to try CGI, but cited concerns and challenges surrounding CGI for their lack of consistent or frequent use. Participants at this level of implementation either stated that they did not believe that CGI was the most effective instructional strategy, or they cited reasons why CGI could not be reasonably implemented in their classroom. If provided, classroom artifacts, such as student work and instructional resources, did not demonstrate the use of CGI.

Level III: Transitioning. In the transitioning phase, participants demonstrated instructional practices that reflected belief congruous with Cognitively Guided Instruction as well as knowledge and some application of CGI strategies. Participants explicitly stated beliefs that aligned with a CGI construct and could give examples of their application of these beliefs and strategies. In the transitioning level of implementation, participants often employed a combination of CGI and traditional teacher-centered instruction. While participants in this level of implementation sometimes provided examples of how they had yet to fully integrate CGI, they were able to identify how they would be more successful in the future and stated their perceived value of CGI.

Level IV: Implementing. In the implementing level, participants gave multiple, specific examples of their use of CGI strategies and the beliefs that informed these instructional practices. Participants at this level of implementation integrated vocabulary specific to cognitively guided instruction throughout their interviews, could provide step-by-step lesson descriptions that demonstrated their use of CGI, and provided their pedagogical beliefs that informed their instructional choices. In many cases, participants provided multiple classroom artifacts as evidence of the use of these strategies and discussed their relationship with beliefs and instructional practices associated with CGI.

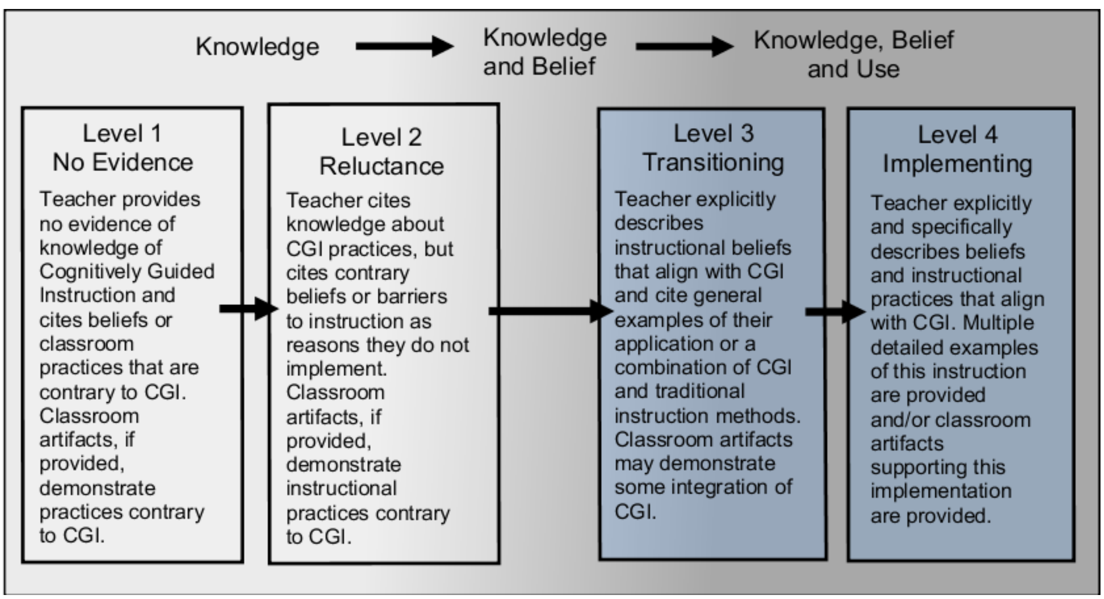

Figure 4. Summary of levels of implementation.

While much of the exisiting literature in documenting the adoption of CGI beliefs and implementation of strategies does not assess teachers in each construct, it quickly became evident during interviews that teachers could be implementing at a high level in one construct and a low level in another construct. The inconsistencies of adoption and implementation across constructs may reveal differences in course outcomes between the blended and face-to-face participants.

In the following section, the responses for each construct and theme are summarized, levels of implementation are described, and levels of implementation between the blended and face-to-face sections of the course are compared to help understand the relationship between course environment and use of new instructional strategies. Two additional themes that emerged from interviews are also discussed: methods for gathering information about children's knowledge and perceptions of barriers to utilizing stratgies that align with each teacher's instructional beliefs.

Levels of CGI Implementation Within Each Construct

Construct I: Students construct their own mathematical knowledge vs. students are the receivers of knowledge. Construct I elicited abstract responses, representing only a belief about how children learn and the role of the teacher, rather than instructional practices and strategies shaped by beliefs seen within the other three constructs. Common words to describe the role of a teacher, such as "guide," "facilitator," and "expert, were used in almost all of the participants' responses at some point in the interviews. These common words, as well as the context surrounding them, helped shape the definitions of each level of implementation within Construct I.

Non-Practicing. Teachers identified in level I in the first CGI construct stated their belief in a more traditional teacher role, in which the teacher provides knowledge and problem solving strategies unto the students, making the students receivers of knowledge. Teachers at level I in this construct frequently cite themselves as experts that children should learn from and discuss the importance of providing students with more efficient problem solving strategies. They may discuss specific mathematical concepts that students must learn from their instruction as well as problem solving strategies students should adopt to be more successful. Relevant to this level is that the teacher does not cite or acknowledge the belief that students can construct their own mathematical knowledge without the teacher providing it first. There is no evidence that the teacher learned or retained the CGI course concepts, much less adopted them within their instruction. A typical level I response about the role of the teacher included:

> The number one thing I always go back to with anything in math is how do I think about it? As a person who I feel is somewhat half decent in math, if I think about it that way, how can I get my kids to think about it that way? If I do this problem in these steps, how can I show that in a very simple way and simplify it, so that I can show it to them and get them to think the same way I do, if that makes sense. (Interview 1)

Reluctant. Teachers in the reluctant phase of Construct I quickly acknowledged the CGI oriented belief that students should construct their own mathematical knowledge, that students bring prior knowledge to math, and that students should be able to discover their own problem solving strategies, but then cited reasons why they could not, or chose not to adopt this belief. At this level, teachers clearly retained knowledge about the belief, often citing the CGI course when discussing it, but explained why students could not learn this way, or why the structure of the classroom prevented them from allowing students to learn by investigation. Typical responses of a level II teacher in this construct included

> I believe a teacher needs to teach. I think that it's really great to let kids discover every single concept and it would be really great if we had an infinite amount of time, but with more than 20 students in a classroom and an hour and a half to teach math I don't have time to let them discover every concept. (Interview 2)

And another response was:

> I like that kind of instruction, but I just don't think it can be the only thing you do. I feel like kids have to have a foundation so I think maybe I don't agree with everything that we learned in my—in the class because I think you can spend a lot of time on one little tiny problem, they don't get enough practice on—they don't make it part of who they are if they don't get enough practice. (Interview 2)

Some teachers at this level cited their students as the reason they could not adopt this belief. "I do think it's important for them to try to be their own solvers with everything, but that's not where they are" (Interview 22). Some teachers specifically cited worrying their general student population prevented them from utilizing investigational strategies with the class:

> I think the idea of a teacher being the facilitator is okay; however, they need direct instruction. I don't care what anyone says about that, no matter what they—especially when you're working with a group that is title [Title I] and they're extremely low. They still need direct instruction. I'm all for them investigating and learning and figuring things out, but they still need direct instruction in fourth grade. You can't expect to just walk around and just to facilitate and monitor and look. I still think it's still very important. (Interview 8)

Transitioning. Teachers who responded at the transitioning level of implementation for Construct I explicitly stated their beliefs that students could construct their own mathematical knowledge using discovery and prior knowledge. Characteristic of these teachers was their acknowledgement that while they believe students can construct their own knowledge and that the teacher is a guide, they may have not always believed this and that they sometimes have difficulty allowing children to struggle through the discovery process:

> I know that it's all about discovery, and they want students to come to that answer on their own, but I feel sometimes it just frustrates 'em. So sometimes I feel it's better to help lead them through, and show them a way of thinking. Then have them use that next time for their own benefit, or also to take that and maybe construct their own reasoning from that. (Interview 14)

Transitioning teachers appeared to identify areas in which they still need to feel comfortable allowing students to construct knowledge and why this is essential to the learning process. Some Level III teachers stated that they believe children should construct their own knowledge, but worried about the ability of low-performing students to construct knowledge without guidance from the teacher and expressed concern that all students benefit equally from cognitively guided strategies:

> Those low, low kids—it's not low, low kids that are answering those questions on how to build it, how to see it, how to be abstract. Even concrete, it's hard for them to even be concrete. It's always those middle kids that are—middle and high kids that are always able to understand a little bit better and those other kids are kind of just sitting there. They need to have an understanding as well. Maybe sometimes they just—I always let them try it on their own but if they don't figure it out on their own, then it's like okay, let's show what the kids—what people come up with and let's model what it is. (Interview 8)

Implementing. Teachers in the Implementing level consistently discuss the importance of students constructing mathematical knowledge throughout the interview. These teachers use the words "facilitator" and "guide," as well as "construct" and "discovery." They express the importance of students coming up with their own strategies for problem solving and why they should articulate their strategies to others as a means of developing deep understanding of mathematical concepts. Typical responses of an Implementing teacher included: "I think it's (the role of a teacher) more of a facilitator. I don’t consider myself a math genius; like, ‘Open up your brains. Let me pour it in,’” and

> Mostly just kind of guiding them, letting them explore. The beginning of the year is just a lot of exploring the tools and playing with the tools. Mostly just guiding them. They do a lot of the talking, they do a lot of the figuring out the answers. I don’t get up and say, “This is how we’re gonna do it. You’re gonna count from a higher number.” The kids are sharing that with each other and exploring it together. (Interview 4)

Construct II: Instruction should be designed so that children can construct mathematical meaning vs. instruction is planned to allow the teacher to present knowledge. While closely related to Construct I, Construct II differs in that teachers described specific instructional practices that aligned with their beliefs regarding whether instruction should be student centered for the construction of knowledge or teacher centered for the presentation of knowledge. Responses related to this construct frequently included the use of student grouping, student access to classroom resources, movement and use of classroom spaces, cooperative versus individual learning, and questioning strategies. Teachers’ descriptions of instructional practices and their reasoning for making those choices defined the levels of implementation within this construct.

Non-Practicing. Responses in level one described classroom instruction that is teacher centered. At this level, the process of problem solving is modeled by the teacher and students are given the opportunity to practice the strategy provided to attain mastery. Typically the teacher demonstrates solving problems step-by-step: “Well, I introduce it by lining up that like an algorithm, and then I show them how to circle and move on, from the ones to the tens to the hundreds place” (Interview 6). Teachers who gave non-practicing responses mentioned direct instruction and guided practice as an instructional strategy:

> It’s direct instruction. I do a portion of my lesson with direct instruction where I am presenting the concept. I work through—first, I talk about it. Then we work through a lot of examples on the board. Then I do guided instruction where I’m watching them as they— and working with them. (Interview 2)

In these responses, teachers did not mention student centered strategies, providing no evidence that they had retained belief or knowledge from the CGI course. When asked how she introduced a new topic, one teacher simply responded, “I use direct instruction. Many students need teacher led instruction to understand the proper steps to solve math problems” (Interview 23). Teachers supported their description of teacher-centered instruction with reasons for why instruction is designed this way:

> First, I teach them all in steps. What is the first step? The first step is identifying the numbers. They pull out the numbers, out of the word problem. What’s the second step? Identifying are you gonna add or are you gonna subtract. Then, they put the actual symbols in. Then, the third step is to solve it. They do it step-by-step. I really like to teach ‘em step-by-step because it helps them with the—when they get harder questions or harder math problems, they can visualize that and still pull everything out—still the basics, even though it’s harder. (Interview 9)

Instruction in the non-practicing level of this construct was characterized by a lack of student sharing. At this level, teachers check work for correctness without requiring students to articulate their thinking either to other students or to the teacher (Figure 5). When asked what students do with their work once they complete the practice problems, one teacher replied: “They show it to me and I usually mark it off and then I have them go put it back” (Interview 16).

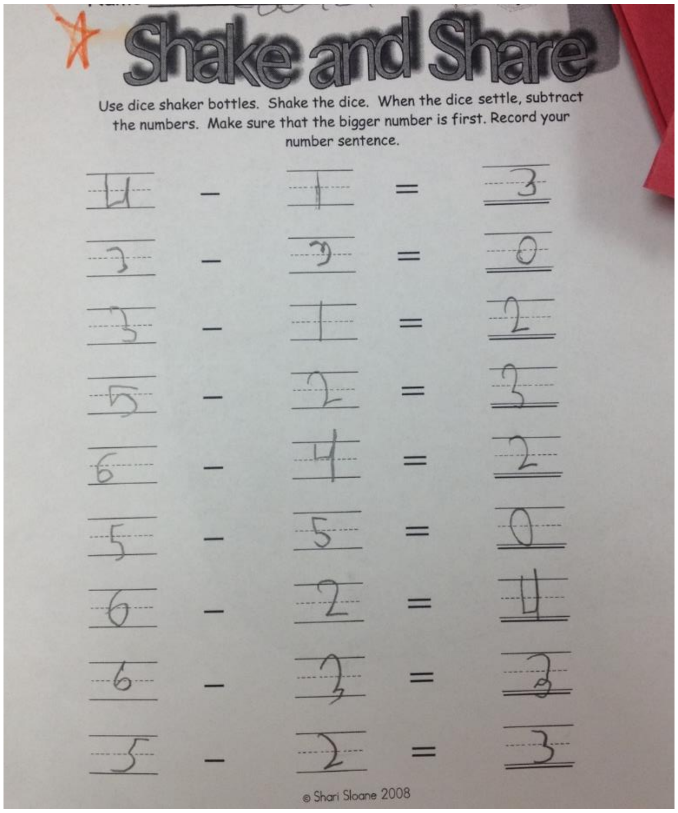

Figure 5. Student artifact representing close-ended questions.

Reluctant. Reluctant teachers within Construct II demonstrated knowledge of strategies associated with student-centered instructional practices, yet expressed concerns or challenges related to implementing these practices. These teachers provided evidence that they had retained some of the knowledge about instructional practices from the CGI course, but may not believe in their effectiveness or struggle with application of the strategies. Thus, the student-centered strategies are used infrequently, if at all. Most significantly, reluctant teachers recognized investigation as a problem solving technique, but did not allow students to practice investigation with any consistency stating that they believe that modeling problem solving was more beneficial for students. The reluctant teacher often cited that modeling should occur before students are left to solve similar problems on their own:

> I feel like there should be some modeling going on. That's just my personal bent, that you can't just expect little seven and eight-year-olds to discover everything on their own. There should be sometimes modeling or going through, here's what a good, complete solution would look like... (Interview 9)

Reluctant teachers in this construct frequently expressed concerns over the time student sharing and articulation of understanding took in class:

> My concern with that is students often tune out, or the student who's sharing doesn't talk loudly or clearly enough, and so they start to tune out. I do want them to feel each other's work is important valid, but at the same time we can't be wasting time. (Interview 9)

When utilizing student-centered strategies, the reluctant teacher sometimes struggled to explain why it was important to student learning. Reluctant teachers could sometimes provide one or two student artifacts that portrayed student articulation of problem solving, but the majority of classroom artifacts did not provide space for students to explain their thinking.

Transitioning. Transitioning teachers explicitly state their belief in the effectiveness of student-centered instructional practices and discuss using of a combination of student-centered and some teacher-centered instructional practices. Their description of student-centered instruction that promotes construction of knowledge is specific, typically including the opportunity for students to discover problem solving strategies and then to share multiple strategies with their fellow classmates. These teachers described the initial introduction to problems in a similar way:

> I just give them a prompt, a situation. It may be numbers on the board—but at least I'm saying it loud, a story. They try to solve by themselves, try to figure it out, what they can do. Then, I'm just walking around, looking at my students who

have a better strategy or who got to the answer and what strategies they used (Interview 13),

generally giving the students time to work with the problem with whichever strategy they prefer.

Teachers in the transitioning level of Construct II integrated student sharing in daily lessons and value students' discovery of multiple strategies for problem solving.

> My biggest thing with my kids on any kind of problems is telling them that there's a million ways to get to an answer. There's only one right answer when it comes to math, but you can get there a million different ways. Just because one person sees it as addition, doesn't mean it's—you can do it as subtraction too. It introduces just an idea and then says, "Okay, you guys go look. Then we come back together and discuss and break down the ideas and have the aha moments and the new strategies that come out of that that the kids invent on their own, which is fantastic. (Interview 3)

The description of instructional strategies and the integration of student sharing time was often supported with classroom or student artifacts demonstrating that students are encouraged to show the problem solving strategy in their work and gives students space to use the strategy that they understand best or that is most efficient (Figure 6).

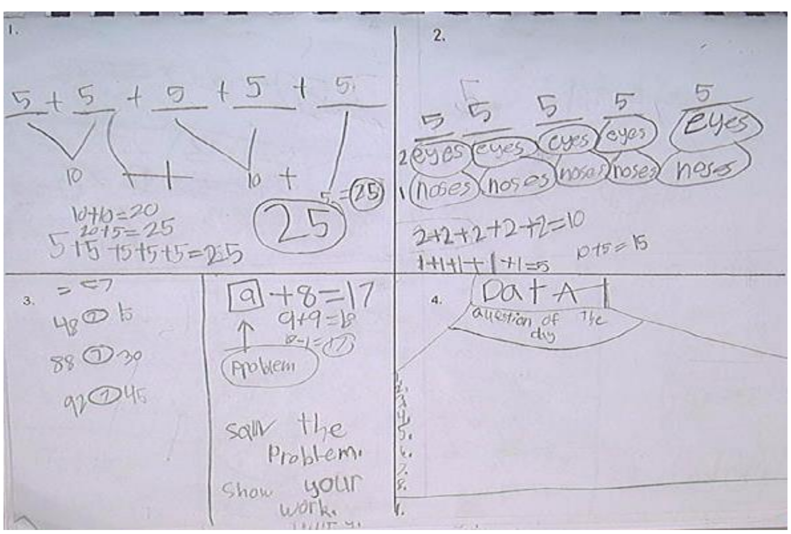

Figure 6. Daily student math journal.

Other teachers at the transitioning level were able to describe and provide student artifacts for attempts at new lessons in which students are presented with a real-world word problem, given time to discover a solution on their own, and create a presentation of their strategies to share their classmates (Figure 7).

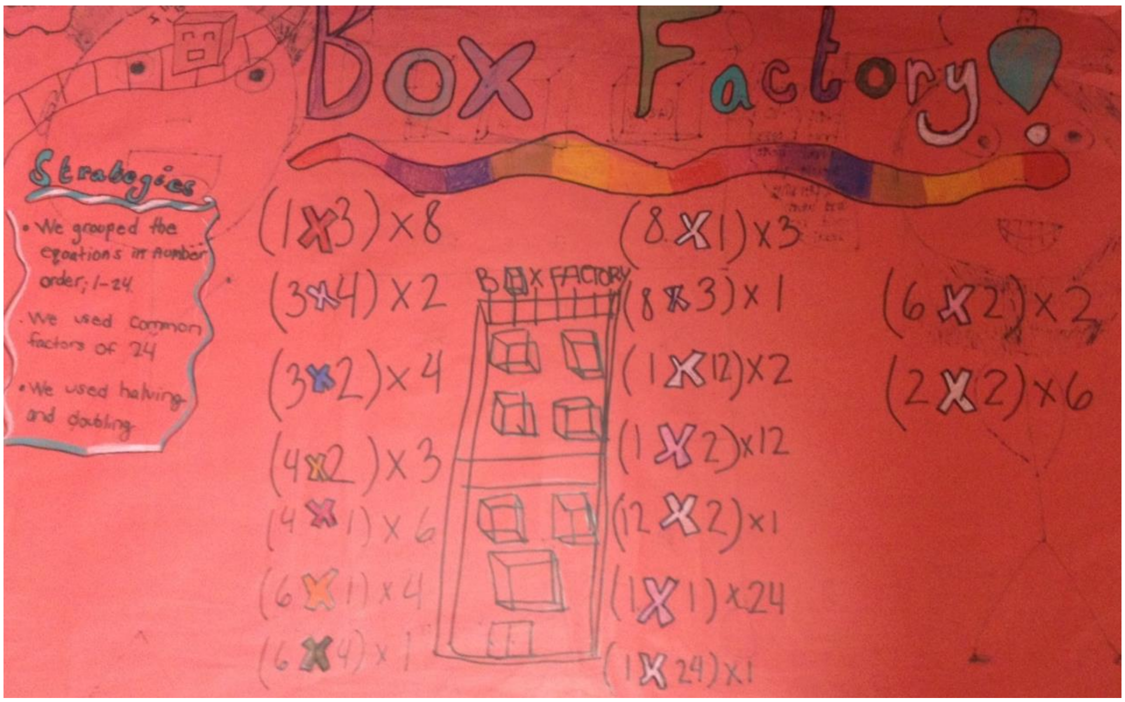

Figure 7. Student example of “box factory” investigation.

Transitioning teachers were likely to cite a change in their instruction from previous methods of instruction, describing their combination of student-centered strategies with teacher-centered instruction:

> I always have them share under the document camera so that they can show their friends how they did it. Sometimes that leads to other kids going, "Oh, but if I did that, then I could also do this." It just leads to really nice conversations. I really appreciated that from the CGI class that I took this year. It was just a fantastic

> way to do it. I had already been doing that in small doses, but I started doing it a lot more. I got braver after taking the class, to be honest. (Interview 3)

And,

> To be honest with you, I did a really bad job with that earlier in the year. I've been trying to do a better job towards the end. What I'll do, and what I've been doing, is I've been providing them word problems. Sometimes I'll have word problems, and I'll have them do them by themselves; sometimes I'll have 'em do 'em in groups; and not have the answer already explained. Then once they've tried to work on it for a while, I'll bring the answer, so they can see what's done. Other times I'll have them come up and share their work. (Interview 14)

While able to specifically describe frequent use of student-centered instruction, transitioning teachers can identify when they struggle with student-centered instruction with certain groups of students:

> I have some students who struggle so much, but sometimes I need to modify the strategy. It's not like they can figure it out by themselves. That's still hard for me, for that type of a student, to let them try it. I still tell them, "Try to do it," but when I see that they can't—they really can't figure it out, so that's when I need to show them my strategy. (Interview 13)

Frequently, transitioning teachers continued to integrate some direct instruction in their lessons, but always allowed students to first discover solution strategies on their own:

> I will introduce a problem that we're gonna be working with and let the kids explore what they know about it, what they think that they know. Kind of play around and discover what they can about it and then we talk about it and why that we see patterns and why we can do—why we can figure it out without even knowing how to solve it yet. We start out with a lot of that and then I really go into the direct instruction and teach it to them. Then a lot of practicing and then I let them go and I walk around and monitor that they're actually on the right track. (Interview 4)

Implementing. Teachers in the implementing phase of Construct II describe student construction of mathematical knowledge as essential to children's learning and provide numerous, detailed examples of instructional practices that align with this belief. Use of student-centered instruction is consistent, providing daily opportunities for student discovery of problem solving that encourage the use of multiple problem solving strategies, rather than teacher modeled lessons. Student articulation of mathematical understanding occurs within all lessons through purposeful teacher questioning and student presentation of problem solving strategies. Teachers at the implementation level found ways to differentiate the CGI strategies for low-expectancy and primary students who could not yet write proficiently. For example, in primary grades, implementing teachers provided evidence of student interviews and student sharing, in which they asked the student to explain their problem solving technique, and then the teacher transcribed their strategy as a reflection (Figure 8).

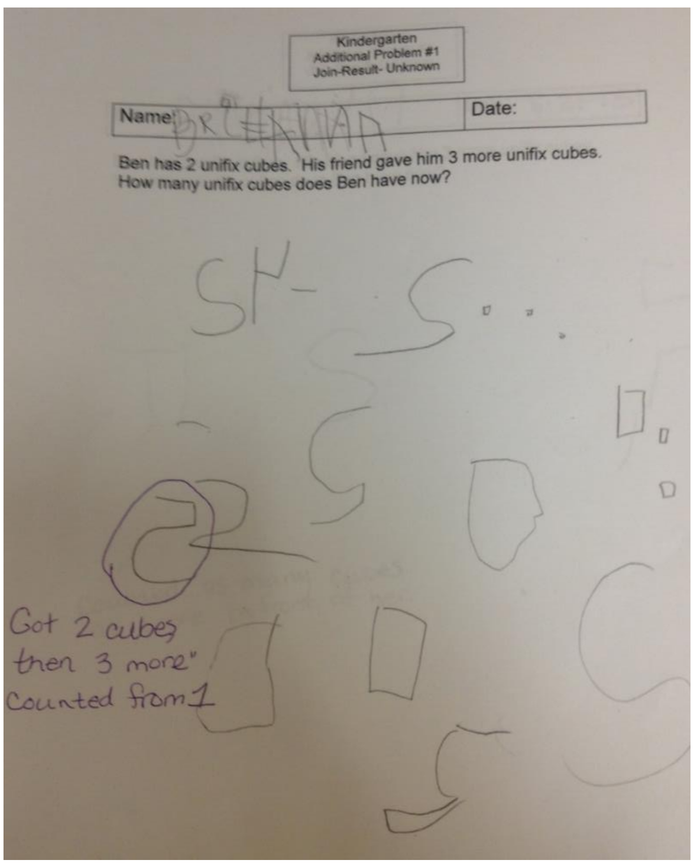

Figure 8. Teacher transcription of primary student’s strategy.

In the upper grades, the students used detailed written reflections explaining each step of their problem solving strategies and then shared these with their classmates (Figure 9).

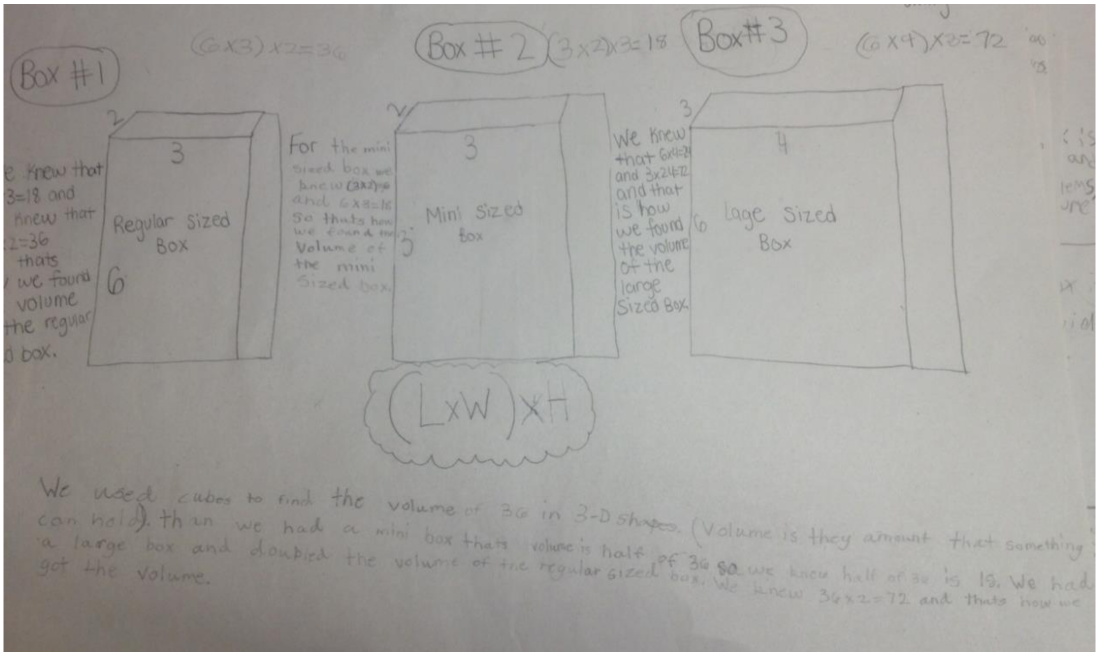

Figure 9. Upper grade reflection of problem solving strategies.

Construct III: The sequence of instruction is designed around children's mathematical knowledge. Reponses related to the third construct reflect the teachers' beliefs regarding whether children's prior knowledge should inform instructional decisions versus sequencing instruction based on resources and mathematical structures. In general, all teachers agreed that students come to school with prior knowledge and that there are differences in the prior knowledge they possess. The differences among responses typically related to instructional decisions regarding how the teacher learns about children's prior knowledge and how this information impacts instructional planning and sequencing. Words such as assessment, observation, interviews, questioning, and reflection were commonly used in these responses. Teachers also discussed the extent to which curriculum maps, pacing guides, and district adopted resources impacted their instructional planning.

Non-Practicing. Non-practicing teachers in this construct primarily discussed using district adopted textbooks and teacher resources, as well as the curriculum map when planning instructional sequencing. Typical responses included, "I followed the math program and you have to follow it consecutively" (Interview 2), "We follow the rubric (pacing guide) that's given to us by the district" (Interview 16), and "Basically go by the book, it is just kinda laid out for you, and you just kind of go in order. It basically tells you scripted how to teach it" (Interview 7). Non-practicing teachers typically did not elaborate on their use of adopted to resources and the curriculum map and pacing guides, simply stating that that is what is done.

Non-practicing teachers also lacked specific reasons for the numbers they to use in math problems, how they knew students were ready to move to more efficient problem solving strategies, and when students were ready for two- and three-digit equations, or based decisions on their adopted resources and the district pacing guide. When asked why she believed students were ready to memorize facts to become more efficient, one teacher replied: "I actually went pretty much by the curriculum this year, so when it was introduced in the map, I followed along with that" (Interview 12).

Reluctant. Teachers in the reluctant level of implementation believed it was important to find out about what their students know and agreed that students' knowledge should influence instructional sequencing, but often did not gather information about student knowledge using strategies taught in the CGI course, such as student interview and observation, even though they could cite those strategies. The difficulty reluctant teachers cited in integrating these strategies into their practice was reflected in Interview 9,

> You can't interview every child the way some of these—I'm sorry to say—pie-in-the-sky notions might be—sometimes a quiz or a little, a problem-solving half-sheet with one problem at the top, is maybe the most efficient way time wise."

Instead, these teachers relied on pen and paper assessment which may not provide evidence of student problem solving strategies, only mastery.

Reluctant teachers also described institutional pressures to use district adopted resources and pacing guides when making decisions despite knowing what their students might need. One teacher described the pressure she is under to expose students to enough concepts prior to district standardized assessments:

> The only reason that my team and I felt constrained to stick with the maps are those summatives, knowing when the kids take the summative, they'd better be up to date on the skills that they're going to be assessed on. (Interview 9).

She expressed, however, that this was probably not what was best for students' learning and that she hoped to change her practice in the future, "I think for sure next year I'm definitely going back to how I did it two years ago, because it's a horrible think to feel like, oh, now we have to move on because we're getting short of time."

Transitioning. Transitioning teachers expressed a belief that students' knowledge should inform instruction and attempt to integrate frequent formal and informal assessments, such as interviews, observations, and written reflections that guide planning and sequencing of lessons. Transitioning teachers could generally discuss strategies they have attempted that align with those presented in the CGI course, but may be less specific about how the information they gather about student knowledge informs instruction and sequencing and sometimes fall back on resources and pacing guides to make decisions.

One transitioning teacher specifically discussed her application of an informal assessment strategy:

> You can do pretests. Give little assessments, informal, just walking around looking, seeing what they can do. A lot of times I'll do stuff where I'll have different levels of problems. I'll have small problems that are easier than mid, and then complex, and then I'll let kids work at their own levels, and I just say, "Work at the ones where you feel comfortable with," and then walk around and see where they're at with that. That shows me what their level is. (Interview 14)

Despite this specific discussion of gathering information, she later describes how she sequences instruction by saying: "I just follow the curriculum guide, and planning with my partners. We stay in line with the curriculum that the district provides. That's basically it."

Transitioning teachers had difficulty describing information that tells them when students are ready to move to more efficient problem solving strategies and fluency, but believe that students should progress only once they have developed a deep understanding of the mathematical concept. When asked how she knows that students are ready to be introduced to the addition sign, one teacher states: "Because the textbook tells us to. On a more personal note, probably just because I want them to understand what it means before they just see a sign" (Interview 19). While the teacher believes in a progression of learning in which students have developed an understanding of what addition is prior to seeing the sign needed in an algorithm, she is still learning how to understand behaviors that indicate students are ready to move to more efficient strategies.

Implementing. Teachers at the Implementing level of Construct III describe the process of learning about students' knowledge to guide instruction as an essential part of planning for instruction. They specifically describe what they do to gather this information, utilizing strategies presented in the CGI course, such as interviewing and observation, and can describe how the information guides the lesson that day and future lessons. For example, one teacher describes the process of learning about the differences in what students know as a purposeful, daily practice.

> One of the things that I do in my classroom is like a math journal, so every morning, we do some—well, it's known as CGI, like word problems, or even if it's a skill or concept we're learning throughout the week, I post it up and just kind of like a review daily, so that's a little assessment for me to observe, and I can always grab a book and say, "Okay. Where is this kid, and where do I need to work on?" Then I can grab my little kiddos if they're struggling throughout a skill and pull 'em for small-group instruction, so a lot of small-group instructions, a lot of data points that I do. A lot of people are not big in data, but it doesn't have to be this big assessment and everybody sits down. It's just a quick check-in, like where are you at, and where do I need to support you. (Interview 10)

Teachers at the implementing level of Construct III cited specific behaviors and skills they look for when observing and interviewing students. When asked how she plans her lessons to meet the needs of her students, one teacher described what observation can tell her about their current knowledge:

> A lot of observation. At the beginning, especially of our multiplication unit, I let them play a lot of games. We did a lot of math fact games; do they know their facts? If they know their facts, how do they use them to solve other problems? I went around and did a lot of observation to see what they're doing; what do they say to each other? I took a lot of notes to see that and then to see what strategies they do use to show that they understand what the numbers mean, or are they just following an algorithm. (Interview 4)

Construct IV: Instruction should be designed around word problems rather than mathematical structures and algorithms. Responses that fell into the fourth construct encompassed beliefs about the use of word problems versus algorithms in instruction. In general, all teachers interviewed integrate word problems in some capacity in their lessons and believe that students should be exposed to and proficient at solving word problems. The differences in responses that defined levels at this construct were related to the teachers' knowledge of the types of word problems presented in CGI, their use of multiple problem types, their beliefs about memorization of mathematical facts, and the extent of their use of algorithms in instruction.

Non-Practicing. Teachers defined as non-practicing in the fourth construct design instructional around algorithms rather than word problems. Non-practicing teachers discussed the use of word problems in a lesson if prompted to do so by their adopted resources, but primarily use algorithms or number sentences in instruction and for independent student practice. For example, one teacher described her decision to use word problems by saying: “It’s usually based on what we’re learning at that time. Then I try to weave a word problem in with the algorithm or whatever we’re teaching” (Interview 6). Teachers at this level did not discuss specific CGI problems types, nor could they explain the importance of introducing different problems types with students when prompted. Non-practicing teachers believed that students needed to memorize specific facts before they can master a mathematical concept and spend instructional time on memorization of facts or prompt parents to drill students on facts at home.

> Well, this year, what I did is I spent the whole month of December on division, and I started with our basic facts. I gave them a test to see if what—they knew their facts already, and I had quite a few that did not, and so each day—we made a flip book for division with all of our facts on it. Each day we went over a different fact and we found our fact family with that, which also we tied into multiplication. Then they would practice that fact at home for homework. We’d come back. We’d go over it, and then move onto the next fact the next day. (Interview 5)

Another teacher discussed how essential it was for students to memorize facts before they could effectively solve problems,

> Yes, I have students memorize facts after they have had lots of practice with the understanding behind the fact. For example, I teach 5th grade. We are currently working on multiplying and dividing fractions. If they do not have their multiplication facts memorized, then these problems are painstakingly long to accomplish. We also have the standard to teach 3-digit by 3-digit multiplication.

> If they do not have their multiplication facts memorized, then these problems take up to 15 minutes to solve. (Interview 26)

Reluctant. Within the fourth construct, teachers at the reluctant level used word problems as part of instruction, but still believed practice sheets of algorithms were a significant part of mastering a mathematical concept. Typically, reluctant teachers used word problems only after the students had practiced solving the mathematical concept step by step with algorithms. Some teachers stated that presenting a problem with an algorithm would be easier for students that introducing word problems. One teacher described the visual cues of algorithms as essential for students to understand how to solve:

> Because in the level they're at right now, the word problems are not as much visual as the algorithms. The algorithms are visual. They can see the six on the board. They can see the ten. They know, in the middle, they gotta figure out how much in the middle, four. In the word problems, when you're going through and saying, like you said, "They have six toys and Madison came over with a couple more and now they have 11 altogether. How many did Madison bring?" I don't know. We haven't gone there yet. (Interview 16)

When prompted about the kinds of word problems they present in class and that students should be able to solve, reluctant teachers often replied with the words, "all kinds" or "all sorts," without citing specific types presented within the CGI course when asked to be more specific. Other teachers at this level believed that certain word problem types were too difficult for students to understand. For example, when one teacher was asked if she presented a specific problem type to her students in which one of the parts is unknown, she replied:

> We don't. That's a higher level math problem, than what I've noticed for our Common Core Standards to teach. However, with saying that, I will do that with math equations, but not so much with word problems. I'll have a math equation that we do look at, because I do like them to see that outside the box. It's not just "this plus this equals this." It's "blank equals" and to figure out that blank. We

> will do that with math equations, but we haven't really got into the word problems like that. (Interview 16)

Additionally, reluctant teachers believed that students should memorize facts in order to become fluent in a mathematical concept, even though they knew that it contradicted the beliefs presented in the CGI course. Typical responses about memorizing facts included:

> I do kind of. Without that accountability thing of at least a semi time-test, some of them and some of their parents will never take it seriously, and they will be counting on their fingers for life. I also know that sometimes memorizing doesn't equate to truly understanding. (Interview 9)

and

> Well, after they've understood, I guess, the concept of multiplication and why they're using it, then I personally think that memorizing them helps them become more fluent. I know a lot of people don't believe that, but I think that—and they get stuck, and they're counting on their fingers over and over. It hinders their process, versus just being able to recall it quickly. (Interview 6)

Significantly, reluctant teachers stress memorizing facts and fact fluency, believing students must memorize the facts before they can be successful in solving word problems or in mastery of a concept. In interview 9, the teacher reflected her belief that efficient problem solving was more important than and deep understanding of numbers by stating,

> Think of what we're expecting kids to do. I sometimes think, if you say to someone, "Well, instead of six plus nine, think of moving one from the six over to the nine to make it a ten, then you only have ten plus five. That equals fifteen." Oh, my gosh. That's so much overload. They would rather just learn six plus nine is fifteen.

Transitioning. Teachers in the transitioning level of Construct IV primarily designed math instruction around word problems, can describe the different CGI problem types, and may even discuss the integration of new types of word problems in class. For example, one teacher described her transition to using more word problems in class,

> Well, I recently took CGI class. Before then, it was pretty much based on the standards and how the standards are written, that they can put two items together.

> But now I do a lot of the story problems, most of them I make up on my own, but after taking the CGI class, that helped me build more problems for the class. (Interview 15)

Transitioning teachers have knowledge of all problems types, but may believe that some are too difficult for all students. These teachers may supplement instruction with algorithms or frequently ask students to complete algorithms for homework and practice. Transitioning teachers placed a primary focus on student construction of knowledge through word problems, but still believed requiring memorization of facts can help a student become more efficient.

Implementing. Teachers who are implementing in Construct IV design instruction around word problems and do not believe memorization is necessary or appropriate for students to learn. Teachers in this level can specifically describe CGI problem types and believe that students should be exposed to all problem types, even if some types are more difficult than others.

> Well, we do a lot of kinds of word problems. I did a class on CGI, Cognitive Guided Instruction, and word problems should have everyday things that are happening. "Suzie went to the store yesterday. She got three gummy bear bags. She wants to share 'em with her friends. How would she do that?" When there's a missing piece or part unknown, like, let's say, "We had ten pennies in your pocket, but you walked to school and you only have seven left. How many did you lose on the way to school?" Things like that, the missing piece, cuz I don't think—they have a real hard time with that. (Interview 19)

And,

> The CGI helped with that. Making sure that—a lot of the times, I see CGI teach—it's very easy to pick them out. Because they'll stop having, "Here's your information, and get the answer at the end." Instead, it's mixed and matched, where, "Here's your total, and you need to manipulate the data, the numbers within the problem, figure out the missing part," which is a struggle for students, so I am trying to do some of that. (Interview 1)

Implementing teachers not only discussed the various CGI problem types, they also stressed that it was important to expose all students to each of the different problem types.

> We do the CGI ones. I think definitely the joining problems are important. The ones with the missing add-ins. Those seem to be difficult for first graders, and I know that they do that a lot in upper grades, so I feel like that's important for them to be able to do in first grade so they are ready for it when they get into the upper grades. Because they do a lot of that in the upper grades, and especially when they go into high school and that kind of thing. If we can relate it to everyday stuff, then it's—they have a better understanding of how to solve problems in the real world. If they've got something that's a missing add in problem in the real world, then they have a better understanding of it if we've talked about it in class too. (Interview 22)

Implementing teachers do not believe that asking students to memorize facts is appropriate, rather that students develop fluency over time and that requiring students to memorize facts before they understand a concept can prevent them from having a deep understanding of mathematical processes.

> I think some naturally have a tendency to start memorizing them. I don't use a strategy of where they memorize. We use strategy of, "Can you give me combinations of five? What would be a combination of five?" Two numbers would have to equal five. That's more of the strategy we use. I wouldn't say—some of them know it right away, but I don't say, "What's one plus four and two plus three," because I don't feel like that's giving them a good idea of number sense. That's just rote memorization. (Interview 3)

Some implementing teachers cited a specific shift in perspective about memorization. When asked whether she requires students to memorize facts, one teacher responded:

> Not like I used to. I used to more, but now, no. I want them to understand. I don't want them to memorize. The conversation we had amongst teachers the other day was teaching kids when they're dividing fractions, you "Keep Switch Flip," and how I tell my kids, "You absolutely cannot use that language at all in my room. At all." Teachers were arguing whether it was a good thing or a bad thing. I absolutely don't have them memorize things anymore. (Interview 20)

Difference in Beliefs and Instructional Practices Between Blended and Face-to-Face Participants

Once the interview responses were grouped by construct, summarized for each participant, and each participant was labeled at the non-practicing, reluctant, transitioning, or implementing level for each construct, quantitative analysis of the results helped to reveal differences in implementation of CGI strategies among the blended and face-to-face participants. In summarizing the coding, each label for implementation represented a continuum of instructional belief knowledge, belief, and use. Non-practicing CGI teachers represented a lack of knowledge and use of CGI practices, reluctant CGI teachers provided evidence of knowledge about CGI practices, but a lack of belief and use, transitioning teachers represented knowledge and belief in CGI practices, but used a combination of CGI and traditional instructional practices, and implementing teachers demonstrated comprehensive knowledge and beliefs about CGI strategies and provided consistent and specific use of CGI strategies in their instruction. The quantitative analysis of these levels allowed for comparisons to be made between the blended and face-to-face participants.

Of the 26 participants interviewed, 10 completed the blended course, and 16 completed the face-to-face course. This convenience sample represented 50 percent of the course completers from each section of the course. The demographics of the interview participants were similar in age, years of total teaching experience, and years of teaching experience within the district to the total population of course completers within their section (Tables 21 through 24). Additionally, there were no statistically significant differences in age, years of district experience, or years of total teaching experience between the participants interviewed from blended course and the face-to-face course (age, p=0.086; years of total experience, p=0.994; years of district experience, p=0.781)

Table 21

Demographics of Blended Participants (Completers Versus Interview Participants)

	Course Completers n = 20	Interview Participants n= 10
Age		
Mean	42.90	40.40
Standard Deviation	11.72	10.31
Years of Total Teaching Experience		
Mean	6.15	4.60
Standard Deviation	4.83	4.25
Years of District Experience		
Mean	4.70	3.20
Standard Deviation	5.01	3.16

Table 22

Demographics of Face-to-Face Particpants (Completers Versus Interview Participants)

	Course Completers n = 31	Interview Participants n= 16
Age		
Mean	35.58	33.63
Standard Deviation	11.09	8.79
Years of Total Teaching Experience		
Mean	6.61	4.94
Standard Deviation	6.02	4.65
Years of District Experience		
Mean	5.13	3.06
Standard Deviation	6.12	4.65

Table 23

Demographics of Interview Participants (Blended Versus Face-to-Face)

	Blended n = 10	Face-to-Face n = 16	Total n = 26
Age			
Mean	40.40	33.63	36.23
Standard Deviation	10.31	8.79	9.80
Years of Total Teaching Experience			
Mean	4.60	4.94	4.81
Standard Deviation	4.25	4.65	4.42
Years of District Experience			
Mean	3.20	3.06	3.12
Standard Deviation	3.16	4.65	4.07

Table 24

Demographics of Interview Participants

Interview Number	Environment	Years of District Experience	Years of Teaching Experience	Age
1	Blended	1	5	32
2	Blended	5	8	53
3	Face-to-Face	5	5	38
4	Face-to-Face	1	1	23
5	Face-to-Face	1	1	23
6	Blended	7	8	31
7	Face-to-Face	1	5	31
8	Face-to-Face	2	5	42
9	Blended	10	14	52
10	Face-to-Face	2	6	31
11	Face-to-Face	1	4	26
12	Blended	1	1	49
13	Face-to-Face	1	3	33
14	Face-to-Face	1	1	36
15	Blended	3	3	45
16	Blended	2	2	42
17	Face-to-Face	1	5	46
18	Face-to-Face	1	4	30
19	Face-to-Face	2	5	47
20	Face-to-Face	1	1	26
21	Face-to-Face	1	1	24
22	Face-to-Face	8	12	32
23	Blended	1	3	46
24	Blended	2	2	24
25	Blended	2	2	30
26	Face-to-Face	19	19	50

Participants demonstrating low levels of implementation and high levels of implementation existed in both the blended and face-to-face courses For example, face-to- face participants responded at each of the four implementation levels of Construct I. Blended participants responded at all four levels of implementation of Construct III. These patterns indicate that regardless of course environment, the participants' responses about instruction represented a range of beliefs

In spite of this range within courses, in general, a greater percentage of face-to-face participants' interviews provided evidence of higher levels of implementation of CGI strategies than blended participants (Table 25) within each of the four CGI constructs. For example, 75% of the face-to-face participants responded in the transitioning or implementing level of Construct II, designing instruction for student construction of knowledge versus the teacher's presentation of knowledge. In this construct, only 30% of blended participants responded at the transitioning or implementing level and 70% were categorized as non-practicing or reluctant.

Table 25

Comparison of Implementation Levels (Blended Versus Face-to-Face)

	Non-Practicing	Reluctant	Transitioning	Implementing
Construct I				
Blended	20.0%	50.0%	30.0%	0%
Face-to-face	6.3%	31.3%	25.0%	37.5%
Construct II				
Blended	20.0%	50.0%	30.0%	0%
Face-to-face	0%	25.0%	25.0%	50.0%
Construct III				
Blended	30.0%	30.0%	30.0%	10.0%
Face-to-face	0%	0%	37.5%	62.5%
Construct IV				
Blended	0%	60.0%	20.0%	20.0%
Face-to-face	6.3%	6.3%	31.3%	56.3%

Note: Construct I: Students construct knowledge versus receive it.
Construct II: Instruction should be student-centered and constructivist versus teacher-centered
Construct III: Student knowledge should guide instructional sequencing
Construct IV: Instruction should be designed around solving word problems rather than algorithms and mathematical structure.

Several patterns existed within constructs that indicate differences in outcomes between blended and face-to-face. First, while 50% of face-to-face participants were categorized as implementing in Construct I, signifying a belief that students construct mathematical knowledge rather than receive it from the teacher, 0% percent of blended participants were categorized as implementing and only 30% percent were categorized as transitioning, indicating that blended participants held a more teacher-centered belief. A similar pattern is evident in Construct II, in which the levels of non-practicing and reluctant represent teacher-centered instructional practices, and the levels of transitioning and implementing represent student-centered instructional practices. Again, 50% of face-to-face participants were categorized as implementing, demonstrating knowledge and stated beliefs in student-centered instruction as well as primarily designing instruction for students' construction of knowledge. Zero percent of blended participants, however, were categorized as implementing.

Conversely, an absence of face-to-face participants categorized at low levels of implementation existed within constructs. Within construct III, zero percent of face-to-face participants were categorized as non-practicing or reluctant, indicating that all face-to-face participants retained knowledge and instructional beliefs that students' knowledge should guide mathematical sequencing and could show evidence of this practice in their classroom.

Finally, as compared to the face-to-face section, the blended section had a greater percentage of participants characterized as reluctant in all four constructs. The reluctant level was defined by teachers referencing knowledge, beliefs, or instructional strategies from the CGI course, but stating that they chose not to or could not use them in their classroom. The higher percentage of blended than face-to-face participants in the reluctant level indicates that, while knowledge from the CGI course was retained, it did not impact their instructional practice as it did for face-to-face participants.

By using a comparison of means and an analysis of variance, this difference in implementation levels among groups appears to be statistically significant for all four of the CGI constructs. In order to eliminate a relationship between age, years of total teaching experience, or years of teaching experience and levels of implementation, the demographics of non-practicing and reluctant participants were compared to those of transitioning and implementing participants within each construct. No significant difference existed between the ages, the years of total teaching experience, or the years of district teaching experience of non-practicing and reluctant teachers versus transitioning and implementing teachers, indicating that the difference was more likely a result of environment.

Differences in Response to Instructional Barriers

The discrepancy in the percentage of participants labeled as reluctant between the blended and face-to-face sections revealed the additional theme of response to instructional barriers. The last question in each interview asked the participants to identify any barriers that prevented them from providing instruction in the way they believed was best for students. Three of the ten blended interview participants and two of the 16 face-to-face participants reported that there were no barriers to instruction. The remaining participants identified barriers such as limited time for instruction and planning, lack of resources, unsuitable curriculum pacing guides, and students' lack of prior knowledge. Once these responses were analyzed, several patterns emerged.

First, a greater number of blended participants identified students' lack of prior knowledge as a barrier to instruction. Specifically, five of the eight blended participants who identified barriers to instruction cited students' lack of prior knowledge as a primary reason that they could not instruct as they would like to, as compared with only one face-to-face participant citing students' prior knowledge as a barrier.

Some participants who identified a barrier to or challenge in instruction stated that this impacted their ability to instruct children in the way they wish. For example, in interview 23, the participant discussed the negative impact district curriculum pacing guides had on student learning,

> One barrier that I feel is the resources that we have. We are constantly trying to make something work that simply doesn't. I also feel that common core standards have massive gaps that must be taught. Since it skips important steps in the learning process, students are being left confused and frustrated.

She could not see ways to adapt of modify the pacing guides and maps to meet the needs of her students, while still achieving the curriculum objectives for the year. One teacher described the student-centered instruction and the lack of instruction about algorithms taught in the CGI course as detrimental and a barrier to student learning:

> I don't necessarily agree with all the new ways of teaching the addition, subtraction, algorithms, and I really think there's lots of gaps because of that. I've noticed in my class—I mean, they still struggle even this year with working on the strategies to add and subtract, using a number line. A lot of 'em still struggle to add and subtract, and I find that that's really sad for the end of third grade, because they're not being taught the algorithm. (Interview 6)

The lack of ability to overcome challenges in instruction, as well as the lack of use of CGI strategies, often resulted in an implementation score of "reluctant." Conversely, other participants identified the challenges but were able to provide specific strategies that helped them overcome the challenges. These participants were also more likely to cite the use of CGI strategies in their instruction and therefore be characterized as transitioning or implementing. For example, in Interview 3, the teacher described her ability to adapt the curriculum map and use of resources in a way that met the needs of her students:

> Following Curriculum Pacing Guide I mean, there are things that you have to follow obviously with the curriculum map, so sometimes maybe you feel like

> you're not doing something that you'd like to do—but that's your professional judgment to supplement. I've supplemented throughout the year with different things that I've found but still stuck to the curriculum. It's just adding a little bit more. I don't think that it prevents me from teaching the way that I want to. I enjoy being able to have my kids be little investigators in there and create their own sense of understanding with it. I don't feel hindered by it.

Another teacher described responding to challenges as part of her job and that these challenges only create barriers to instruction if she allows it:

> Well, I think everybody would like for every student to come in and sit down and be excited about learning. Their day would just go really easily, but that's not life. Are there barriers? Well, maybe, but it doesn't keep me from doing my job. I'm taking whatever struggles or barriers, maybe, and using that as a way to help my students learn even more. It's a challenge for me, but it's one that I'm accepting and I'm happy to do. (Interview 22)

While 14 of the blended participants identified challenges in instruction, 9 of these participants provided solutions that helped them overcome the challenges so that they did not become barriers to instruction. Of the seven blended interview participants who discussed challenges in instruction, only one was able to identify solutions that helped them overcome the barrier. These differences suggest that the blended section of the course did not encourage the discovery of strategies to help overcome classroom challenges in the same way that the face-to-face section did.

Conclusion

In this chapter, the results of data collection were presented. First, the population of the study was described, comparing participant characteristics such as age, years of total teaching experience, years of teaching experience within the district, and experience with online learning environments. Retention rates were then compared between the blended and face-to-face course sections, further examining the relationships between course withdrawal and participant characteristics such as age, years of experience, and experience in online environments. Third, participant satisfaction of course completers was compared between the blended and face to face course sections, examining satisfaction with course content, learner-learner interaction, learner instructor interaction, and learner technology interaction. Next, responses to instructional pre- and post- surveys and changes in beliefs from the beginning to the end of the course were analyzed to determine differences between the blended and face-to-face course sections. Finally, the responses from instructional belief and practice interviews held twelve weeks after course completion were coded and analyzed to illuminate differences in retention of beliefs and knowledge, and application of instructional practices between the blended and face-to-face participants. In the following chapter, the study is summarized, the implications of the results are discussed, and recommendations for practice and future research are presented.

CHAPTER 5

Summary, Recommendations, and Implications

Chapter 5 provides a summary of the study, including a discussion of the implications of the results, acknowledgment of the limitations of the study, and recommendations for future practice and research. The initial summary presents a brief overview of the first three chapters including a restatement of the problem and themes from relevant existing literature and the methodology of the study. The remainder of the chapter discusses the results of the study, their implications on practice, and recommendations for practice and future research.

Summary of the Study

While teacher quality and accountability are not new concerns, recent legislation prompting new teacher evaluation standards and the adoption of a common curriculum underscore a continued need for highly effective and well-trained teachers (The White House, 2009; ADE, 2011). In their desire to increase student learning and achievement, both administrators and teachers will likely continue to value effective professional development that is efficient and effective.

The expansion of blended course environments may have the capacity to transform the way in which teachers engage in professional development. The allure of blended professional development courses may include multiple perceived benefits, including increased flexibility in the completion of course requirements and a decreased impact on personal time and time away from instructing students. For school and district leaders, blended learning may hold the promise of reaching a greater number of teachers and reducing costs associated with classroom release time. However, teacher professional development should not only be designed to be convenient for teachers, possibly contributing to in high levels of participant satisfaction, it should also be delivered to effectively elicit desired outcomes of professional development, including increased teacher content knowledge, the adoption of new instructional strategies, and ideally, the potential for a positive impact on student learning and achievement.

In the literature review, I discuss the relevant existing literature regarding teacher professional development and blended learning, highlighting significant themes. First, understanding and evaluating teacher professional development is complex. Though many platforms for professional development exist, such as workshops, conferences, professional learning communities, mentoring, and in-service training during meetings, not one is identified as having greater outcomes. Instead, specific characteristics of professional development that could exist in a variety of platforms have been identified, including duration, relevancy to content area, the inclusion of active learning strategies, collaboration, and alignment to institutional goals. What defines impact or positive outcomes may be viewed as equally complex. While the use of surveys assessing professional development participant satisfaction or perception of learning may be seen as convenient, Guskey (2000) argues that additional outcomes, including knowledge, change in practice, organizational support, and student learning should be included in professional development evaluation to gain a true understanding of professional development efficacy.

The purpose of this study was to compare the outcomes of professional development between blended and face-to-face courses as measured by course retention, participant satisfaction, change in instructional beliefs, and impact on retained beliefs and instructional practices. This study attempted to control for inconsistencies common in other related research, eliminating differences in course content, course materials and resources, time spent in the course, and instructors.

The mixed-method study relied on the use of survey data, interviews, and the analysis of classroom artifacts to increase understanding of the outcomes of blended and face-to-face professional development. A total of 64 participants enrolled in blended and face-to-face sections of professional development for Cognitively Guided Instruction; 32 enrolled in the blended section and 32 enrolled in face-to-face. Participants self-selected the environment based on preference. Each participant completed a pre-course survey that included 48 items used to learn about their instructional beliefs surrounding math. The pre-survey included additional items to learn about their reason for selecting the course environment in which they enrolled and their previous experience in online or blended environments. Of the 64 participants, 20 blended participants and 31 face-to-face participants completed the 14 week course. Seven of the 13 non-completers were interviewed to understand the reasons for course withdrawal. Upon course completion, the participants completed a post-course survey that reassessed their instructional beliefs surrounding mathematics as well as additional items regarding participant satisfaction.

Ten of 20 blended and 16 of the 32 face-to-face course completers agreed to participate in an interview about their instructional practices 3 months following completion of the course. During interviews, participants were asked to describe their instructional practices in math and discuss their reasons for using such practices. When possible, classroom artifacts in the form of student work samples were collected to support the participants' responses.

Implications of the Results and Conclusions

Retention

Research Question 1 compares the differences in course completion between blended and face-to-face professional development courses, and compares the catalysts for course withdrawal. Findings from this study align with previous research in blended and online learning that has indicated that attrition can be higher in blended environments (Cavanaugh, Gillan, Kromrey, Hess, & Blomeyer, 2004; Rabe- Hemp, Woollen, & Humiston, 2009; Rovai & Jordan, 2004). Existing research in blended learning has indicated that increased attrition may be related to either challenges related to a lack of connection participants have with the course content, other classmates, or the course instructor (Oh & Lim, 2005; Rabe- Hemp, Woollen, & Humiston, 2009; Rovai & Jordan, 2004). Rovai and Jordan (2004) reported that some teachers believe the flexibility of blended environments led to their successful completion of professional development that they could not have achieved in a traditional face-to-face course. Conversely, the findings of this research suggest teachers are less likely to be successful completing a blended course, that time may be a significant and primary factor in course withdrawal, and that the flexibility in when participants are able to complete course requirements may result in falling behind in the course. Lower completion rates in the blended course and the increased likelihood that older, more experienced teachers may withdraw from blended courses, may suggest that these blended environments are not the best fit for all teachers. The results also demonstrate that despite the inability to complete a blended course, participants may continue to prefer blended courses, or express an interest in blended courses in the future.

Increased attrition in blended courses may have important implications for both teachers and educational leaders. First, teachers should recognize that blended courses may be more or equally difficult to manage and complete if they are concerned about conflicting commitments. It is possible that differences in retention rates may be a function of a participant's difficulty to allocate time to complete course requirements, or it may be that the type of person who enrolls in a blended course is inherently busier than one who selects a face-to-face section. Regardless, decreased completion compared to face-to-face courses may suggest that the anytime, anyplace benefit of blended learning allows regular and consistent course participation to be deprioritized in favor of family and professional obligations.

Schools and districts cannot necessarily assume that providing blended learning professional development will reach more teachers or result in financial savings if completion rates are considerably lower than face-to face courses. Considering the increased attrition rates for more experienced teachers, districts and schools also may need to consider the demographics of their teachers when designing courses and provide traditional courses for teachers as an option.

Participant Satisfaction

Research Question 2 compared participant satisfaction between the blended and face-to-face sections of the professional development course. The results of the participant satisfaction survey revealed that blended participants were equally or more satisfied with several aspects of the course as compared to their face-to-face counterparts.

Despite a focus on the same course content, the use of the same course resources, and being taught by the same instructors, blended participants expressed greater satisfaction in these three areas than face-to-face participants. Additionally, the blended participants were generally more satisfied with the course and how it met their learning needs. In spite of this, only 65% of blended course completers believed that the blended environment offered an equal learning experience as face-to-face courses. The results of this study are consistent with the high levels of participants satisfaction found by Owston, Wideman, Murphy, and Lupshenyuk (2008); however they provide more specific information regarding satisfaction with particular components of the course and provide a comparison between blended and face-to-face satisfaction. Unlike the findings of Owston et al., whose teachers reported dissatisfaction with online components of their blended course such as the online journals, participants in this study reported being more satisfied with course materials, activities, and assignments as compared to the face-to-face participants.

These results may hold additional significance when considered in the context of the reasons for course environment selection among blended participants. In the initial pre-survey, all participants were asked why they had chosen to enroll in the course that they did. While face-to-face participants primarily cited reasons related to a perception of superior learning in face-to-face environments compared to blended environments, blended participants primary stated that they choose the course because of the flexibility it offered. Several participants stated that they preferred the flexibility of being able to participate at anytime and anywhere, while others stated that they needed the flexibility due to other obligations. Those who stated they needed the flexibility often stated that they were unable to participate in traditional, face-to-face professional development courses. It is possible that the perceived benefits of flexibility may result in greater course satisfaction even if participants do not believe that blended environments promote equal learning outcomes.

Impact on Instructional Beliefs

The third research question compared changes in belief about mathematical instruction between blended and face-to-face participants. The Cognitively Guided Instruction course encourages a student-centered classroom in which constructivist principles are applied, student knowledge is gathered through interviews and observation, and this information is then used to guide instructional planning. Rather than promoting memorization and use of algorithms, teachers are encouraged to use word problems in instruction, and students are believed to develop efficiently and fluency naturally over time. These principles may belie a teacher's existing beliefs about children's learning, therefore a course cannot be effective in impacting instruction unless it first impacts a teacher's instructional beliefs. As indicated by the results of the instructional belief surveys presented in Chapter 4, the blended and face-to-face course participants demonstrated a similar change in instructional beliefs throughout the course and similar adoption of CGI beliefs by the end of the course. From these results, it can be concluded that both blended and face-to-face professional development courses can influence instructional beliefs equally.

Retention of Instructional Beliefs and Impact on Instructional Practice

Perhaps one of the most significant outcomes of this study addresses Research Question 4, comparing the retention of knowledge and beliefs and their impact on classroom practices. The previous research on the relationship between changes in instructional beliefs and knowledge on instructional practice suggests that the adoption of constructivist beliefs following professional development typically results in the application of these instructional practices in the classroom (Schifter & Fosnot 1993; Schifter & Simon, 1992; Carpenter et al., 1989; Fennema et al., 1996).

The results of this study, however, indicate that changes in instructional beliefs may not always precipitate changes in instructional practice and that participation in blended professional development may be associated with less retention of beliefs over time and less significant impacts on instruction. Despite greater participant satisfaction in the blended course, no significant difference in post course survey scores, and similar change in instructional beliefs between the two courses, marked differences existed in the retention of CGI beliefs and use of CGI strategies between blended and face-to-face participants three months after course completion. Blended participants not only reported lower levels of implementation, they also were more likely to be considered reluctant in their implementation, identifying barriers to the implementation of CGI, or doubts about its benefits to student learning. In the case of these reluctant learners, it was not that they did not retain specific knowledge learned in the course, they simply could not, or did not, enact these strategies. Participants who did not apply CGI strategies in their classroom cited a lack of instructional time, insufficient resources, low levels of student prior knowledge, and student behavior as barriers to use of instructional practices, yet many of the face-to-face participants recognized similar challenges and provided strategies to overcome them.

This "problem with enactment," described by Kennedy (1999), occurs when teachers have learned and can discuss a specific pedagogy or instructional practice, but cannot implement the strategies in the context of a classroom. Kennedy argues that it is impossible for teachers to apply intellectual understanding of pedagogy or theory to practice without a sufficient understanding of the potential challenges presented by specific students, strategies to handle difficult classroom situations, and the ability to envision the use of new strategies within the realities of their classroom.

The specific responses from blended participants describing CGI strategies as “pie-in-the-sky notions” or as ineffective and impossible with certain populations of students suggest that Kennedy’s problem of enactment is more likely after participation in the blended format of the CGI professional development. Face-to-face participants were more likely to cite barriers to instruction, but provided strategies that allowed them to overcome the challenges and integrate cognitively guided instruction. Greater reluctance to adopt CGI beliefs or implement strategies on the part of the blended participants could indicate that the blended courses may provide knowledge about instructional pedagogies and strategies, but do not influence teachers to internalize new instructional beliefs in the same way face-to-face courses do. The results may suggest that while blended courses provided adequate exposure to new pedagogy and beliefs, they may not expose teachers to the potential challenges that can occur when implementing new strategies, nor do they provide sufficient opportunity for teachers to discuss strategies to overcome barriers to instruction. In this study, the course materials and resources, instructors, assignments, and duration were identical. However, the once difference existed in the way in which participants interacted in five of the class sessions. The face-to-face participants had the opportunity to engage in discussion with all class members, while blended participants engaged in discussion via discussion boards in the online environment. This may have restricted dialogue about potential challenges in implementation and subsequent discussion of possible solutions. The nature of communication and collaboration in blended courses may not provide teachers with the support needed to overcome the challenges of implementing new instructional strategies or determining how they apply in the context of their school.

These findings help build upon the results of Owston et al. (2008) in which teachers reported inconsistent levels of confidence when asked if they would be able to implement new instructional strategies learned in blended professional development. While these researcher attributed low levels of confidence to low levels of mathematical content knowledge, the results of this study suggest that teachers in blended environments may not have the opportunities to learn sufficient strategies to overcome challenges and transfer course knowledge and beliefs into classroom practice. In addition, while Owston et al. (2008) argued that the change in pre and post course surveys that indicated a shift towards constructivist instructional beliefs, this study suggests that changes in instructional beliefs do not necessarily result in changes in instructional practices.

Limitations

There are several limitations to the study which should be considered when generalizing the findings to other populations.

First, the number of teachers participating in this study, while consistent with other studies in the area of blended professional development, is low. Caution should be taken in interpreting the statistical significance of the quantitative results. While this study showed no significant difference between the blended and face-to-face participants' change in instructional beliefs, it is possible that a larger population would yield statistically significant differences showing greater consistency with measures of classroom instructional practices.

Second, the sample for this study included teachers who had a great deal of choice in participating in the professional development course. The teachers were not required by the district to take a CGI course and selected the blended or face-to-face environment based on their preference, as described in Chapter 4. The degree to which teachers adopted CGI instructional beliefs and transferred the instructional practices into practice could be impacted if the teacher did not have a choice in engaging in a professional development course. Each of the teachers selected the CGI course from a myriad of district professional development offerings. Therefore, if the subject of the course is not one that the teacher feels forced to participate in due to institutional pressure, they may experience a different level of course satisfaction and may be more or less likely to adopt belief systems and implement instructional strategies. Additionally, if the teacher has only the option of a blended course, they may be more or less satisfied or more or less likely to adopt instructional beliefs and practices as compared to the teachers in this study. While choice of environment could have impacted the outcomes of the study, care was taken to account for any differences between the blended and face-to-face courses. A similar number of participants began each section, and each section included teachers of comparable ages and years of teaching experience. As measured by the instructional belief survey, the teachers began the course with similar attitudes and beliefs about mathematical instruction. Finally, although interviews were coded utilizing multiple coding cycles and informed by previous research in the implementation of instructional strategies, the use of multiple coders for inter-relater reliability or member checking, would have increased the reliability and validity of the results.

Recommendations

Recommendations for Practice

While the anytime, anywhere benefit of blended courses may assist teachers who have specific scheduling conflicts with face-to-face courses, the flexibility alone may not be enough for teachers who are simply busy and believe blended courses will be easier to complete. Teachers should view the online portion of blended course as sessions and allocate specific and consistent time in their schedule to complete course requirements. Since collaboration with colleagues is associated with effective professional development ((Borko, 2004; Darling-Hammond, Wei, Andee, Richardson, & Orphanos, 2009; Desimone, 2009; Garet, Porter, Desimone, Birman, & Suk Yoon, 2001; Putnam & Borko, 1997; Wilson & Berne, 1999), it may be beneficial for teachers to sign up for blended courses with other teachers at their schools site so they can profit from their support. Teachers participating in blended professional development should attempt to identify potential barriers to implementing new strategies that may result from institutional structures and pressures and availability of resources, then voice any concerns to instructors and fellow classmates that that strategies to overcome barriers can be identified.

Instructors of blended professional development should seek training on engagement strategies specific to online learning to promote consistent and continuous participant engagement throughout the course. Additional support should be provided in the course to help teachers be successful in the implementation of new instructional strategies. Therefore instructors should attempt to identify institutional pressures, resources, and outside initiatives that may be incongruous with the goals of the course and provide teachers with the opportunity to discuss strategies to overcome these challenges. The use of discussion boards, online resource repositories, and follow-up support from instructional mentors or coaches may help participants overcome challenges in implementation.

The outcomes of this study should also inform districts about their professional development practices and how to best invest fiscal and human resources to yield the greatest outcomes. Most significantly, districts must look beyond traditional measurements of professional development outcomes, focusing on evaluations that assess the use of new instructional practices following professional development. Districts should also consider the characteristics of teachers participating in professional development. Retention rates within this study demonstrate that teacher with more teaching experience were less likely to complete blended courses. These teachers may benefit from the option of face-to-face professional development courses. When allocating resources for professional development, districts should recognize the potential for high attrition in blended courses and may need to accept that they may not impact as many teachers as they wish, even if there is a high level of interest in blended formats.

Recommendations for Future Research

While there appears to be an increase in the popularity of and faith in blended learning environments, there is inadequate research in the area of blended teacher professional development. Those studies that do exist examine limited outcomes of participation. This study begins to provide meaningful evidence of instructional outcomes, but it also confirms the need to more rigorously examine blended professional development.

While linking professional development to student outcomes such as achievement can be difficult, the increase in accountability across the country may provide additional achievement and teacher quality to researchers. Many states, including Arizona, have adopted new teacher quality evaluation tools to collect more consistent data about specific instructional practices. The data these evaluation frameworks provide about specific classroom practices may be compared with professional development participation to determine which environments have the most significant impact in the classroom and on student achievement (The White House, 2009; ADE, 2011). In states such as Arkansas, which have recently adopted professional development frameworks that include an online component, it may become easier to conduct large scale studies that examine the relationships between participation in certain types of professional development on long term teacher quality indicators or student achievement.

Future research may attempt to understand the reasons for differences in the retention of beliefs and enactment between blended and face-to-face participants. Since collaboration has been identified as an important component in professional development, researchers may learn from examining the interactions that occur in blended courses. Do instructional practices in blended courses, such as online discussion board requirements, inadequately replicate the interactions of face-to-face courses and limit the perspectives of participants? Could this preclude transfer of pedagogical knowledge and new beliefs into classroom practice? Researchers should investigate the ways in which discussions about barriers to instruction occur organically in face-to-face courses as compared to discussion boards of blended courses to determine the exposure all participants have to identifying challenges and solutions when implementing new instructional strategies.

Summary and Reflections

Over the last two years in which this study was conducted, schools across the country have grappled with the adoption and implementation of common curriculum standards, increased accountability and more rigorous standardized assessments, and pressures to provide evidence of high-quality and effective teaching. Districts, schools, and individual educators will understandably thirst for strategies that result in successful and high-achieving students.

This study comparing the outcomes of blended professional development to a traditional face-to-face model extends the current understanding of blended professional development effectiveness, providing additional knowledge about reasons for course attrition, differences in course satisfaction, and, most importantly, the impact on subsequent classroom instruction. While the impact on instruction is perhaps one of the significant outcomes of professional development for its propensity to affect student learning, classroom instruction following professional development has been largely unexamined in previous research. The outcomes of the study indicate that blended environments may result in high levels of participant satisfaction and changes in instructional beliefs and knowledge equal to face-to-face professional development, blended environments may yield lower completion rates and less of an impact of classroom practice. The results of this study can help inform districts on best practices for professional development and provide guidance regarding the potential challenges and limitation of blended learning environments, ensuring the most efficient use of time and resources. Additionally, they underscore the need for rigorous evaluation of professional development outcomes, and that measures of professional development success typically employed by districts, such as participant satisfaction surveys, are inadequate, painting an incomplete picture of course efficacy.

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APPENDIX A

LETTER OF CONSENT FOR INTERVIEW PARTICIPANTS

Dear Teacher:

I am a graduate student under the direction of Dr. David Garcia in the Mary Lou Fulton Teachers College at Arizona State University. I am conducting a research study to analyze the relationship between teacher professional development and instructional practices.

I am inviting your participation, which will involve one interview taking place in April. The interviews are scripted, and will last between 25 and 45 minutes. You have the right not to answer any question, and to stop the interview at any time.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty; your participation will not have any bearing on your evaluation, and your evaluator will not see the results of interviews or observation.

Your participation in this study will benefit not only your school and school district, but also the field of education by providing school and district leaders with new knowledge about the impact of professional development on classroom instruction. There are no foreseeable risks or discomforts to your participation.

Your responses will be anonymous; you will never be identified by name to anyone. The results of this study may be used in reports, presentations, or publications but your name will not ever be used. Interview and observation data will be coded to protect your identity.

I would like to audiotape this interview. The interview will not be recorded without your permission. Please let me know if you do not want the interview to be taped; you also can change your mind after the interview starts, just let me know. The interviews will be recorded digitally, and stored on my computer and dropbox account for a minimum of 5 years.

If you have any questions concerning the research study, please contact me at 602-326-5684, or by email at stephleake@gmail.com. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788. Please let me know if you wish to be part of the study.

Thank you for your consideration,

Stephanie Leake

APPENDIX B

MATHEMATICAL BELIEF SURVEY PRE-SURVEY

* Please enter the number assigned to you by your instructor.
Note: the number will not be used to identify the respondent.

This survey consists of a series of statements. As you read each statement, you will know whether you agree or disagree with it. Please indicate your level of agreement with each statement on a scale of "Strongly Agree" to "Strongly Disagree." If you are not sure, mark "Undecided."

Do not spend much time with any statement, but be sure to answer every statement. Work fast but carefully. There are no "right" or "wrong" answers. The only correct responses are those that reflect what you believe to be true. Be sure to respond to each item in a way that reflects your beliefs.

This information will be used to understand the impact of this professional development. Your responses will remain confidential. Thank you for your time.

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. Children should solve word problems before they master computational procedures.	○	○	○	○	○
2. Teachers should encourage children to find their own solutions to math problems even if they are inefficient.	○	○	○	○	○
3. Children should understand computational procedures before they spend much time practicing them.	○	○	○	○	○
4. Time should be spent solving simple word problems before children spend much time practicing computational procedures.	○	○	○	○	○
5. Teachers should teach exact procedures for solving word problems.	○	○	○	○	○
6. Children should understand the meaning of an operation (addition, subtraction, multiplication, or division) before they memorize number facts.	○	○	○	○	○
7. The teacher should demonstrate how to solve simple word problems before children are allowed to solve word problems.	○	○	○	○	○
8. The use of key words is an effective way for children to solve word problems.	○	○	○	○	○
9. Mathematics should be presented to children in such a way that they can discover relationships for themselves.	○	○	○	○	○
10. Even children who have not learned basic facts can have effective methods for solving problems.	○	○	○	○	○
11. It is important for a child to be a good listener in order to learn how to do mathematics.	○	○	○	○	○
12. Most young children can figure out a way to solve simple word problems.	○	○	○	○	○

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
13. Children should have many informal experiences solving simple word problems before they are expected to memorize number facts.					
14. An effective teacher demonstrates the right way to do a word problem.					
15. Children should be told to solve problems the way the teacher has taught them.					
16. Most young children have to be shown how to solve simple word problems.					
17. Children's written answers to paper-and-pencil mathematical problems indicate their level of understanding.					
18. The best way to teach problem solving is to show children how to solve one kind of problem at a time.					
19. It is better to provide a variety of word problems for children to solve.					
20. Children learn math best by figuring out for themselves the ways to find answers to simple word problems.					
21. Children usually can figure out for themselves how to solve simple word problems.					
22. Recall of number facts should precede the development of an understanding of the related operation (addition, subtraction, multiplication, or division).					
23. Children will not understand an operation (addition, subtraction, multiplication, or division) until they have mastered some of the relevant number facts.					
24. Most children cannot figure math out for themselves and must be explicitly taught.					

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
25. Children should understand computational procedures before they master them.					
26. Children learn math best by attending to the teacher's explanations.					
27. It is important for a child to discover how to solve simple word problems for him/herself.					
28. Children should be allowed to invent ways to solve simple word problems before the teacher demonstrates how to solve them.					
29. Time should be spent practicing computational procedures before children are expected to understand the procedures.					
30. The goals of instruction in mathematics are best achieved when students find their own methods for solving problems.					
31. Allowing children to discuss their thinking helps them to make sense of mathematics.					
32. Teachers should allow children who are having difficulty solving a word problem to continue to try to find a solution					
33. Children can figure out ways to solve many math problems without formal instruction.					
34. Teachers should tell children who are having difficulty solving a word problem how to solve the problem.					
35. Frequent drills on the basic facts are essential in order for children to learn them.					
36. Most young children can figure out a way to solve many mathematics problems without adult help.					

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
37. Teachers should allow children to figure out their own ways to solve simple word problems.					
38. It is better to teach children how to solve one kind of word problem at a time.					
39. Children should not solve simple word problems until they have mastered some number facts.					
40. Children's explanations of their solutions to problems are good indicators of their mathematics learning.					
41. Given appropriate materials, children can create meaningful procedures for computation.					
42. Time should be spent practicing computational procedures before children spend much time solving problems.					
43. Teachers should facilitate children's inventions of ways to solve simple word problems.					
44. It is important for a child to know how to follow directions to be a good problem solver.					
45. To be successful in mathematics, a child must be a good listener.					
46. Children need explicit instruction on how to solve word problems.					
47. Children should master computational procedures before they are expected to understand how those procedures work.					
48. Children learn mathematics best from teachers' demonstrations and explanation.					

Thank you very much for completing this survey. Please click on the DONE button to submit your responses.

APPENDIX C

MATHEMATICAL BELIEF AND COURSE SATISFACTION:

FACE-TO-FACE BELIEF POST-COURSE SURVEY

*Please enter the number assigned to you by your instructor.
Note: the number will not be used to identify the respondent.

There are two parts to this survey. The first part consists of a series of statements and as you read each statement, you will know whether you agree or disagree with it. Please indicate your level of agreement with each statement on a scale of "Strongly Agree" to "Strongly Disagree." If you are not sure, mark "Undecided."

Do not spend much time with any statement, but be sure to answer every statement. Work fast but carefully. There are no "right" or "wrong" answers. The only correct responses are those that reflect what you believe to be true. Be sure to respond to each item in a way that reflects your beliefs.

This information will be used to understand the impact of this professional development. Your responses will remain confidential.

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. Children should solve word problems before they master computational procedures.	○	○	○	○	○
2. Teachers should encourage children to find their own solutions to math problems even if they are inefficient.	○	○	○	○	○
3. Children should understand computational procedures before they spend much time practicing them.	○	○	○	○	○
4. Time should be spent solving simple word problems before children spend much time practicing computational procedures.	○	○	○	○	○
5. Teachers should teach exact procedures for solving word problems.	○	○	○	○	○
6. Children should understand the meaning of an operation (addition, subtraction, multiplication, or division) before they memorize number facts.	○	○	○	○	○
7. The teacher should demonstrate how to solve simple word problems before children are allowed to solve word problems.	○	○	○	○	○
8. The use of key words is an effective way for children to solve word problems.	○	○	○	○	○
9. Mathematics should be presented to children in such a way that they can discover relationships for themselves.	○	○	○	○	○
10. Even children who have not learned basic facts can have effective methods for solving problems.	○	○	○	○	○
11. It is important for a child to be a good listener in order to learn how to do mathematics.	○	○	○	○	○
12. Most young children can figure out a way to solve simple word problems.	○	○	○	○	○

.

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
13. Children should have many informal experiences solving simple word problems before they are expected to memorize number facts.	○	○	○	○	○
14. An effective teacher demonstrates the right way to do a word problem.	○	○	○	○	○
15. Children should be told to solve problems the way the teacher has taught them.	○	○	○	○	○
16. Most young children have to be shown how to solve simple word problems.	○	○	○	○	○
17. Children's written answers to paper-and-pencil mathematical problems indicate their level of understanding.	○	○	○	○	○
18. The best way to teach problem solving is to show children how to solve one kind of problem at a time.	○	○	○	○	○
19. It is better to provide a variety of word problems for children to solve.	○	○	○	○	○
20. Children learn math best by figuring out for themselves the ways to find answers to simple word problems.	○	○	○	○	○
21. Children usually can figure out for themselves how to solve simple word problems.	○	○	○	○	○
22. Recall of number facts should precede the development of an understanding of the related operation (addition, subtraction, multiplication, or division).	○	○	○	○	○
23. Children will not understand an operation (addition, subtraction, multiplication, or division) until they have mastered some of the relevant number facts.	○	○	○	○	○
24. Most children cannot figure math out for themselves and must be explicitly taught.	○	○	○	○	○

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
25. Children should understand computational procedures before they master them.	○	○	○	○	○
26. Children learn math best by attending to the teacher's explanations.	○	○	○	○	○
27. It is important for a child to discover how to solve simple word problems for him/herself.	○	○	○	○	○
28. Children should be allowed to invent ways to solve simple word problems before the teacher demonstrates how to solve them.	○	○	○	○	○
29. Time should be spent practicing computational procedures before children are expected to understand the procedures.	○	○	○	○	○
30. The goals of instruction in mathematics are best achieved when students find their own methods for solving problems.	○	○	○	○	○
31. Allowing children to discuss their thinking helps them to make sense of mathematics.	○	○	○	○	○
32. Teachers should allow children who are having difficulty solving a word problem to continue to try to find a solution	○	○	○	○	○
33. Children can figure out ways to solve many math problems without formal instruction.	○	○	○	○	○
34. Teachers should tell children who are having difficulty solving a word problem how to solve the problem.	○	○	○	○	○
35. Frequent drills on the basic facts are essential in order for children to learn them.	○	○	○	○	○
36. Most young children can figure out a way to solve many mathematics problems without adult help.	○	○	○	○	○

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
37. Teachers should allow children to figure out their own ways to solve simple word problems.					
38. It is better to teach children how to solve one kind of word problem at a time.					
39. Children should not solve simple word problems until they have mastered some number facts.					
40. Children's explanations of their solutions to problems are good indicators of their mathematics learning.					
41. Given appropriate materials, children can create meaningful procedures for computation.					
42. Time should be spent practicing computational procedures before children spend much time solving problems.					
43. Teachers should facilitate children's inventions of ways to solve simple word problems.					
44. It is important for a child to know how to follow directions to be a good problem solver.					
45. To be successful in mathematics, a child must be a good listener.					
46. Children need explicit instruction on how to solve word problems.					
47. Children should master computational procedures before they are expected to understand how those procedures work.					
48. Children learn mathematics best from teachers' demonstrations and explanation.					

The second part of the survey will gather information about your perceptions of this course. It consists of a series of statements and as you read each statement, you will know whether you agree or disagree with it. Please indicate your level of agreement with each statement on a scale of "Strongly Agree" to "Strongly Disagree."

	Strongly Agree	Agree	Disagree	Strongly Disagree
49. I am very satisfied with this course				
50. This course met my learning needs				
51. The course documents (lessons, lecture notes, or media) used in this class facilitated my learning				
52. The assignments and activities in this course facilitated my learning				
53. In this class the instructor was an active member of the discussion offering direction to comments				
54. I was able to get individualized attention from my instructor if needed				
55. This course created a sense of community among students				
56. In this class the discussion provided opportunity for problem solving with other students				

Please answer the following two questions as either Yes or No

	Yes	No
57. Have you ever taken an online or blended class?		
58. Have you ever used Blackboard as an instructor or as a student?		

59. What were your reasons for choosing the face-to-face CGI class rather than the blended (online) class?

Thank you very much for completing this survey. Please click on the DONE button to submit your responses.

APPENDIX D

MATHEMATICAL BELIEF AND PARTICIPANT SATISFACTION:

BLENDED BELIEF POST- COURSE SURVEY

*** Please enter the number assigned to you by your instructor.**
Note: the number will not be used to identify the respondent.

There are two parts to this survey. The first part consists of a series of statements and as you read each statement, you will know whether you agree or disagree with it. Please indicate your level of agreement with each statement on a scale of "Strongly Agree" to "Strongly Disagree." If you are not sure, mark "Undecided."

Do not spend much time with any statement, but be sure to answer every statement. Work fast but carefully. There are no "right" or "wrong" answers. The only correct responses are those that reflect what you believe to be true. Be sure to respond to each item in a way that reflects your beliefs.

This information will be used to understand the impact of this professional development. Your responses will remain confidential.

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1. Children should solve word problems before they master computational procedures.	○	○	○	○	○
2. Teachers should encourage children to find their own solutions to math problems even if they are inefficient.	○	○	○	○	○
3. Children should understand computational procedures before they spend much time practicing them.	○	○	○	○	○
4. Time should be spent solving simple word problems before children spend much time practicing computational procedures.	○	○	○	○	○
5. Teachers should teach exact procedures for solving word problems.	○	○	○	○	○
6. Children should understand the meaning of an operation (addition, subtraction, multiplication, or division) before they memorize number facts.	○	○	○	○	○
7. The teacher should demonstrate how to solve simple word problems before children are allowed to solve word problems.	○	○	○	○	○
8. The use of key words is an effective way for children to solve word problems.	○	○	○	○	○
9. Mathematics should be presented to children in such a way that they can discover relationships for themselves.	○	○	○	○	○
10. Even children who have not learned basic facts can have effective methods for solving problems.	○	○	○	○	○
11. It is important for a child to be a good listener in order to learn how to do mathematics.	○	○	○	○	○
12. Most young children can figure out a way to solve simple word problems.	○	○	○	○	○

.

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
13. Children should have many informal experiences solving simple word problems before they are expected to memorize number facts.					
14. An effective teacher demonstrates the right way to do a word problem.					
15. Children should be told to solve problems the way the teacher has taught them.					
16. Most young children have to be shown how to solve simple word problems.					
17. Children's written answers to paper-and-pencil mathematical problems indicate their level of understanding.					
18. The best way to teach problem solving is to show children how to solve one kind of problem at a time.					
19. It is better to provide a variety of word problems for children to solve.					
20. Children learn math best by figuring out for themselves the ways to find answers to simple word problems.					
21. Children usually can figure out for themselves how to solve simple word problems.					
22. Recall of number facts should precede the development of an understanding of the related operation (addition, subtraction, multiplication, or division).					
23. Children will not understand an operation (addition, subtraction, multiplication, or division) until they have mastered some of the relevant number facts.					
24. Most children cannot figure math out for themselves and must be explicitly taught.					

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
25. Children should understand computational procedures before they master them.	○	○	○	○	○
26. Children learn math best by attending to the teacher's explanations.	○	○	○	○	○
27. It is important for a child to discover how to solve simple word problems for him/herself.	○	○	○	○	○
28. Children should be allowed to invent ways to solve simple word problems before the teacher demonstrates how to solve them.	○	○	○	○	○
29. Time should be spent practicing computational procedures before children are expected to understand the procedures.	○	○	○	○	○
30. The goals of instruction in mathematics are best achieved when students find their own methods for solving problems.	○	○	○	○	○
31. Allowing children to discuss their thinking helps them to make sense of mathematics.	○	○	○	○	○
32. Teachers should allow children who are having difficulty solving a word problem to continue to try to find a solution	○	○	○	○	○
33. Children can figure out ways to solve many math problems without formal instruction.	○	○	○	○	○
34. Teachers should tell children who are having difficulty solving a word problem how to solve the problem.	○	○	○	○	○
35. Frequent drills on the basic facts are essential in order for children to learn them.	○	○	○	○	○
36. Most young children can figure out a way to solve many mathematics problems without adult help.	○	○	○	○	○

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
37. Teachers should allow children to figure out their own ways to solve simple word problems.					
38. It is better to teach children how to solve one kind of word problem at a time.					
39. Children should not solve simple word problems until they have mastered some number facts.					
40. Children's explanations of their solutions to problems are good indicators of their mathematics learning.					
41. Given appropriate materials, children can create meaningful procedures for computation.					
42. Time should be spent practicing computational procedures before children spend much time solving problems.					
43. Teachers should facilitate children's inventions of ways to solve simple word problems.					
44. It is important for a child to know how to follow directions to be a good problem solver.					
45. To be successful in mathematics, a child must be a good listener.					
46. Children need explicit instruction on how to solve word problems.					
47. Children should master computational procedures before they are expected to understand how those procedures work.					
48. Children learn mathematics best from teachers' demonstrations and explanation.					

The second part of the survey will gather information about your perceptions of this course. It consists of a series of statements and as you read each statement, you will know whether you agree or disagree with it. Please indicate your level of agreement with each statement on a scale of "Strongly Agree" to "Strongly Disagree."

	Strongly Agree	Agree	Disagree	Strongly Disagree
49. I am very satisfied with this course	○	○	○	○
50. This course met my learning needs	○	○	○	○
51. The course documents (lessons, lecture notes, or media) used in this class facilitated my learning	○	○	○	○
52. The assignments and activities in this course facilitated my learning	○	○	○	○
53. In this class the instructor was an active member of the discussion offering direction to comments	○	○	○	○
54. I was able to get individualized attention from my instructor if needed	○	○	○	○
55. This course created a sense of community among students	○	○	○	○
56. In this class the discussion provided opportunity for problem solving with other students	○	○	○	○
57. I am very confident in my abilities to use computers	○	○	○	○
58. I can deal with most difficulties I encounter when using computers	○	○	○	○
59. I am very satisfied with this blended course	○	○	○	○
60. I would like to take another blended online course	○	○	○	○
61. This blended course met my learning needs	○	○	○	○
62. I feel blended courses are as effective as face-to-face courses	○	○	○	○

Thank you very much for completing this survey. Please click on the DONE button to submit your responses.

APPENDIX E

MATHEMATICAL BELIEFS AND IMPLEMENTATION INTERVIEW PROTOCOL AND QUESTIONS

Turn on the tape recorder.

Say to teacher:

We are interested in how you teach mathematics in your classroom and why you teach it the way that you do. I am going to ask you some specific questions about the way you teach and why you teach as you do. There are no right or wrong answers to these questions. We are interested in your opinions and ideas. I have a number of questions to ask. I would appreciate it if you would save any additional comments, which do not pertain to the specific question asked, until the end of the interview. If at that time you have comments to add, I would be interested in hearing them. As you can see, I will be audiotaping your responses.

1. Would you select the content with which you work the most during the year: Addition, Subtraction, Multiplication, Division.

_ *Insert the selected content into questions when necessary.*

2. A. Describe as specifically as you can the lesson in which you introduce ( ) to your class. We are interested in the way you organize and present the mathematics content as well as the specific teaching methods and strategies that you use.

Select <u>*two*</u> *things that the teacher said that (s)he did such as the way (s)he sequenced the lesson; organized the lesson; explained the certain concepts; or taught a specific skill.* <u>*For each*</u> *one, ask question IB.*

B. You said that you (*insert the teacher's specific words).* <u>Why</u> did you decide to do that?
—*Probe once if necessary.*

3. A. What do you try to have your children learn about ( ) during the year?

—*Probe once if necessary.*

B. Describe the knowledge the children in your classroom had about ( ) when they <u>started</u> the school year.

—*Probe once if necessary.*

C. Children have different abilities and knowledge about ( ). How do you find out about these differences?

~*Probe once if necessary.*

4. A. Are there certain kinds of word problems you believe that children should learn to solve in the ( ) grade? If so, what are they?

If teacher has difficulty understanding what is meant by kinds of word problems, ask Could you give me some examples of word problems you use?

—*Probe once if necessary.*

B. Why do you choose those kinds of problems?

--*Probe once if necessary.*

C. Would you have children in your classroom solve a problem like: Ann had 7 toy cars. Her brother gave her some more. Now she has 12 toy cars. How many toy cars did her brother give to Ann?

Depending on what the response was, select one of the following.

C. Why <u>would</u> you include a problem like that? or Why <u>wouldn't</u> you include a problem like that?

—*Probe once if necessary.*

D. Can you describe how you work with word problems with your students?

--*Probe once if necessary.*

5. Do you have children memorize facts sometime during the school year?

Yes- A. When?

B. Do you teach facts?

C. How do you decide when?

D. How do you have children memorize the facts?

6. A. Would you describe the lesson in which you introduce the ( ) sign to your children?

Insert plus, minus, multiplication, division.

Select <u>two</u> things that the teacher said. For each one, ask question 6B.

B. You said that you (*insert the teacher's specific words).* Why did you decide to do that?

7. A. Do you work with 2 or 3 digit numbers in ( )?

Are there special characteristics of the numbers you work with?

If no, ask about the previous level of content.

B. How do you introduce ( ) with 2 digit numbers?

C. How do your students learn to ( ) with 2 digit numbers?

D. How do you decide how to teach ( ) with 2 digit numbers.

8. How do you use a math text book in your mathematics teaching?

If the teacher says that (s)he does not use a textbook, ask what do you use in place of the textbook and how do you use it?

--*Probe once if necessary.*

9. How do you decide what mathematics to teach and how to teach it?

--*Probe once if necessary.*

10. What do you think the role of the teacher should be in teaching mathematics to ( ) graders?

—*Probe once if necessary*. What do you think your responsibility should be in teaching mathematics to ( ) graders?

11. You have talked a lot about your teaching of mathematics. Many teachers report to us that they can't teach mathematics the way they want to. Do you perceive any barriers or obstacles that keep you from teaching math the way you want to. Could you tell us about them?

APPENDIX F

PARTICIPANTS BY SCHOOL

School		Blended	Face to Face	Total
School A	Count	1	0	1
	% within Environment	3.10%	0.00%	1.60%
School B	Count	1	0	1
	% within Environment	3.10%	0.00%	1.60%
School C	Count	0	1	1
	% within Environment	0.00%	3.10%	1.60%
School D	Count	2	9	11
	% within Environment	6.30%	28.10%	17.20%
School E	Count	0	4	4
	% within Environment	0.00%	12.50%	6.30%
School F	Count	3	1	4
	% within Environment	9.40%	3.10%	6.30%
School G	Count	2	3	5
	% within Environment	6.30%	9.40%	7.80%
School H	Count	1	0	1
	% within Environment	3.10%	0.00%	1.60%
School I	Count	0	2	2
	% within Environment	0.00%	6.30%	3.10%
School J	Count	1	1	2
	% within Environment	3.10%	3.10%	3.10%
School K	Count	2	1	3
	% within Environment	6.30%	3.10%	4.70%
School L	Count	1	1	2
	% within Environment	3.10%	3.10%	3.10%
School M	Count	10	4	14
	% within Environment	31.30%	12.50%	21.90%
School N	Count	3	3	6
	% within Environment	9.40%	9.40%	9.40%
School O	Count	1	1	2
	% within Environment	3.10%	3.10%	3.10%
School P	Count	4	0	4
	% within Environment	12.50%	0.00%	6.30%
School Q	Count	0	1	1
	% within Environment	0.00%	3.10%	1.60%
Total	Count	32	32	64
	% within Environment	100.00%	100.00%	100.00%

APPENDIX G

PRESURVEY FREQUENCIES

1A. Children should solve word problems before they master computational procedures.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	1.6	1.6
Disagree	15	23.4	25.0
Undecided	18	28.1	53.1
Agree	21	32.8	85.9
Strongly Agree	9	14.1	100.0
Total	64	100.0	

2A. Teachers should encourage children to find their own solutions to math problems even if they are inefficient.

	Frequency	Percent	Cumulative Percent
Disagree	3	4.7	4.7
Undecided	13	20.3	25.0
Agree	32	50.0	75.0
Strongly Agree	16	25.0	100.0
Total	64	100.0	

3A. Children should understand computational procedures before they spend much time practicing them.

	Frequency	Percent	Cumulative Percent
Disagree	16	25.0	25.0
Undecided	12	18.8	43.8
Agree	27	42.2	85.9
Strongly Agree	9	14.1	100.0
Total	64	100.0	

4A. Time should be spent solving simple word problems before children spend much time practicing computational procedures.

	Frequency	Percent	Cumulative Percent
Disagree	10	15.6	15.9
Undecided	13	20.3	36.5
Agree	32	50.0	87.3
Strongly Agree	8	12.5	100.0
Total	63	98.4	
Missing	1	1.6	
Total	64	100.0	

5A. Teachers should teach exact procedures for solving word problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	8	12.5	12.5
Disagree	38	59.4	71.9
Undecided	10	15.6	87.5
Agree	638	9.4	96.9
Strongly Agree	1 8	1.6	98.4
Total	63	98.4	
Missing	1	1.6	100.00
Total	64	100.0	

6A. Children should understand the meaning of an operation (addition, subtraction, multiplication, or division) before they memorize number facts.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	1.6	1.6
Disagree	4	6.3	7.8
Undecided	5	7.8	15.6
Agree	31	48.4	64.1
Strongly Agree	23	35.9	100.0
Total	64	100.0	

7A. The teacher should demonstrate how to solve simple word problems before children are allowed to solve word problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	4	6.3	6.3
Disagree	31	48.4	54.7
Undecided	8	12.5	67.2
Agree	17	26.6	93.8
Strongly Agree	4	6.3	100.0
Total	64	100.0	

8A.The use of key words is an effective way for children to solve word problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	2	3.1	3.1
Disagree	13	20.3	23.4
Undecided	9	14.1	37.5
Agree	34	53.1	90.6
Strongly Agree	6	9.4	100.0
Total	64	100.0	

9A. Mathematics should be presented to children in such a way that they can discover relationships for themselves.

	Frequency	Percent	Cumulative Percent
Undecided	6	9.4	9.4
Agree	34	53.1	62.5
Strongly Agree	23	35.9	98.4
Total	63	98.4	
Missing	1	1.6	100.0
Total	64	100.0	

10A. Even children who have not learned basic facts can have effective methods for solving problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	1.6	1.6
Disagree	2	3.1	4.7
Undecided	2	3.1	7.8
Agree	30	46.9	54.7
Strongly Agree	29	45.3	100.0
Total	64	100.0	

11A. It is important for a child to be a good listener in order to learn how to do mathematics.

	Frequency	Percent	Cumulative Percent
Disagree	17	26.6	26.6
Undecided	17	26.6	53.2
Agree	26	40.6	93.8
Strongly Agree	4	6.3	100.0
Total	64	100.0	

12A. Most young children can figure out a way to solve simple word problems.

	Frequency	Percent	Cumulative Percent
Disagree	3	4.7	4.7
Undecided	10	15.6	20.3
Agree	35	54.7	75.0
Strongly Agree	16	25.0	100.0
Total	64	100.0	

13A. Children should have many informal experiences solving simple word problems before they are expected to memorize number facts.

	Frequency	Percent	Cumulative Percent
Disagree	6	9.4	9.4
Undecided	5	7.8	17.2
Agree	37	57.8	75.0
Strongly Agree	16	25.0	100.0
Total	64	100.0	

14A. An effective teacher demonstrates the right way to do a word problem.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	7	10.9	10.9
Disagree	34	53.1	64
Undecided	16	25.0	89.0
Agree	5	7.8	96.8
Strongly Agree	2	3.1	100.0
Total	64	100.0	

15A. Children should be told to solve problems the way the teacher has taught them.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	18	28.1	28.1
Disagree	43	67.2	95.3
Undecided	3	4.7	100.0
Total	64	100.0	

16A. Most young children have to be shown how to solve simple word problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	3	4.7	4.7
Disagree	36	56.3	61.0
Undecided	16	25.0	86.0
Agree	9	14.1	100.00
Total	64	100.0	

17A: Children's written answers to paper-and-pencil mathematical problems indicate their level of understanding.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	1.6	1.6
Disagree	8	12.5	14.1
Undecided	9	14.1	28.1
Agree	35	54.7	82.8
Strongly Agree	11	17.2	100.0
Total	64	100.0	

18A. The best way to teach problem solving is to show children how to solve one kind of problem at a time.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	8	12.5	12.5
Disagree	29	45.3	57.8
Undecided	19	29.7	87.5
Agree	8	12.5	100.0
Total	64	100.0	

19A. It is better to provide a variety of word problems for children to solve.

	Frequency	Percent	Cumulative Percent
Disagree	1	1.6	1.6
Undecided	13	20.3	21.9
Agree	40	62.5	84.4
Strongly Agree	10	15.6	100.0
Total	64	100.0	

20A. Children learn math best by figuring out for themselves the ways to find answers to simple word problems.

	Frequency	Percent	Cumulative Percent
Disagree	2	3.1	3.1
Undecided	10	15.6	18.7
Agree	43	67.2	85.9
Strongly Agree	8	12.5	98.4
Total	63	98.4	
System	1	1.6	100
Total	64	100.0	

21A. Children usually can figure out for themselves how to solve simple word problems.

	Frequency	Percent	Cumulative Percent
Disagree	3	4.7	4.7
Undecided	17	26.6	31.3
Agree	40	62.5	93.8
Strongly Agree	4	6.3	100.0
Total	64	100.0	

22A. Recall of number facts should precede the development of an understanding of the related operation (addition, subtraction, multiplication, or division).

	Frequency	Percent	Cumulative Percent
Strongly Disagree	10	15.6	15.6
Disagree	27	42.2	57.8
Undecided	13	20.3	78.1
Agree	13	20.3	98.4
Total	63	98.4	
Missing	1	1.6	
Total	64	100.0	

23A.Children will not understand an operation (addition, subtraction, multiplication, or division) until they have mastered some of the relevant number facts.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	7	10.9	10.9
Disagree	34	53.1	64.0
Undecided	10	15.6	79.6
Agree	13	20.3	100.0
Total	64	100.0	

24A. Most children cannot figure math out for themselves and must be explicitly taught.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	18	28.1	28.1
Agree	38	59.4	87.5
Undecided	7	10.9	98.4
Total	63	98.4	
Missing	1	1.6	100.0
Total	64	100.0	

25A. Children should understand computational procedures before they master them.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	5	7.8	7.8
Disagree	38	59.4	67.2
Undecided	10	15.6	82.8
Agree	10	15.6	98.4
Strongly Agree	1	1.6	100.0
Total	64	100.0	

26A. Children learn math best by attending to the teacher's explanations.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	3	4.7	
Disagree	38	59.4	7.8
Undecided	18	28.1	35.9
Agree	5	7.8	95.3
Total	64	100.0	

27A. It is important for a child to discover how to solve simple word problems for him/herself.

	Frequency	Percent	Cumulative Percent
Disagree	1	1.6	1.6
Undecided	4	6.3	7.9
Agree	53	82.8	90.7.1
Strongly Agree	5	7.8	98.4
Total	63	98.4	
Missing	1	1.6	100.0
Total	64	100.0	

28A. Children should be allowed to invent ways to solve simple word problems before the teacher demonstrates how to solve them.

	Frequency	Percent	Cumulative Percent
Disagree	2	3.1	3.1
Undecided	11	17.2	20.3
Agree	37	57.8	78.1
Strongly Agree	14	21.9	100.0
Total	64	100.0	

29A. Time should be spent practicing computational procedures before children are expected to understand the procedures.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	5	7.8	7.8
Disagree	21	32.8	40.6
Undecided	15	23.4	64.0
Agree	23	35.9	100.0
Total	64	100.0	

30A. The goals of instruction in mathematics are best achieved when students find their own methods for solving problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	1.6	1.6
Disagree	3	4.7	6.3
Undecided	9	14.1	20.3
Agree	43	67.2	87.5
Strongly Agree	8	12.5	100.0
Total	64	100.0	

31A. Allowing children to discuss their thinking helps them to make sense of mathematics.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	1.6	1.6
Undecided	1	1.6	3.1
Agree	19	29.7	32.8
Strongly Agree	43	67.2	100.0
Total	64	100.0	

32A. Teachers should allow children who are having difficulty solving a word problem to continue to try to find a solution.

	Frequency	Percent	Cumulative Percent
Disagree	5	7.8	7.8
Undecided	13	20.3	28.1
Agree	39	60.9	89.1
Strongly Agree	7	10.9	100.0
Total	64	100.0	

33A. Children can figure out ways to solve many math problems without formal instruction.

	Frequency	Percent	Cumulative Percent
Disagree	6	9.4	9.4
Undecided	17	26.6	35.9
Agree	36	56.3	92.2
Strongly Agree	5	7.8	100.0
Total	64	100.0	

34A. Teachers should tell children who are having difficulty solving a word problem how to solve the problem.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	3	4.7	4.7
Disagree	33	51.6	56.3
Undecided	17	26.6	82.9
Agree	11	17.2	100.0
Total	64	100.0	

35A. Frequent drills on the basic facts are essential in order for children to learn them.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	4	6.3	6.3
Disagree	28	43.8	50.1
Undecided	13	20.3	70.4
Agree	17	26.6	97
Strongly Agree	1	1.6	98.5
Total	63	98.4	
Missing	1	1.6	100.00
Total	64	100.0	

36A. Most young children can figure out a way to solve many mathematics problems without adult help.

	Frequency	Percent	Cumulative Percent
Disagree	7	10.9	10.9
Undecided	19	29.7	40.6
Agree	37	57.8	98.4
Strongly Agree	1	1.6	100.0
Total	64	100.0	

37A Teachers should allow children to figure out their own ways to solve simple word problems.

	Frequency	Percent	Cumulative Percent
Disagree	1	1.6	1.6
Undecided	6	9.4	10.9
Agree	46	71.9	82.8
Strongly Agree	11	17.2	100.0
Total	64	100.0	

38A. It is better to teach children how to solve one kind of word problem at a time.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	3	4.7	4.7
Disagree	29	45.3	50.0
Undecided	20	31.3	81.3
Agree	11	17.2	98.5
Strongly Agree	1	1.6	100.0
Total	64	100.0	

39A. Children should not solve simple word problems until they have mastered some number facts.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	5	7.8	7.8
Disagree	46	71.9	79.7
Undecided	7	10.9	90.6
Agree	6	9.4	100.0
Total	64	100.0	

40A. Children's explanations of their solutions to problems are good indicators of their mathematics learning.

	Frequency	Percent	Cumulative Percent
Disagree	1	1.6	1.6
Undecided	1	1.6	3.1
Agree	33	51.6	54.7
Strongly Agree	29	45.3	100.0
Total	64	100.0	

41A. Given appropriate materials, children can create meaningful procedures for computation.

	Frequency	Percent	Cumulative Percent
Undecided	7	10.9	10.9
Agree	36	56.3	67.2
Strongly Agree	21	32.8	100.0
Total	64	100.0	

42A. Time should be spent practicing computational procedures before children spend much time solving problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	3	4.7	4.7
Disagree	310	48.4	53.1
Undecided	20	31.3	84.4
Agree	10	15.6	100.0
Total	64	100.0	

43A. Teachers should facilitate children's inventions of ways to solve simple word problems.

	Frequency	Percent	Cumulative Percent
Disagree	2	3.1	3.1
Undecided	4	6.3	9.4
Agree	39	60.9	70.3
Strongly Agree	19	29.7	100.0
Total	64	100.0	

44A. It is important for a child to know how to follow directions to be a good problem solver.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	3	4.7	4.7
Disagree	24	37.5	42.2
Undecided	20	31.3	73.5
Agree	16	25.0	98.5
Strongly Agree	1	1.6	100.0
Total	64	100.0	

45A. To be successful in mathematics, a child must be a good listener.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	1.6	1.6
Disagree	20	31.3	32.9
Undecided	24	37.5	70.4
Agree	19	29.7	100.00
Total	64	100.0	

46A. Children need explicit instruction on how to solve word problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	2	3.1	3.1
Disagree	35	54.7	57.8
Undecided	16	25.0	82.8
Agree	11	17.2	100.00
Total	64	100.0	

47A. Children should master computational procedures before they are expected to understand how those procedures work.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	4	6.3	6.3
Disagree	30	46.9	53.2
Undecided	16	25.0	78.2
Agree	13	20.3	98.4
Strongly Agree	1	1.6	100.0
Total	64	100.0	

48A. Children learn mathematics best from teachers' demonstrations and explanation.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	3	4.7	4.7
Disagree	32	50.0	54.7
Undecided	19	29.7	84.4
Agree	9	14.1	98.4
Total	63	98.4	
Missing	1	1.6	100.0
Total	64	100.0	

APPENDIX H

POST SURVEY FREQUENCIES

1. Children should solve word problems before they master computational procedures.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	2	3.9	3.9
Disagree	7	13.7	17.6
Undecided	3	5.9	23.5
Agree	20	39.2	62.7
Strongly Agree	19	37.3	100.0
Total	51	100.0	

2. Teachers should encourage children to find their own solutions to math problems even if they are inefficient.

	Frequency	Percent	Cumulative Percent
Disagree	4	7.8	7.8
Agree	25	49.0	56.9
Strongly Agree	22	43.1	100.0
Total	51	100.0	

3. Children should understand computational procedures before they spend much time practicing them.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	3	5.9	5.9
Disagree	18	35.3	41.2
Undecided	4	7.8	49.0
Agree	15	29.4	78.4
Strongly Agree	11	21.6	100.0
Total	51	100.0	

4. Time should be spent solving simple word problems before children spend much time practicing computational procedures.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	2.0	2.0
Disagree	9	17.6	19.6
Undecided	4	7.8	27.5
Agree	25	49.0	76.5
Strongly Agree	12	23.5	100.0
Total	51	100.0	

5. Teachers should teach exact procedures for solving word problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	10	19.6	19.6
Disagree	34	66.7	86.3
Undecided	4	7.8	94.1
Agree	2	3.9	98
Strongly Agree	4	2.0	100.0
Total	51	100.0	

6. Children should understand the meaning of an operation (addition, subtraction, multiplication, or division) before they memorize number facts.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	2.0	2.0
Disagree	5	9.8	11.8
Undecided	4	7.8	19.6
Agree	23	45.1	64.7
Strongly Agree	18	35.3	100.0
Total	51	100.0	

7. The teacher should demonstrate how to solve simple word problems before children are allowed to solve word problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	6	11.8	11.8
Disagree	31	60.8	72.6
Undecided	6	11.8	84.4
Agree	6	11.8	96.2
Strongly Agree	1	2	98.1
Total	50	98.0	
Missing	1	2.0	100.0
Total	51	100.0	

8. The use of key words is an effective way for children to solve word problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	11	21.6	21.6
Disagree	8	15.7	37.3
Undecided	8	15.7	53
Agree	20	39.2	92.2
Strongly Agree	4	7.8	100.0
Total	51	100.0	

9. Mathematics should be presented to children in such a way that they can discover relationships for themselves.

	Frequency	Percent	Cumulative Percent
Agree	17	33.3	33.3
Strongly Agree	34	66.7	100.0
Total	51	100.0	

10. Even children who have not learned basic facts can have effective methods for solving problems.

	Frequency	Percent	Cumulative Percent
Agree	17	33.3	33.3
Strongly Agree	34	66.7	100.0
Total	51	100.0	

11. It is important for a child to be a good listener in order to learn how to do mathematics.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	2	3.9	3.9
Disagree	17	33.3	37.2
Undecided	12	23.5	60.7
Agree	17	33.3	94.0
Strongly Agree	3	5.9	100.0
Total	51	100.0	

12. Most young children can figure out a way to solve simple word problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	2.0	2.0
Agree	28	54.9	56.9
Strongly Agree	22	43.1	100.0
Total	51	100.0	

13. Children should have many informal experiences solving simple word problems before they are expected to memorize number facts.

	Frequency	Percent	Cumulative Percent
Disagree	1	2.0	2.0
Undecided	2	3.9	6.0
Agree	29	56.9	63
Strongly Agree	18	35.3	98.00
Total	50	98.0	
Missing	1	2.0	100.0
Total	51	100.0	

14. An effective teacher demonstrates the right way to do a word problem.

	Frequency	Percent	Cumulative Percent
Disagree	6	11.8	11.8
Undecided	38	72.58	84.3
Agree	3	5.9	90.2
Strongly Agree	4	7.8	100.0
Total	51	100.0	

15. Children should be told to solve problems the way the teacher has taught them.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	24	47.1	47.1
Disagree	25	49.0	96.1
Undecided	1	2.0	98
Missing	1	2.0	100.0
Total	51	100.0	

16. Most young children have to be shown how to solve simple word problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	8	15.7	15.7
Disagree	35	68.6	84.3
Undecided	4	7.8	92.1
Agree	3	5.9	98.0
Total	50	98.0	
Missing	1	2.0	100.0
Total	51	100.0	

17. Children's written answers to paper-and-pencil mathematical problems indicate their level of understanding.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	2.0	2.0
Disagree	4	7.8	10.0
Undecided	8	15.7	25.7
Agree	34	66.7	92.4
Strongly Agree	3	5.9	98
Total	50	98.0	
Missing	1	2.0	100.0
Total	51	100.0	

18. The best way to teach problem solving is to show children how to solve one kind of problem at a time.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	10	19.6	19.6
Disagree	29	56.9	76.5
Undecided	9	17.6	94.1
Agree	2	3.9	98
Total	50	98.0	
Missing	1	2.0	100.00
Total	51	100.0	

19. It is better to provide a variety of word problems for children to solve.

	Frequency	Percent	Cumulative Percent
Disagree	1	2.0	2.0
Undecided	2	3.9	6.0
Agree	25	49.0	56.0
Strongly Agree	22	43.1	98
Total	50	98.0	
Missing	1	2.0	100.00
Total	51	100.0	

20. Children learn math best by figuring out for themselves the ways to find answers to simple word problems.

	Frequency	Percent	Cumulative Percent
Disagree	2	3.9	4.0
Undecided	3	5.9	10.0
Agree	29	56.9	68.0
Strongly Agree	16	31.4	100.0
Total	50	98.0	
Missing	1	2.0	
Total	51	100.0	

21. Children usually can figure out for themselves how to solve simple word problems.

	Frequency	Percent	Cumulative Percent
Disagree	3	5.9	5.9
Undecided	4	7.8	13.7
Agree	32	62.7	76.4
Strongly Agree	11	21.6	98
Total	50	98.0	
Missing	1	2.0	100.0
Total	51	100.0	

22. Recall of number facts should precede the development of an understanding of the related operation (addition, subtraction, multiplication, or division).

	Frequency	Percent	Cumulative Percent
Strongly Disagree	10	19.6	19.6
Disagree	25	49.0	68.6
Undecided	7	13.7	82.3
Agree	6	11.8	95.1
Strongly Agree	2	3.9	98
Total	50	98.0	
Missing	1	2.0	100.00
Total	51	100.0	

23. Children will not understand an operation (addition, subtraction, multiplication, or division) until they have mastered some of the relevant number facts.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	8	15.7	15.7
Disagree	35	68.6	84.3
Undecided	4	7.8	92.1
Agree	3	5.9	98
Total	50	98.0	
System	1	2.0	100.0
Total	51	100.0	

24. Most children cannot figure math out for themselves and must be explicitly taught.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	18	35.3	35.3
Disagree	29	56.7	92
Undecided	2	3.9	96
Strongly Agree	1	2.0	98
Total	50	98.0	
Missing	1	2.0	100.0
Total	51	100.0	

25. Children should understand computational procedures before they master them.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	9	17.6	17.6
Disagree	26	51	68.6
Undecided	4	7.8	76.4
Agree	11	21.6	98
Strongly Agree	1	2.0	100.0
Total	51	100.0	

26. Children learn math best by attending to the teacher's explanations.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	4	7.8	7.8
Disagree	34	66.7	74.5
Undecided	9	17.6	92.1
Agree	4	7.8	100.0
Total	51	100.0	

27. It is important for a child to discover how to solve simple word problems for him/herself.

	Frequency	Percent	Cumulative Percent
Disagree	1	2.0	2.0
Undecided	4	7.8	9.8
Agree	27	52.9	62.7
Strongly Agree	17	33.3	96.1
Total	49	96.1	
Missing	2	3.9	100.0
Total	51	100.0	

28. Children should be allowed to invent ways to solve simple word problems before the teacher demonstrates how to solve them.

	Frequency	Percent	Cumulative Percent
Undecided	3	5.9	5.9
Agree	28	54.9	60.8
Strongly Agree	20	39.2	100.0
Total	51	100.0	

29. Time should be spent practicing computational procedures before children are expected to understand the procedures.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	9	17.6	17.6
Disagree	26	51.0	68.6
Undecided	6	11.8	80.4
Agree	8	15.7	96.1
Strongly Agree	2	3.9	100.0
Total	51	100.0	

30. The goals of instruction in mathematics are best achieved when students find their own methods for solving problems.

	Frequency	Percent	Cumulative Percent
Disagree	1	2.0	2.0
Undecided	3	5.9	8.0
Agree	29	56.9	66.9
Strongly Agree	17	33.3	98.0
Total	50	98.0	
Missing	1	2.0	100.0
Total	51	100.0	

31. Allowing children to discuss their thinking helps them to make sense of mathematics.

	Frequency	Percent	Cumulative Percent
Undecided	1	2.0	2.0
Agree	11	21.6	23.5
Strongly Agree	39	76.5	100.0
Total	51	100.0	

32. Teachers should allow children who are having difficulty solving a word problem to continue to try to find a solution.

	Frequency	Percent	Cumulative Percent
Disagree	3	5.9	5.9
Undecided	4	7.8	13.7
Agree	32	62.7	76.5
Strongly Agree	12	23.5	100.0
Total	51	100.0	

33. Children can figure out ways to solve many math problems without formal instruction.

	Frequency	Percent	Cumulative Percent
Disagree	1	2.0	2.0
Undecided	3	5.9	7.8
Agree	29	56.9	64.7
Strongly Agree	18	35.3	100.0
Total	51	100.0	

34. Teachers should tell children who are having difficulty solving a word problem how to solve the problem.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	4	7.8	7.8
Disagree	31	60.8	68.6
Undecided	10	19.6	88.2
Agree	6	11.8	100.0
Total	51	100.0	

35. Frequent drills on the basic facts are essential in order for children to learn them.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	10	19.6	19.6
Disagree	28	54.9	74.5
Undecided	3	5.9	80.4
Agree	9	17.6	98
Strongly Agree	1	2.0	100.0
Total	51	100.0	

36. Most young children can figure out a way to solve many mathematics problems without adult help.

	Frequency	Percent	Cumulative Percent
Disagree	2	3.9	3.9
Undecided	3	5.9	9.8
Agree	36	70.6	80.4
Strongly Agree	10	19.6	100.0
Total	51	100.0	

37. Teachers should allow children to figure out their own ways to solve simple word problems.

	Frequency	Percent	Cumulative Percent
Undecided	1	2.0	2.0
Agree	26	51.0	52.9
Strongly Agree	24	47.1	100.0
Total	51	100.0	

38. It is better to teach children how to solve one kind of word problem at a time.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	5	9.8	9.8
Disagree	35	68.6	78.4
Undecided	8	15.7	94.1
Agree	2	3.9	98.0
Strongly Agree	1	2.0	100.0
Total	51	100.0	

39. Children should not solve simple word problems until they have mastered some number facts.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	11	21.6	21.6
Disagree	36	70.6	92.2
Undecided	2	3.9	96.0
Agree	1	2.0	98.0
Strongly Agree	1	2.0	100.0
Total	51	100.0	

40. Children's explanations of their solutions to problems are good indicators of their mathematics learning.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	1	2.0	2.0
Disagree	1	2.0	3.9
Undecided	1	2.0	5.9
Agree	26	51.0	56.9
Strongly Agree	22	43.1	100.0
Total	51	100.0	

41. Given appropriate materials, children can create meaningful procedures for computation.

	Frequency	Percent	Cumulative Percent
Undecided	2	3.9	3.9
Agree	32	62.7	66.7
Strongly Agree	17	33.3	100.0
Total	51	100.0	

42. Time should be spent practicing computational procedures before children spend much time solving problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	9	17.6	17.6
Disagree	31	60.8	78.4
Undecided	6	11.8	90.2
Agree	3	5.9	96.1
Strongly Agree	2	3.9	100.0
Total	51	100.0	

43. Teachers should facilitate children's inventions of ways to solve simple word problems.

	Frequency	Percent	Cumulative Percent
Disagree	3	5.9	5.9
Undecided	3	5.9	11.8
Agree	26	51.0	62.7
Strongly Agree	19	37.3	100.0
Total	51	100.0	

44. It is important for a child to know how to follow directions to be a good problem solver.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	5	9.8	9.8
Disagree	23	45.1	54.9
Undecided	8	15.7	70.6
Agree	14	27.5	98.0
Strongly Agree	1	2.0	100.0
Total	51	100.0	

45. To be successful in mathematics, a child must be a good listener.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	4	7.8	7.8
Disagree	20	39.2	47.0
Undecided	14	27.5	74.5
Agree	2	23.5	98.0
Strongly Agree	1	2.0	100.0
Total	51	100.0	

46. Children need explicit instruction on how to solve word problems.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	6	11.8	11.8
Disagree	37	72.5	84.3
Undecided	4	7.8	92.1
Agree	4	7.8	100.0
Total	51	100.0	

47. Children should master computational procedures before they are expected to understand how those procedures work.

	Frequency	Percent	Cumulative Percent
Disagree	4	7.8	7.8
Undecided	5	9.8	17.6
Agree	33	64.7	82.4
Strongly Agree	9	17.6	100.0
Total	51	100.0	

48. Children learn mathematics best from teachers' demonstrations and explanation.

	Frequency	Percent	Cumulative Percent
Strongly Disagree	5	9.8	9.8
Disagree	30	58.8	68.6
Undecided	8	15.7	84.3
Agree	7	13.7	98.0
Total	50	98.0	
Missing	1	2.0	100.0
Total	51	100.0	

49. I am very satisfied with this course.

	Frequency	Percent	Cumulative Percent
Disagree	6	11.8	11.8
Agree	22	43.1	54.9
Strongly Agree	23	45.1	100.0
Total	51	100.0	

50. This course met my learning needs.

	Frequency	Percent	Cumulative Percent
Disagree	4	7.8	7.8
Agree	25	49.0	56.9
Strongly Agree	22	43.1	100.0
Total	51	100.0	

51. The course documents (lessons, lecture notes, or media) used in this class facilitated my learning.

	Frequency	Percent	Cumulative Percent
Disagree	1	2.0	2.0
Agree	28	54.9	56.9
Strongly Agree	22	43.1	100.0
Total	51	100.0	

52. The assignments in this course facilitated my learning.

	Frequency	Percent	Cumulative Percent
Disagree	3	5.9	5.9
Agree	28	54.9	60.8
Strongly Agree	20	39.2	100.0
Total	51	100.0	

53. In this class the instructor was an active member of the discussion offering direction to comments.

	Frequency	Percent	Cumulative Percent
Disagree	1	2.0	2.0
Agree	18	35.3	37.3
Strongly Agree	32	62.7	100.0
Total	51	100.0	

54. I was able to get individualized attention from my instructor if needed.

	Frequency	Percent	Cumulative Percent
Disagree	2	3.9	3.9
Agree	22	43.1	47.1
Strongly Agree	27	52.9	100.0
Total	51	100.0	

55. This course created a sense of community among students.

	Frequency	Percent	Cumulative Percent
Disagree	10	19.6	19.6
Agree	27	52.9	72.5
Strongly Agree	14	27.5	100.0
Total	51	100.0	

56. In this class the discussion provided opportunity for problem solving with other students.

	Frequency	Percent	Cumulative Percent
Disagree	8	15.7	15.7
Agree	23	45.1	60.8
Strongly Agree	20	39.2	100.0
Total	51	100.0	

APPENDIX I

COMPARISON OF BLENDED AND FACE-TO-FACE PRE SURVEY MEANS

		Count	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Subscale 1	Blended	32	3.5502	.46321	.08189	2.50	4.33
	Face to Face	32	3.4929	.39290	.06946	2.75	4.50
	Total	64	3.5215	.42706	.05338	2.50	4.50
Subscale 2	Blended	32	3.7192	.58182	.10285	2.50	4.92
	Face to Face	32	3.4167	.45496	.08043	2.42	4.33
	Total	64	3.5679	.54007	.06751	2.42	4.92
Subscale 4	Blended	32	3.8698	.43220	.07640	3.00	4.58
	Face to Face	32	3.7410	.34220	.06049	3.09	4.33
	Total	64	3.8054	.39211	.04901	3.00	4.58
Total Score	Blended	32	3.7479	.38081	.06732	2.90	4.31
	Face to Face	32	3.6222	.32847	.05807	3.09	4.46
	Total	64	3.6850	.35841	.04480	2.90	4.46

APPENDIX J

COMPARISON OF BLENDED AND FACE-TO-FACE POST SURVEY MEANS

		Count	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Subscale 1	Blended	20	3.9375	.38415	.08590	3.33	4.83
	Face to Face	31	3.7623	.45336	.08143	3.00	4.58
	Total	51	3.8310	.43227	.06053	3.00	4.83
Subscale 2	Blended	20	3.9250	.55862	.12491	3.08	4.92
	Face to Face	31	3.7688	.50448	.09061	2.75	5.00
	Total	51	3.8301	.52651	.07373	2.75	5.00
Subscale 4	Blended	20	4.2299	.36849	.08240	3.50	5.00
	Face to Face	31	4.0672	.39582	.07109	3.08	4.92
	Total	51	4.1310	.38993	.05460	3.08	5.00
Total Score	Blended	20	4.1032	.37509	.08387	3.48	4.81
	Face to Face	31	3.9111	.36657	.06584	3.27	4.83
	Total	51	3.9864	.37824	.05296	3.27	4.83

APPENDIX K

COMPARISON OF BLENDED AND FACE-TO-FACE DIFFERENCE SCORES

		Count	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Subscale 1	Blended	20	.4030	.39861	.08913	-.25	1.17
	Face to Face	31	.2741	.48540	.08718	-.67	1.25
	Total	51	.3246	.45364	.06352	-.67	1.25
Subscale 2	Blended	20	.2375	.43113	.09640	-.42	1.33
	Face to Face	31	.3441	.44656	.08020	-.58	1.33
	Total	51	.3023	.43937	.06152	-.58	1.33
Subscale 4	Blended	20	.3171	.39336	.08796	-.58	.92
	Face to Face	31	.3265	.41535	.07460	-.58	1.00
	Total	51	.3228	.40290	.05642	-.58	1.00
Total Score	Blended	20	.3652	.28800	.06440	-.10	.81
	Face to Face	31	.2887	.34120	.06128	-.42	1.03
	Total	51	.3187	.32061	.04489	-.42	1.03

APPENDIX L

INSTITUTIONAL REVIEW BOARD APPROVAL

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	David Garcia ED
From:	Mark Roosa, Chair Soc Beh IRB
Date:	04/11/2013
Committee Action:	**Exemption Granted**
IRB Action Date:	04/11/2013
IRB Protocol #:	1303009009
Study Title:	Comparison Study of Face-to-Face and Blended Teacher Professional Development

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(1) (2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.