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Teachers' Practice of Mathematical Reform Techniques in the Classroom

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COLLEGE OF EDUCATION

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Mark Bradley Turner

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2016

Abstract

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MSEd, Walden University, 2007

BME, Georgia College & State University, 1998

Doctoral Study Submitted in Partial Fulfillment

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Abstract

In 1989, the National Council of Teachers of Mathematics advocated for a *reform mathematics* approach to mathematics education. Teachers in a large suburban school district in the southeastern United States are expected to use strategies that are consistent with reform mathematics. It is not known whether faculty members of a large elementary school in that district have adopted reform mathematics teaching strategies. Reform mathematics is an endeavor to move away from the traditional, direct instruction approach of the teacher as the sole provider of information toward the teacher as a facilitator of knowledge. Reform mathematics allows students to construct their own understanding through experience. The purpose of this study was to examine the use of reform mathematics through teachers' self-report of current practices and classroom observations. A quantitative survey study design was used that included data collection from a self-report survey and teacher observations. Thirty-one teachers responded to the survey, and 15 of the teachers were observed. The survey results showed overall positive agreement (M = 4.54 on a 6-point Likert scale) with reform mathematics. The observation results revealed that teachers were using reform mathematics strategies in their classrooms. Nonetheless, the results indicated room for improvement. A staff development project was designed to provide teachers with targeted training to implement reform mathematics strategies more fully. This study will initiate social change by introducing and reinforcing current, data-driven teaching techniques to affect positive future student achievement and success.

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Dedication

This study is dedicated to my family—for the encouragement, support, and love throughout. This is especially true for my wife, Katie, who was always scolding me for staying up too late working on research, a draft, or data analysis, and reminding me that I could—no—would get through this. To my in-laws who have always treated me as their own son.

And finally to my mother and stepfather, who still love to embarrass me when they introduce me to someone I have never met before. I think my mother has memorized all of my accomplishments since kindergarten and recites them regularly. They always gave me the freedom to follow my dreams and encouraged me to be the best I can, no matter what I am doing. Thanks, Mom.

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I would also like to acknowledge my colleagues and administration for their support and for allowing me to base my research on our school. It really places action research into its greatest context. Thank you.

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Section 1: The Problem

Introduction

In 1989, the National Council of Teachers of Mathematics (NCTM) advocated for a *reform mathematics* approach to mathematics education. At this point in time, however, it is not known whether faculty in a large suburban elementary school, the focus school, in the southeastern United States have adopted reform mathematics teaching strategies.

When studying the history of education, one finds the ever-changing, hotly debated topics of who should be taught what, when, and how. Modern education is no different. Two of the current prevailing but opposing theories on educational delivery are constructivism and direct instruction (DI). Constructivism stems from the belief that when students construct their own meaning through experience, there is a stronger connection to what is learned. The students are at the center of their own learning (Colburn, 2007; Duffy & Cunningham, 1996; Loyens, Rikers, & Schmidt, 2007; Pegues, 2007). With DI, teachers are the center of student learning. Students are expected to assimilate the knowledge and skills taught directly from their teachers (Harris & Graham, 1996; Leno & Dougherty, 2007; Viadero, 2002).

The teaching of mathematics has long been considered a top priority, from antiquity to today. Recently, however, there has been a movement toward reform mathematics. Ross, McDougal, Hogaboam-Gray, and LeSage (2003) described reform mathematics in terms of nine dimensions (see Appendix B). The dimensions of reform mathematics contain phrases such as "construction of mathematical ideas through student discovery"; "open-ended problems"; "the teacher's role in reform settings is that of co-learner and creator of a mathematical community rather than sole knowledge expert"; and "in reform teaching the classroom is organized to promote student-student interaction" (Ross et al., 2003, p. 348). Through an examination of the literature, I show how these operational definitions and others are consistent with constructivism. The focus of this study is a descriptive exploration of teachers' self-report and of observation of their actual teaching. Specifically, in this study, I sought to determine the extent to which inservice teachers practice reform mathematics in their classrooms.

Many teachers seem to rely on DI methods of teaching, specifically in mathematics. There are many constraints on teachers' time, especially in regard to testing and assessment (Allen, 2011; No Child Left Behind [NCLB], 2002; Stemhagen, 2011; Wallace, 2009). Students are required to pass various assessments, usually at the end of the school year. Considerable pressure is placed on teachers to ensure that their students perform well on these tests. Teachers' educational preparation, yearly evaluations, and perhaps even pay may be directly linked to student performance on these tests (Crowe & Center for American Progress, 2011; Goldhaber & Hansen, 2010; National Council on Teacher Quality, 2010; New Teacher Project, 2010). In order to achieve these objectives, it is logical that teachers would choose a teaching method that would result in the fastest acquisition of knowledge and skills. However, research has indicated that a constructivist approach to teaching mathematics may lead to a higher level of learning than DI (Allevato & Ochunic, 2009; Kamii, Rummelsberg, & Kari, 2005; Krosenberg & van Luit, 2002; see also discussion on TIMSS studies by Hiebert et al., 2005; Martinez, 2001).

Some leaders in mathematics question whether constructivism can be defined in mathematics instruction. Lee V. Stiff (2001), NCTM President (2000-2002), wrote an article addressing constructivism entitled “Constructivist Mathematics and Unicorns.” Stiff wrote, “Like unicorns, ‘constructivist math’ does not exist. There are, however, several theories about learning that are categorized as ‘constructivism,’ and they can be linked to standards-based mathematics" (para. 5). This assertion is consistent with many articles and discussions that basically state that constructivism is little more than a loose collection of diverse practices that resemble student-centered learning (Colburn, 2007; Duffy & Cunningham, 1996; Faulkenberry & Faulkenberry, 2006; Loyens et al., 2007; Pegues, 2007; Quale, 2012; Simpson, 2002). Because of the difficulty in defining constructivism, it is difficult to determine which practices may or may not be constructivist. This difficulty is an indication that many teachers may not understand constructivist theory, or perhaps do not know how to implement it successfully in the math classroom.

The NCTM developed its *Principles and Standards of School Mathematics* (2000) in order to guide teachers, students, and any other interested party in the development of mathematics education. In the preface of the publication, the NCTM stated,

> The recommendations in it are grounded in the belief that all students should learn important mathematical concepts and processes with understanding. *Principles and Standards* makes an argument for the importance of such understanding and describes ways students can attain it. (NCTM, 2000, p. ix)

The key terms cited from the preface are *concepts*, *processes*, and *understanding*. Fostering student understanding is at the heart of constructivist principles. While DI methods can be used to teach a child specific skills, constructivism focuses on student understanding (Colburn, 2007; Duffy & Cunningham, 1996; Loyens et al., 2007; Pegues, 2007).

The NCTM (2000) listed these specific principles of mathematics education:

1. Equity: Excellence in mathematics education requires equity—high expectations and strong support for all students.
2. Curriculum: A curriculum is more than a collection of activities; it must be coherent, focused on important mathematics, and well articulated across the grades.
3. Teaching: Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.
4. Learning: Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.
5. Assessment: Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.
6. Technology: Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning. (pp. 10-11)

Based on these principles, NCTM places a high value on student learning in regard to understanding, especially in Principles 3 and 4. NCTM further delineated these principles in its two publications *Standards: Content—Numbers and Operations, Algebra, Geometry, Measurement, and Data Analysis and Probability*; and *Process—Problem Solving, Reasoning and Proof, Communication, Connection, and Representation* (p. 29). According to NCTM (2000), the “Process Standards . . . highlight ways of acquiring and using content knowledge” (p. 29). It is this acquisition of knowledge by student-centered means that is at the heart of reform mathematics and constructivism.

Kepner (2010), former president of NCTM, wrote in one of his monthly messages,

> We know that too many of our students leave our schools with a vision of mathematics as a set of unconnected and independent facts with no clear sense of how the ideas fit together nor of how mathematics can help them earn a living, guide them as citizens, or affect their daily lives. You, the Council, and I have the responsibility to see that our students receive a coherent mathematical experience as they progress through the grades, one that expands their vision of mathematics and their connections to it. (para. 7)

It is this disconnect that Kepner described that reform mathematics may help to correct. Rather than teaching skills independent of context, student discovery and real-world application and problem solving can provide the coherence for students that Kepner argued is missing from mathematics education (Allevato & Ochunic, 2009; Hiebert et al., 2005; Martinez, 2001; Schank, 2007).

Determining how teachers interpret and implement these ideas of mathematics is a difficult matter, but it can be done via a self-report survey (Allen, 2011; Stemhagen, 2011). However, Allen (2011) pointed to the possibility of teachers overreporting their responses to surveys. Making observations of teachers can support more realistic evaluation of teaching practice. While in a teacher preparation program, student teachers are continually observed and evaluated on their performance. Once they graduate, however, each school system has its own method for evaluating its teachers. Even so, any school district will have teachers with many years of experience, even 30 to 40 years, as well as teachers who are only in their first few years of professional practice. The difference between educational philosophies cannot be understated, and yet all teachers are necessarily required to implement district policy. As teachers get into the daily work of teaching, there is no reliable way to know what teaching practices are used, or even if teachers' philosophies align with the teaching methods they are using (Allen, 2011; Bray, 2011; Ross et al., 2003; Stemhagen, 2011).

This study explored the mathematics instructional practices of teachers in one large elementary school within a large suburban school district in the southeastern United States. The district has won national awards and is recognized as a leader in the state. Because of its size, this district often delegates the implementation of district policy or reform to local schools. The local schools are provided with support from the district in the form of coaching sessions by expert personnel, after-hours staff development sessions, and websites dedicated to lessons, resources, and ideas, among other things. The purpose of this study was to examine the use of reform mathematics instructional practices through teachers' self-report of current practices and classroom observations of teachers' practice of mathematics reform.

Definition of the Problem

One of the issues faced by teachers of mathematics in the focus school is that the methodologies of reform mathematics and constructivism are generally unknown to most of them. Currently, in the study district, there is no mechanism in place to evaluate teacher implementation of these practices outside of the usual assessment system. This system typically consists of six observations per year: four brief, 10-minute observations and two formal observations of 30 minutes each. Even with six observations per year, there is no guarantee that any number of them will occur during math instruction. There is also no guarantee that the administrators themselves will be well versed in reform mathematics. Many teachers may rely on traditional methods of teaching mathematics and may not consider reform mathematics as a constructivist teaching technique. Even those teachers who advocate constructivist methods in other subjects, such as reading and writing, may rely on lecture, lists of practice problems, and other DI models of teaching, especially when presented with timelines, deadlines, and benchmarks to reach. The Third International Mathematics and Science Study 1999 video study demonstrated that countries with the highest achievement in mathematics, especially Japan, placed a higher emphasis on problem solving and inventive student solutions to math problems (Hiebert et al., 2005; Martinez, 2001).

Reform mathematics or constructivist techniques may be considered too time consuming or too involved given ever-increasing time constraints placed on teachers.

Even Dewey (1938) agreed that properly planning high-quality experiential lessons was indeed more difficult. DI may be perceived to allow for faster student assimilation of material in a shorter amount of time, with emphasis placed on algorithms and performance on high-stakes tests (Allen, 2011; Stemhagen, 2011). This study provides information on teachers' practices in the study school as they relate to reform mathematics and constructivism. The goal is to use the results of this study to design a staff development program that will address specific teacher needs and provide appropriate activities that will further develop teachers' use of reform mathematics and constructivist teaching techniques.

In today's educational environment with NCLB (2002), national standards such as Common Core (Common Core State Standards Initiative [CCSSI], 2015), and high-stakes testing, teachers must take great care in ensuring that their students perform well on these tests. Many claim the supremacy of either constructivism or DI, and studies and articles have addressed the merits of both (Duffy & Cunningham, 2006; Harris & Graham, 2006; Hartley, 2007; Kim & Axelrod, 2005; Leno & Dougherty, 2007; Morrone, Harkness, D'Ambrosio, & Caulfield, 2004; Robertson, 2006; Ryder, Burton, & Silberg, 2006; Viadero, 2002; West & Skoog, 2006). Too many elementary school teachers seem to favor a more traditional approach, which may include lecture and extensive use of worksheets. Many teachers may not be acquainted with the term *constructivism* or the teaching practices it entails. Research has shown that students may learn best when they are required to discover the answer themselves with the use of problem-solving skills (Allevato & Ochunic, 2009; Hiebert et al., 2005; Martinez, 2001; Schank, 2007). Still, DI can be an effective teaching strategy and has an important place in most classrooms (Engelmann, 2007). This study investigated the concern that teachers may not fully understand reform mathematics, or even constructivism, and how to integrate it successfully with DI into their classroom.

Today's elementary classroom is very diverse. There are students with varying abilities and varying family backgrounds, and yet they must all master the same material. The best classroom environment is probably one that includes elements from both constructivism and DI. The issue at hand is that the current research fails to offer teachers strategies and tips to unify and balance both methods. Further, teachers may not fully understand how to implement each method.

Rationale

Evidence of the Problem at the Local Level

The district in this study has always had the reputation of being progressive in education. It is a large district of over 130 schools and 120,000 students and has the resources necessary to provide extensive professional development as needed. However, to date, there are no formal evaluation procedures in place to identify the level to which teachers are using professional development opportunities. This district, while mandating some district-wide policies, allows for local latitude and control over the implementation of these mandates.

The local school in this study has a history of excellent test results in annual standards-based testing. These tests include the Criterion-Referenced Competency Tests (CRCT), the Iowa Assessments (formerly the Iowa Test of Basic Skills), and the

Cognitive Abilities Test. A score of 850 and above on the yearly CRCT is considered to be exceeding state standards. Currently, the average CRCT score for students in this school is over 850 in all subject areas. The percentage of students who either meet or exceed the state standard is more than 97% in mathematics. The mandate from NCLB (2002) was for 100% of the students to meet or exceed standards by the year 2014, and this school was well underway toward already achieving that score (NK, personal communication, 2011, 2012).

Administrators of this school district have directed teachers to teach mathematics for conceptual understanding. This district has adopted the phrase *balanced numeracy* as a companion to its longtime focus on *balanced literacy*. The focus of balanced numeracy is on small-group and individualized instruction, with lessons designed with conceptual understanding, including concrete-abstract lessons involving manipulatives, and a heavy emphasis on problem solving. However, the district is much too large for all teachers to be observed in all settings to ensure compliance. Local schools are tasked with implementing the mandate and ensuring the compliance of the teachers, with support from district resources, such as staff development opportunities and coaching sessions. In an elementary school with more than 80 educators and only three administrators, it is exceedingly difficult to monitor all teachers in all subjects. Most teachers are all-inclusive and teach all subjects, from language arts to science and social studies, in addition to mathematics. Administrators are also tasked with monitoring implementation of other content-specific programs for these other nonmath subjects. Because the school administrators have many tasks to complete during their work day, it is physically impossible for them to ensure that teachers are following district policies in their teaching practices and, therefore, administrators rely on and trust that teachers will be professional and use the latest in teaching methodology without close supervision or follow-up.

No two educators will quite hold the same educational philosophy. While reform mathematics is a push away from direct instruction of mathematics (Ross et al., 2003), many teachers hold the belief that DI is the best way to teach mathematics (Engelmann, 2007; Kim & Axelrod, 2005; see also Adams, 1995; Becker & Engelmann, 1995; Bareiter & Kurland, 1981; Bock, Stibbins, & Proper, 1977; Grossen, 1995; Leno & Dougherty, 2007; Przychodzin, Marchand-Martella, Martella, & Azim, 2004). Therefore, it is safe to conclude that some teachers in the study school may not be implementing the instructional practices of the balanced numeracy approach to the same degree as others.

With student achievement very high at this school, any argument against a particular teacher's practices or his or her teaching preference would be hard to justify. Even then, it is difficult to know what teachers' practices actually are. Teaching practice is often a topic of discussion among teacher colleagues and vertical teams, particularly because a new textbook adoption is being considered for this school. Many teachers seem to favor a more traditional method of teaching mathematics, very often for the reasons already mentioned. In fact, one teacher once stated and later repeated (DC, personal communication, September 30, 2008 & May 24, 2012), "I don't need to use manipulatives; I teach for mastery." The original conversation occurred after observing part of a lesson using manipulatives with an upper grade class. This teacher proceeded to explain that she did not need to use manipulatives or other math tools because she never had yet her students had always performed at high levels on standardized tests. She went on to argue how upper grade students were too old to be using blocks like younger students. What this teacher failed to understand is that while younger students often need more concrete learning models, older students (and even adults) can benefit from multiple modes of learning, too, whether auditory, visual, or tactile. Statements like these point to a hardened attitude against the tenets of the reform mathematics movement. Apart from observation or interview, there is no way to accurately determine teachers' practices in the math classroom in this school.

Because a teacher's espoused teaching philosophy may not align with the teaching methodology used in the classroom, I used two data collection techniques that allowed me to compare the two. A self-report survey is a convenient and reliable way to measure teachers' practices on a broad basis. The survey created by Ross et al. (2003), *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform*, has been validated to ensure its effectiveness. Observation of actual lessons, a second data collection technique, provided yet another way to ascertain teachers' practices. From these findings, specific local staff development programs may be developed to address the specific needs of the school in regard to implementing reform mathematics, including those mandates from the district that fall under this definition. Real-world problem solving and experiential tasks are encouraged by the district, and even required under the new Common Core (CCSSI, 2015) curriculum adopted by the state. This approach is in keeping with calls for research from advocacy groups. The results of this study could then be a catalyst to enable other local schools to conduct a similar study to increase this type of teaching and learning based on a school site's specific needs.

Evidence of the Problem From the Professional Literature

In today's global society, comparisons of factors are made to gauge the effectiveness of citizens in competing in a global marketplace. Education is an essential component of these comparisons. For many years, data for the Trends in International Mathematics and Science Study (TIMSS; originally, the Third International Mathematics and Science Study) have been gathered using written standardized tests as well as videotaped lessons. These studies are usually conducted with students in Grades 4 and 8. These data are then compared by country and analyzed for student and teacher achievement and efficacy. What has been noted through several cycles of these studies is that students in the United States are often outperformed by students in other countries, most notably in Japan (Hiebert & Stigler, 2004; Hiebert et al., 2005; House, 2009; Jacobs et al., 2006; Martinez, 2001; TIMSS, 2010; see also Eacott & Holmes, 2010). Then additional analyses were made that compared other variables, such as teaching practice and teacher philosophy, across countries. These analyses indicated that mathematics teaching in those countries outperforming the United States is often more focused on problem solving and student-centered instruction (Hiebert & Stigler, 2004; Hiebert et al., 2005; House, 2009; Jacobs et al., 2006; Martinez, 2001; TIMSS, 2010).

Reform mathematics has become a buzzword describing the trend of changing the practice and perception of mathematics education (Ross et al., 2003). According to the TIMSS results data, the teaching practices that have been linked to higher student performance are many of the components of reform mathematics instruction (Hiebert et al., 2005; Martinez, 2007)**.** Some of these teaching strategies include open-ended questioning, peer-to-peer interaction, real-life situational problems, and scaffolded instruction (Ross et al., 2003).

As mentioned earlier, the NCTM in its *Principles and Standards of School Mathematics* (2000) advocated the importance of student understanding in relation to mathematical concepts. While skill acquisition is important, understanding why those skills are needed, as well as why and how they are used and applied, is equally important. This ability to achieve practical application and use of mathematics may make the difference in international comparison, and ultimately global competition for jobs and resources. The NCTM published its initial guiding research in 2010 in *Linking Research and Practice: The NCTM Research Agenda Conference Report* (Arbaugh et al., 2010). In this report, 10 major guiding research questions are described within the larger concept of 25 overall research questions. Additionally, the authors addressed the apparent gap between so-called pure research and research that directly benefits teachers and other educational practitioners.

Allen (2011) and Stemhagen (2011) recently published a couple of corresponding articles in which they discussed this very gap. Stemhagen used a self-report survey with a large population to ask teachers about their teaching beliefs and their teaching practices. He focused on the differences between what he called a “transmittal” system, which he described as “traditional,” and constructivist practice. Allen responded to this study by expanding the constructivist framework to include a more general discussion of constructivism, as well as by addressing the possibility of a self-report survey being skewed by teachers overreporting their use of constructivist practices. Dewey (1938) even lamented in his publication *Experience and Education* about what he called the "new" or "progressive" movement in education: "Hence the only ground I can see for even a temporary reaction against the standards, aims, and methods of the newer education is the failure of educators who professedly adopt them to be faithful to them in practice" (p. 90).

The purpose of this study was to use an established self-report survey to establish a baseline set of data with which to enact targeted staff development opportunities for teachers. While the survey for this study, *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform* (Ross et al., 2003), has been found to be reliable and valid (see Section 2), to truly determine the actual teaching practices at this school location, a series of observations was used to clarify the results of the survey. In order to provide a clear comparison between the survey results, which are quantitative, and the observations, the observational data were collected via a rubric with a quantitative rating scale (see Appendix D). These results will allow meaningful staff development opportunities to be designed that are aligned to the specific needs of the faculty of the study school.

Definitions

Reform mathematics: Teaching and learning mathematics that is based on real-world mathematics application, student-centered discovery, and focus on student understanding of mathematical concepts and ideas. This includes, but is not limited to "conjecturing, problem solving, and investigation of mathematical ideas" (Franco, Sztajn, & Ortigao, 2007, p. 394); fostering student discussion, or talk, of mathematical ideas (Bray, 2011, Brodie, 2011), including the use of tools such as manipulatives, calculators, and computers (Ross et al., 2003); and the use of more daily, informal, application-type assessments (Franco et al., 2007; Ross et al., 2003). This philosophy is in contrast with more "traditional" approaches in which teachers are the main presenters of information, and the focus is on skill acquisition through teaching and practicing algorithms and using formal assessments for those skills (Franco et al., 2007; Ross et al., 2003).

Constructivism: In education, a method of instructional delivery in which the student is the center of the learning activities. The learner actively constructs his or her own meaning as an active process (Colburn, 2007; Duffy & Cunningham, 1996; Pegues, 2007). Emphasis on textbooks and memorization is removed; instead, "students are encouraged to think and explain their reasoning instead of memorizing and reciting facts" (McBrien & Brandt, 1997, p. 24). Duffy and Cunningham (1996) provided a more generalized definition of constructivism:

> The term constructivism has come to serve as an umbrella term for a wide diversity of views . . . However, they do seem to be committed to the general view that (1) learning is an active process of constructing rather than acquiring knowledge, and (2) instruction is a process of supporting that construction rather than communicating knowledge. (p. 171)

Direct instruction: In education, a method of instructional delivery in which the teacher is the center of information for the students (Kim & Axelrod, 2005). DI is a systematic approach by which teachers

- Introduce and explain the purpose of the strategy;
- Demonstrate and model its use;
- Provide guided practice for students to apply the strategy with feedback; and
- Allow students to apply the strategy independently and in teams; and regularly reflect on the appropriate uses of the strategy and its effectiveness. (McTighe, 1997; see also Direct Instruction, 2008)

Significance

Informal discussion and observation point to the possibility that many teachers rely primarily on DI approaches in their mathematics classroom. Current research often focuses on the merits of one method of instructional delivery over another, and even then it is often limited to very specific situations or environments (Hiebert & Stigler, 2004; Hiebert et al., 2005; House, 2009; Jacobs et al., 2006; Martinez, 2001; TIMSS, 2010). In this study, I identified the reported instructional delivery system of the teacher and the observed delivery system and describe any discrepancies. The analysis will assist the teachers and administrators in determining if the current delivery systems used in the focus school are aligned with the educational policies of the district.

Helping teachers to understand how and why they teach is important. Being well-versed in what may be the two most prevailing methods of instructional delivery will help provide the flexibility and the knowledge base for teachers to grow and adapt to students' needs. The first step was to ascertain what teachers' current beliefs were concerning reform mathematics and constructivism, and then observe their teaching. This process allows the teachers to gain insight into their teaching styles and their willingness to accept change. It also provided an opportunity to compare and contrast how teachers say they are teaching and how they are observed teaching. The results will inform not only the teachers involved in the study, but also the school's administrators, so that targeted staff development opportunities can be created and made available to the school at large.

With this information, teachers could benefit by having a wider arsenal of teaching strategies with which to address students' individual learning needs. Students can benefit when teachers employ teaching methodologies that are most effective in bringing about deep, long-term understanding of content. The school community at large could potentially benefit from a more effective learning environment that could very well result in higher test scores, higher morale for teachers and students, and a better overall perception by the community. Additionally, this flexibility in teaching should increase teachers' and the school community's ability to accommodate the differences in students that are inherent in the diverse nature of today's society. These differences are not confined to academic or achievement differences, but also encompass social and cultural differences. These are important implications for positive social change in ever-changing and evolving local communities. This study is an attempt to bridge the existing literature on DI and constructivism and provide a potential first step in creating a balanced approach.

Guiding/Research Question

There has been much research over the last 30 years on “new math,” which has been called by various names, but recent literature uses the term *reform mathematics*. This renewed focus has its roots in constructivist theory and other student-centered learning theories (Chandler & Kamii, 2009; Dewey, 1910, 1938; Faulkenberry & Faulkenberry, 2006; Grinberg, 2005; Hennig, 2010; Inch, 2002; Kamii et al., 2005; Kruckeberg, 2006; Lobato, Clarke, & Ellis, 2005; Loyens et al., 2007; Murphy, 2004; Pegues, 2007; Roberts, 2003; Shirvani, 2009). The United States has long been a leader in international education, but recent international studies have shown that in the areas of mathematics and science, the United States actually lags behind many other countries, including Japan and Hong Kong (Hiebert & Stigler, 2004; Hiebert et al., 2005; House, 2009; Jacobs et al., 2006; Martinez, 2001; TIMSS, 2010). These studies have indicated that other countries often employ methods of instruction that are entirely student centered and more progressive than in the United States. Thus, there is the perceived need for mathematics *reform*.

The local school district where this study was conducted is at the forefront of progressive education, and mathematics is certainly an important focus. Because this district is so large, it is left up to local schools to determine local implementation of their balanced numeracy with support and staff development from the district at large. This study provided a method by which local schools can determine a baseline of reform mathematics implementation by their teachers. These data can be used to create or implement local staff development programs to specifically target these local needs.

The study focused on two research questions:

1. What do teachers self-report as their current practices in mathematics instruction related to using constructivist-based reform mathematics, as measured by the *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform?*
2. What are the observed practices of mathematics reform as measured by the *Rubric for Implementation of Elementary Mathematics Teaching Reform*?

Following is a review of current literature in which I discuss recent theory and application of reform mathematics and constructivist techniques. Especially noteworthy is a discussion of the TIMSS studies from 1995, 1999, and 2007. A description of the self-report survey and the observational rubric used in the study follows the discussion on TIMSS.

Review of the Literature

I used the following specific keywords to search for literature related to my topic: *constructivism*, *direct instruction*, *reform mathematics (math)*, *problem solving*, *writing and mathematics*, *creative mathematics*, and *educational philosophy*. Additionally, I used more generic terms such as *mathematics*, *teaching strategies*, and *elementary classroom*. A wide variety of tools were used for the literature search, including basic Internet searches, but the Walden University Thoreau metasearch resource was the most extensively used. Several journal databases were queried, such as ERIC, Education Research Complete, and many other education- and non-education-related journals. Additionally, the NCTM website and journals were used extensively. Some sources were excluded because emphasis was not placed on elementary education, or because the topics were not correlated to constructivism or reform mathematics. Other sources were excluded because the primary emphasis was on another country and its educational concerns, without direct correlation to the United States.

To better understand the theoretical underpinnings of the movement of reform mathematics, one must understand the more generalized philosophies of constructivism, as well as its theoretical opposite, DI. Both constructivism and DI are defined and discussed as general educational philosophies, as well as in terms of how they each pertain to mathematics instruction. Additionally, DI is compared to constructivism, and what has been reformed in reform mathematics instruction is better identified with an understanding of DI. International studies are also explored to describe ongoing attempts to discover current trends in education and how other countries' teaching models compare to those in the United States, specifically as they relate to student achievement.

Theoretical Foundation

To step into many elementary classrooms is to see children at desks completing worksheets or practicing math drills. In still other classrooms, students are engaged in both large-group and small-group discussions and experiments. What is the best way for students to learn? Some combination of constructivism and DI probably works best, and the teacher determines that based on his or her classroom make-up (Ryder, Burton, & Silberg, 2006). However, many teachers may not be aware of specific teaching techniques, particularly those advocated by constructivists, which may be of great benefit to themselves and their students. In the traditional classroom, teachers teach how they were taught, usually with many worksheets, and often in conjunction with various anthologies or other curriculum resources.

Constructivist principles are those that put the student at the center of his or her own learning (Colburn, 2007; Duffy & Cunningham, 1996; Loyens et al., 2007; Pegues, 2007). In the constructivist classroom, there may be a physical experience in which the student participates, or there may be a simple discussion in which the student is encouraged to discover connections on his or her own. By contrast, DI methods are those that are teacher-centered (Harris & Graham, 1996; Leno & Dougherty, 2007; Viadero, 2002). Lectures and demonstrations are typical methods of DI.

Teaching as a constructivist is an individual matter for teachers (Faulkenberry & Faulkenberry, 2006; Vacc & Bright, 1999), as there is often no set methodology or curriculum (Simpson, 2002). Rather, there are some specific methodologies that fall under the term *constructivism*. Teachers are required to assess students' thinking and be knowledgeable and flexible enough to guide students to a better understanding of concepts (Burns, 2005; Faulkenberry & Faulkenberry, 2006; NCTM, 2000; Vacc & Bright, 1999). While various techniques fall under the umbrella of constructivism, it is ultimately the students, guided by teachers, who provide the motivation for learning concepts and skills in mathematics. These definitions are consistent with the "dimensions of elementary mathematics reform" described by Ross et al. (2003).

Many constructivists trace their philosophies back to those of Dewey and his experiential learning theory (Grinberg, 2005; Kruckeberg, 2006; Lobato et al., 2005; Loyens et al., 2007; Pegues, 2007; Roberts, 2003). Dewey (1938) most concretely codified his philosophy in one of his seminal works, *Experience and Education*, a lecture to Kappa Delta Pi. Throughout this work, Dewey compared what he called *traditional* and *progressive education*. He opened early in the book with this statement: “The history of educational theory is marked by opposition between the idea that education is development from within and that it is formation from without” (Dewey, 1938, para. 1).

Dewey (1938) compared teachers who were the center and controlling factor in how knowledge was transferred with teachers who were members of the social group in which they led and mediated student learning. Teachers in the former group taught concepts often in “isolation” from context, whereas teachers of the latter group provided students with appropriate and stimulating experiences that were relevant to what the students were familiar with and could understand. The goal, ideally, was to inspire students to continue the process on their own (Dewey, 1938). His concepts sound much like the arguments surrounding the controversy of constructivism and DI discussed in this study, even though he wrote the words over 75 years ago. It is this educational dichotomy that forms the basis of this study. There is a belief that experiential learning, in the guise of reform, or constructivist, mathematics, is superior to DI and should be emphasized in the teaching of mathematics.

In summary, constructivist-based reform mathematics in the math classroom may look like this: Students formulate their own approach to mathematics concepts with teacher guidance. This guidance includes exercises in exploration; and problem solving including real-world situations; small-group and classroom discussion; and writing and thinking about mathematics. While basic skills and algorithms may be used, students will have been guided by the teacher and the context of the situation to reach these conclusions at least partially on their own. As Dewey (1938) wrote, “Now, all principles by themselves are abstract. They become concrete only in the consequences which result from their application” (p. 20).

Reform Mathematics

Mathematics education has been transforming itself over the last several decades. The trend, as noted in TIMSS, is a movement toward a more student-centered, or learner-centered approach to mathematics education (Hiebert & Stigler, 2004; Hiebert et al., 2005; House, 2009; Jacobs et al., 2006; Martinez, 2001; TIMSS, 2010). The educational system in the United States is often compared to that of the rest of the world, and as recently as in November 2010, the performance of U.S. students was described as being behind that of other countries’ students (“Fierce Urgency,” 2010).

Schank (2007) wrote an editorial in which he decried “teaching to the test” (p. 84) and lamented students’ lack of interest in math and science. He stated that teachers should be teaching students how to think, not just how to solve an equation. Math is boring because teachers make it boring. Reform mathematics can be described as a movement away from what could be called a traditional approach to mathematics education—teacher-centered instruction such as lecturing, modeling, and drill—toward a more student-centered, problem-solving, hands-on approach (Boaler, 2002; Bray, 2011; Brown, Pitvoric, Ditto, & Kelso, 2009; Fraivillig, Murphy, & Fuson, 1999; Franco et al., 2007; Ross et al. 2003; Smith & Star, 2007).

The next logical question, then, is this: Are teachers' instructional practices reflective of these reforms? Ross et al. (2003) described reform mathematics in terms of nine dimensions and created a self-report survey based on those dimensions. This survey is used to allow researchers to determine teachers' practices in their classroom. These dimensions describe, among other things, the teacher as a "colearner" (Dimension 4, Ross et al., 2003, p. 348) and promote "student-student interaction" (Dimension 6, Ross et al., 2003, p. 348). They also embody "the construction of mathematical ideas through student discovery" (Dimension 3, Ross et al., 2003, p. 348) as opposed to teacher-centered instruction. These ideas directly correlate and are an embodiment of constructivism (Colburn, 2007; Duffy & Cunningham, 1996; Faulkenberry & Faulkenberry, 2006; Pegues, 2007; Quale, 2012). This survey was designed to minimize the discrepancy between teacher self-report and actual practice. A self-report data collection method provides a low-cost way of establishing educational norms at any location (Ross et al., 2003). Other methods for determining implementation of reform instruction exist but are often tied to specific curricula or textbooks instead of a philosophy of instruction (Brown et al., 2009; Huntley, 2009). Educational philosophy, beliefs, and opinions ultimately contribute to how a teacher teaches, although those beliefs are not always observed in practice (Allen, 2011; Bray, 2011, Ross et al., 2003; Stemhagen, 2011). The educational philosophy expressed by these reform ideals can be called *constructivism*.

Defining Constructivism

While the idea of reform mathematics has been adequately defined in the literature, particularly by Ross et al. (2003), the closely related concept of constructivism is less well articulated. However, understanding the roots of constructivism can greatly inform the rationale behind the push for reform mathematics. Constructivism is more of a philosophy or a theory of learning than a methodology (Simpson, 2006). As mentioned earlier, perhaps the best way to describe constructivism is as “an umbrella term for a wide diversity of views” (Duffy & Cunningham, 1996, p. 171; see also Quale, 2012). Hennig (2010) described it by stating that “every constructivist constructs his or her own ideas of ‘constructivism’ anyway, and it should not be surprising that there are some essential differences among constructivists” (p. 3).

In its most general sense, constructivism means that students construct their own understanding by assimilating new knowledge within the construct of their own prior experience. Teaching by DI does not seem to contradict this definition; it is just a matter of how students gain this *new* knowledge. This transfer of knowledge has been dominated by lecture and DI for a long time (Faulkenberry & Faulkenberry, 2006).

According to the NCTM (2000), “Teachers' actions are what encourage students to think, question, solve problems, and discuss their ideas, strategies, and solutions” (p. 17). Furthermore, “effective teaching involves observing students, listening carefully to their ideas and explanations, having mathematical goals, and using the information to make instructional decisions” (NCTM, 2000, p. 18). These statements certainly seem to fall in line with a constructivist view of mathematics and education.

Faulkenberry and Faulkenberry (2006) gave the following as a guideline:

> While constructivism takes on many different forms, the essential core beliefs of constructivism in mathematics education can be summarized as follows:
>
> 1. Mathematical knowledge is actively constructed through a process called reflective abstraction.
> 2. Cognition is evolutionary: cognitive structures adapt to disturbances from novel stimuli in order to accommodate the stimuli in an ordered fashion.
> 3. Constructivism as a teaching practice is difficult to maintain in its purest form, but it is a beneficial style of pedagogy that puts the student, rather than the teacher, at the center of the learning process. (p. 20)

It is difficult to remain pure because teachers must ensure that students acquire certain and specific skills. What, then, can teachers use to implement a constructivist framework and still ensure skill acquisition?

Constructivism in the Math Classroom

Stiff (2001), past president (2000-2002) of the NCTM, explained that constructivism in math “does not exist” (para. 5). This is an interesting premise, especially considering that mathematics is at its heart a hands-on system, even though it tends to be abstracted through the use of numbers and symbols to represent real things, actions, or phenomena.

Murphy (2004) argued that students must be taught explicitly because they may not construct something that is necessary. Specifically, Murphy was concerned that students may not construct certain “calculation strategies” (p. 4) and would, therefore, be at a disadvantage. In her study, Murphy used a DI method to teach a specific mental calculation method to three students. Only two of the students used the strategy, and they each approached it differently. Murphy surmised that the students' previous knowledge and "initial spontaneous approaches" influenced their assimilation of the strategy (p. 13). Murphy acknowledged this as a limitation of the study. This may be viewed as an axiom: Even when students are explicitly taught a mathematical strategy—or anything, for that matter—students may assimilate the material in unpredictable ways. There is no guarantee that students will learn and use the taught strategy as intended.

This does not, however, answer the question of whether students would have figured out the "correct" strategy on their own. Lobato et al. (2005) asserted that sometimes students will not create, construct, or devise a correct or efficient strategy and that a means must be presented to fill in the gaps. Their process of "telling" involves what they called "initiating" and "eliciting" (Lobato et al., 2005, p. 101). In short, teachers must formatively assess students' understanding of a lesson or concept, and then constructively guide them to reach the desired conclusion. Lobato et al. described several case studies in which teachers at various times used questions and other guiding principles to lead students to a desired outcome. In some instances, this required specific, direct intervention in order to correct a perceived gap in understanding.

McLoughlin (2009) took this a step further by advocating a move distinctly into the practical. The fundamental premise was that mathematics is learned by doing something—by applying skills to actual use. McLoughlin made a shift away from what even he acknowledged as student-centered and teacher-centered instruction to advocate a possible third type of instruction that he called “Content-Centered Instruction” (p. 3-ff). He framed his content-centered approach as “Inquiry-Based Learning” (McLoughlin, 2009, p. 6). By his definition, this is neither completely student centered nor completely teacher centered, but rather a fluid combination of the two. Rather than focusing primarily on practice, content is maintained as the most important consideration. He further explained that students must not only be able to obtain the correct answer within a practical setting, but also be able to prove their answer and do it correctly (McLoughlin, 2009, p. 8). This seems to agree with Murphy (2004) and Lobato et al. (2005) and his concerns about students not only getting the correct solutions, but obtaining them in the discipline’s accepted manner, or, in other words, “not just ‘get[ting]’ an answer by ‘any means’” (McLoughlin, 2009, p. 8).

Constructivism and Problem Solving

A longitudinal study by Pianta, Belsky, Houts, and Morrison (2007) followed a large number of fifth grade classrooms. Observations were made to determine what type of instruction happened in these classrooms. The authors noted that more than 90% of the school day was spent in large-group or independent work settings (p. 2). Additionally, these fifth graders “received 500% more instruction in basic skills than teaching focused on problem solving or reasoning” (Pianta et al., 2007, p. 2). This observation is consistent with the TIMSS studies comparing U.S. education with the education provided in other countries (Hiebert et al., 2005; Martinez, 2001). Especially noteworthy is the statistic on basic skills versus problem solving. Why is so much time being devoted to practicing basic skills, and so little time being given to applying those skills? If students are not required to think about the math, or how to apply it, then what are they really learning? In the rush to increase student achievement on tests, teachers may be hampering students' ability to adapt to changing climates of society (Schank, 2007).

Although it is acknowledged that constructivism in the math classroom does not necessarily have a set methodology, several generalizations can be deduced from the research. According to the TIMSS studies (Hiebert et al., 2005; Martinez, 2001), aspects of teaching mathematics that define countries described as *high achieving* include the use of problem solving, making connections, and having students explain their work. Allevato and Onuchic (2009) described an approach used in Brazil called "Teaching-Learning-Evaluation through Problem Solving" (p. 5). Allevato and Onuchic qualified their approach by stating, "It corresponds to work in which a problem is the point of departure for learning, and the construction of knowledge occurs in the process of solving it" (p. 5). Moreover, they asserted that classrooms in Japan often revolve around solving a problem and the multiple approaches that may have been used to achieve the solution. This certainly corresponds to the findings of the TIMSS studies (Hiebert et al., 2005; Martinez, 2001), in which Japanese students were encouraged to not only find their own solutions, but also share and compare their solutions with their peers. The teacher then acted as a facilitator or mediator as the students shared. The overarching conclusion of Allevato and Ochunic (2009) was that "students' construction of knowledge related to mathematical concepts and content occurs more meaningfully and effectively" (p. 9) when approached through problem solving.

Constructivism and Thinking

Faulkenberry and Faulkenberry (2006) added the idea of reflection to the notion of constructivism and problem solving. Not only are students required to actually solve a problem, but they are also required to explain how they arrived at the solution. This act of reflection stimulates metacognition in students (and teachers). In this way, thoughts are organized and new meaning constructed. Similarly, Burns (2004, 2005) advocated the use of writing in the math class in conjunction with discussion in the process of problem solving. Having students discuss and write their explanations not only aids the students, but also allows for invaluable assessment opportunities for the teacher. By focusing on students' interpretations and understanding, a teacher can determine what strategies are being used and how they are being used. Further guidance can then be delivered appropriately. While the open discussions are more for formative assessment, written work can be used as both formative and summative assessments.

Hyde (2007a, 2007b) advocated the use of literacy strategies as part of mathematical problem solving. His basic approach involved thinking about math in the way that students are taught to think about reading. This is especially true with making connections: “math-to-self,” “math-to-world,” and “math-to-math” (Hyde, 2007a, p. 3). This distinctly constructivist approach allows and encourages teachers and students to think actively about math, not just practice individual skills. This interdisciplinary approach also makes vocabulary more standard and lessons more familiar to students. Another cross-curricular link is described as story-telling (Schank & Berman, 2006; see also Schank, 2002). Framing the educational experience in a context that connects to the individual makes it real. It bridges the abstract with the concrete and allows students to internalize the information.

Kline (2008) further reinforced this idea of *thinking* about math. Kline created an atmosphere in which teachers can engage student thinking by playing to their relative strengths and weaknesses. She made a comparison of “extroverts” and “introverts” (p. 145) and explained how not to fall into certain teacher traps. Introverts may know the answer but not vocalize it, whereas extroverts may blurt out answers, right or wrong. Kline advocated the use of incorrect solutions to build discussion. She used those incorrect answers to scaffold a series of questions of how and why, much in the same way a teacher would correct answers. By having students share their thinking, the correct solution was often identified as the students themselves discussed it. When the mistake was found, it became a teaching moment of what not to do.

The shared thinking activity accomplishes several things. First it allows students to feel comfortable with expressing themselves, even if they may be wrong. Secondly, it allows teachers and students alike to question the solution, leading perhaps to another understanding or deeper understanding. Lastly, it gives the teacher the ability to set up an environment of questioning, whether the solution is correct or not. Kline (2008) noted that some teachers will need to fight the urge to correct a student themselves or inadvertently place a negative tone on the students’ answers. In the end, questions lead not only to answers but more questions. This circular approach drives student inquiry and encourages students to construct their own understanding of mathematical concepts.

The Exemplars (http://www.exemplars.com/) has devised a para-curriculum that focuses on problem solving with real-world applications. Exemplars are explicitly tied to NCTM (2000) standards, as well as the Common Core State Standards (CCSSI, 2015). The tasks provided in the Exemplars materials involve not only problems and solutions but differentiation and assessment as well. Exemplars is a form of written product, with emphasis on specific NCTM standards, including communication and making connections. Although it does not replace any existing curriculum, it enhances any currently used method. Exemplars can be completely open-ended for individual and group activities. This means they are situated well within a constructivist framework, and yet there are aspects that can be taught through direct instruction as well.

Positive Studies for Constructivism

Kroesbergen and van Luit (2002) conducted a study in the Netherlands on low-performing math students using a process based on “Realistic Mathematics Education” (p. 361). They claimed it is based on NCTM models in the US from as early as 1989 (p. 361). According to Kroesbergen and van Luit, constructivism requires students to be “proactive” and teachers to “structure” lessons to ensure that students will discover the required knowledge (p. 362). Teachers further aid students by posing questions and problems that will lead students to a solution. Discussion by students, as well as the teacher, will further reinforce the knowledge assimilation. Students remain in control, and they are responsible for introducing the new strategies or concepts. This process introduced by Kroesbergen and van Luit (2002) fits nicely within the *Dimensions of Mathematics Reform* defined by Ross et al. (2003). The idea of student-centered discovery with teacher guidance is at the center of many of the dimensions proposed by Ross et al. (2003), particularly Dimensions 3, 4, 6, 8, and 9 (see Appendix B).

Kroesbergen and van Luit's (2002) study focused on two different teaching methods. The first method was structured instruction, resembling the traditional DI models—"the teacher always tells the children how and when to apply a new strategy" (Kroesbergen & van Luit, 2002, p. 368). The second method was guided instruction, centering on the students—"in the guided instruction condition, much more space is provided for the individual contributions of the students" (Kroesbergen & van Luit, 2002, p. 369). The control group was regular classroom instruction. In general, the students in the guided instruction group were able to outperform students in other groups, but especially on the transfer test. This test was specifically designed to see whether students could take the newly learned skills and apply them in different contexts. The authors commented that "because the students in the GI condition have learned to actively think and talk about these strategies, it is not surprising that they performed particularly well on this test" (Kroesbergen & van Luit, 2002, p. 374).

Another study conducted by Kamii et al. (2005) studied low-performing first graders who were also from low socioeconomic backgrounds. The control group received usual math instruction all year through textbooks, workbooks, and associated activities, while the experimental group received mathematical activities described as "physical-knowledge" based on Piaget's theory of instruction (Kamii et al., 2005). These activities and games were based on students using physical movement or manipulation of materials in their environment and related to the mathematical principle being taught. One example provided by Kamii et al. (2005) was “pick-up sticks.” The activities reflect the ideas in reform mathematics described by Ross et al. (2003) such as program scope, student interaction, and discovery (p. 348).

The experimental condition continued for the first half of the school year, followed by regular math instruction during the second half of the school year. The amount of time spent during the math period was the same for both the experimental and control groups. The results showed that the experimental group outperformed the control group in almost every way. The authors noted that “although the children in the constructivist group did not have traditional instruction in arithmetic during the first half of the school year, they did considerably better on the posttest than those who received traditional math instruction during the entire year" (Kamii et al., 2005, p. 47). The constructivist teaching strategies focused on the use of logic, specifically in word problems. The findings of both studies by Kamii et al. and Kroesbergen and van Luit (2002) support the constructivist approach to teaching mathematics.

Challenges to Constructivism

There are, of course, studies that challenge these findings, at least inasmuch as there are claims that DI models are superior to constructivist ones. One of the longest and most thorough studies is Project Follow Through (1968-1977). Through the Department of Education, researchers of Project Follow Through studied the efficacy of several educational models, including the DI model (Engelmann, 2007; Kim & Axelrod, 2005; see also Adams, 1995; Bareiter & Kurland, 1981; Becker & Engelmann, 1995; Bock et al., 1977; Grossen, 1995). The results showed significant differences between DI and other teaching that employed non-DI instructional methods; specifically that DI was by far the most effective instructional method in the comparison to the others. Engelmann (2007) described two of these other programs: Cognitive Curriculum (High Scope; McClelland, 1970), based on the instructional methods of Jean Piaget; and Bank Street, described as “progressive” and “child-centered,” and heavily influenced by the work of Dewey and others (Grinberg, J.A., 2005). The assertion made by Engelmann (2007) and others (Adams, 1995; Bareiter & Kurland, 1981; Becker & Engelmann, 1995; Bock et al., 1977; Grossen, 1995) was that DI models outperformed other instructional models, specifically those labeled or described as student-centered or experiential. This assertion must be tempered, however, with the before-mentioned acknowledgment that constructivism is neither an explicitly defined methodology, nor a curriculum. It is also important to note that although the student demographics studied were in different locations they were all Title I educational locations (Adams, 1995; Bareiter & Kurland, 1981; Becker & Engelmann, 1995; Bock et al., 1977; Engelmann, 2007; Grossen, 1995). It is entirely possible that the differences observed in the compared programs could be explained by mistakes in implementation or inadequate resources, and not necessarily the underlying philosophy. A broad-based, heterogeneous longitudinal implementation study could not be located in the literature.

A more recent review was made comparing several studies involving DI curriculums and comparing and rationalizing them with NCTM (2000) standards (Przychodzin et al., 2004). The majority of the discussion was focused around how DI can satisfy NCTM (2000) standards, followed by a discussion of several studies in DI.

While most of the studies did show gains in student learning, even impressive ones, most studies assessed the curriculum itself rather than specific teaching techniques or philosophies of instruction like reform mathematics or constructivism (Przychodzin et al., 2004). Because these studies focused on specific curricula, discussion of constructivist techniques was made for comparison purposes and background information. Since constructivist theory encompasses a wide variety of techniques and not a specific curriculum, the comparison against DI can be somewhat skewed.

International Studies

The Third International Mathematics and Science Study (1999) was a video study conducted to compare teaching practices across many nations. For analyzing the performance of the United States, the US was compared with “six higher achieving countries” (Hiebert et al., 2005, p. 111, 114): Australia, Czech Republic, Hong Kong SAR, Japan, the Netherlands, and Sweden. Several conclusions were drawn by Hiebert et al. (2005):

Teachers and classrooms in the US tended to show these “characteristics” (p. 116):

1. “A low level of mathematical challenge” (p. 116),
2. “Prevalence of routine exercises” (p. 117),
3. “Practicing familiar procedures” (p. 117),
4. “Relatively elementary content” (p. 118), and
5. “Absence of mathematical reasoning” (p. 118).

Of particular note was the lack of making connections within the U.S. mathematics classrooms: “virtually none of the making connections problems in the United States were discussed in a way that made the mathematical connections or relationships visible for students” (Hiebert et al., 2005, p. 120). This emphasis on procedure rather than a conceptual understanding may very well contribute to the statements concerning content and challenge. If teachers perceive that their students do ‘get it,’ they may review and continue to emphasize the procedures, leaving little time to explore new concepts or more challenging concepts in depth.

Hiebert and Stigler (2004) noted that the difference in many countries participating in the 1999 Third International Mathematics and Science [Video] Study revolved around the approach to teaching, or more specifically the teaching of conceptual relationships. They noted that although the US did present problem solving as a teaching method about as much as other countries, teachers in the US “always stepped in and did the work for the students or ignored the conceptual aspect of the problem when discussing it” (Hiebert & Stigler, 2004, p. 12). According to their analysis, American students spent less than 1% of their instructional time exploring concepts and relationships (Hiebert & Stigler, 2004, p. 12). Furthermore, the researchers concluded that the curriculum is not necessarily the problem, although that type of reform is often attempted. The problem is how the teachers teach. Teachers should be exposed to examples of reflective teaching strategies and analysis of student work that allows them to focus on these concepts, not just skill acquisition.

Japan was the highest achieving country in the 1999 Third International Mathematics and Science [video] Study. Hiebert et al. (2005) claimed that although much can be learned from the Japanese system, the overall approach of the Japanese is so different from that of the US, that the US cannot completely follow their model without "a nearly complete replacement" (p. 126). Still, Martinez (2001) also made some suggestive comments about the 1999 Third International Mathematics and Science [video] Study. He noted that in Japan, problem solving instruction is the primary focus, with students explaining their own work, rather than receiving the explanation or instruction directly from the teacher. Students actively create their own systems of solutions, not memorizing a preconceived set of rules and procedures (Martinez, 2001).

According to Martinez (2001), math education should move toward understanding and away from relying on isolated skill acquisition absent from application. He suggested a three-step approach that he described as "exploration, invention, and discovery" (p. 115). This approach means that students should "explore" the mathematical concepts being studied, "invent" their own ways of understanding and methods of solving the problems, and "discover" new avenues for application and extension (p. 115). This dichotomy between active and passive learning is what Martinez is trying to underscore.

Another difference of Japanese instruction is the focus on the introduction of new content. Givvin, Hiebert, Jacobs, Hollingsworth, and Gallimore (2005) explored the idea of consistency within and across countries. The overall conclusion of this study was that in its most general sense, many countries do not differ too much from each other on the parts of a mathematics lesson. However, as the focus is placed on individual parts, larger differences, possibly cultural, are more apparent. They found that one significant difference between the Japanese and US script was that while the US focused a large portion of time on “practicing definitions and procedures” (p. 315), classrooms in Japan focused on new content.

Still, Schmidt, Houang, and Cogan (2004) found a different reason to sound the call for action based on the 1995 Third International Mathematics and Science [video] Study, just a few years earlier. At the time, they saw that the lack of achievement in the US was due to a negative view of content standards. Specifically, the United States did not have a specific, national system of standards to which all students were taught because “we believe that America’s poor average achievement, as well as our strong link between achievement and SES [socio-economic status], can be traced in part to our lack of a common, coherent curriculum” (p. 26). The focus of Schmidt et al. was on ‘what’ is taught ‘when,’ and standardizing it across the entire nation. As an additional note, in 2014, the Common Core State Standards (CCSSI, 2015) were adopted by most states in an attempt to create a set of national standards.

Furthermore, House (2009) had another deduction. Another TIMSS assessment was undertaken in 2007. Although this time TIMSS was not a video study, some new information came to light. House’s review focused directly on Japan, consistently shown to be the highest achieving nation among all of the TIMSS studies. While House did not dispute the findings of earlier analyses, his focus was on student opinions, actions, and achievement. In short, students who practiced, memorized, and explained their work tended to have higher achievement scores. Surprisingly, House found that students who "frequently engaged in cooperative learning activities tended to earn lower mathematics test scores" (p. 305). Although cooperative learning activities may be considered a facet of constructivist theory, this puzzling finding need not cause alarm. House acknowledged cultural differences between Japan and the United States, particularly in work ethic, noting that further research would be needed to address these differences (pp. 305-306).

Bracey (2009) wrote a piece comparing, contrasting, and ultimately criticizing large international studies, including the TIMSS. His argument was that comparing a large, diverse nation like the United States to "tiny, homogenous city-states like Hong Kong and Singapore" (Bracey, 2009, p. 4) is basically unfair. It is like comparing apples to oranges in many respects. Bracey further noted that although the educational performance of students is often used as an indicator of economic success, the opposite is often the case. He cited the economic difficulties of Japan, Singapore, and India in the last few decades despite their very high achievement results. Even with recent economic difficulties worldwide, the United States is still among the most productive and innovative countries (Bracey, 2009).

Implementation of NCTM Standards

Because the NCTM Standards play a significant role in shaping mathematics education, understanding how U.S. mathematics classrooms compare with the implementation of NCTM (2000) standards could be an important area for study. Jacobs et al. (2006) conducted a comparison of the 1995 and 1999 Third International Mathematics and Science [video] Study to identify how those U.S. classrooms incorporated NCTM standards. Although the NCTM *Principles and Standards for School*

Mathematics document was not published until 2000, NCTM had asserted the basic principles through other documents and means. Respondent teachers were asked to self-report their assessment of how they implemented the standards. While the teachers held a relatively high opinion of their implementation, the researchers concluded that although there was some implementation, they described it as “at the margins of teaching, rather than at its core” (Jacobs et al., 2006, p. 30). They also noted that the teaching observed in the video study “reflects the kind of traditional teaching that has been documented during most of the past century” (Jacobs et al., 2006, p. 28). They further defined this traditional teaching as whole group presentation followed by individual practice on skills, decidedly a DI approach to teaching.

Other researchers (Allen, 2011; Stemhagen, 2011) have recently studied the difficulties of teachers meeting the needs of educational mandates while holding true to their teaching beliefs. Allen (2011) lamented the resistance of mathematics change in the United States and suggested a constructivist framework as promoted by Stemhagen (2011) to continue the change. Before this can happen, “a fundamental shift in the power dynamic” must occur (Allen, 2011, p. 1). Nevertheless, Allen (2011) continued to describe what she saw as a typical mathematics classroom:

1. Teacher begins the lesson with a warm-up or other launch activity.
2. Class corrects homework from the previous lesson.
3. Teacher presents new material.
4. Class practices new idea or technique.
5. Teacher assigns homework for the next class. (Allen, 2011, p. 2)

Moreover, Allen (2011) asserted that this manner of teaching mathematics year after year not only promotes student anxiety, but begets new teachers who will in turn teach this same way. Stemhagen (2011) stated, and his sentiments were echoed in Allen's (2011) response, that it seems that constructivism is indeed seen as more difficult to implement than traditional methods (p. 9). The more pressures that are placed on teachers, the more difficult it will be to advocate a more constructivist or reform philosophy. Allen's (2011) critique of Stemhagen's (2011) research identified a critical issue, that teachers tend to "over-report their use of more reform-minded practice" (p. 2). Surveys supply very useful data, but how much of it is skewed? A process of teacher observation would be one way to validate the results of the survey design.

Implications

Based on the available literature and the results of this study, many options for the project could be offered. However, a staff development program seems most fitting. The findings indicated that teachers tend to show a positive level of agreement with reform mathematics, but they are not embracing constructivist-based reform mathematics teaching strategies at the highest levels. Continuing teacher education and training seems appropriate. Still, one of the disadvantages presented here is the lack of time, resources, and staffing to properly observe, teach, and mentor a large number of teachers. For that reason, a staff development program, or perhaps a course, using available technology, including video and computer technology, is a viable option. Instead of purchasing materials that may or may not match the needs of the study school, local production of materials will allow the needs of the teaching community to be addressed specifically using local resources and local teachers, and the program can be updated as needed.

Summary

For over a century, the United States has often been viewed as a leader in world politics, economics, and social issues. To that end, the United States should also strive to be a leader in educational issues, as education is ultimately the foundation of any society. Philosophy is often a matter of opinion, and educational philosophy is no different. While there may be no “best” way to teach mathematics, the essence of reform mathematics is based on research and data that are compiled from across the globe. The impact on best practices in education cannot be understated. Students are expected to not only learn mathematics skills, but they also must be able to apply those skills. They must adapt to an ever-changing environment, whether that is in their hometown or across the world.

This study sought to identify both the educational philosophies of the mathematics teachers and the observed instructional methods used in their classroom. Specifically, this study viewed teacher practice as it pertains to constructivist-based, reform mathematics as defined by Ross et al. (2003). Using a self-report survey allows research to be conducted quickly and anonymously, and allows educational leaders to tailor staff development opportunities to keep their teachers trained in the most up-to-date, research-based instructional strategies. As much as students need individualized instruction, so do teachers. The philosophy behind reform mathematics is a current focus of the district and local school, and this study stems from the need to assess teachers’ practices and determine any staff development needs based on those practices. In Section

2, I will discuss the methodology involved in implementing the self-report survey in the local setting and the results of the analysis of the collected data.

Section 2: The Methodology

Introduction

One way to determine how a teacher teaches is to observe that teacher. Considering the number of teachers employed in a large district, it is impractical for administrators to closely monitor through observation each teacher's philosophy and instructional methods. Teachers are hired based on professional qualifications, and their performance is expected to match. Administrators must rely on teachers' professional judgment to teach to the best of their ability. Regular teacher assessment procedures attempt to ensure this. These assessments, though, often do not discern between one teaching philosophy and another. Further, there is the possibility that espoused teaching philosophy does not match teaching practice. A teacher may wholly subscribe to a particular teaching philosophy and yet not consistently apply it in practice. Viewing teachers through the lenses of both a self-report survey and observations allows both their philosophy and practice to be examined. The results of both complement each other to create a more holistic picture of their teaching (Halcomb & Andrew, 2009). In this study, I used a quantitative methodology to answer the research question. Specifically, I collected data through a self-report survey while concurrently conducting a series of classroom observations. The observations were evaluated by a rubric provided in the original survey development by Ross et al. (2003). The observation protocol consisted of a physical copy of this rubric with additional space provided for field notes. Because the rubric was designed by assigning a numeric value to each level, the data were quantitative.

A self-report survey was used to ascertain teachers' perceptions regarding themselves and their philosophies. The survey chosen for this study, designed by Ross et al. (2003), accurately assesses and reflects teaching practices in relation to reform mathematics. The authors determined through their reliability and validity study that their survey accurately reflected the teaching practices of participants. However, without actually observing the teachers in action, there are only self-report data. This statement is not meant to accuse teachers of deliberately falsifying any report to sway any perception of them as teachers, but rather to determine whether their teaching methods mirror their espoused philosophy (Allen, 2011). Combining survey data with observational data allows researchers to explore the mind and practice of the participants more fully (Cameron, 2009; Halcomb & Andrew, 2009; Hesse-Biber, 2010; Niglas, 2009). Collecting quantitative data for the observation allowed for a more objective analysis.

To fully describe the self-report and observational data, a descriptive approach was used in the analysis. The survey, *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform* (Ross et al., 2003), found in Appendix C, was administered to determine teachers' self-reported practices in the math classroom. Concurrently, a series of observations was undertaken to measure teachers' observed practice. A rubric, also created by Ross et al. (2003), *Rubric for Implementation of Elementary Mathematics Teaching Reform*, found in Appendix D, was used to evaluate the observations. The observations gave me an opportunity to allow teachers a platform through which to expand on their opinions and practices. Self-report surveys are excellent tools, but direct observations of classroom practices allow for a more in-depth analysis of what is occurring in the math classroom.

Setting and Sample

This study was conducted in a large suburban elementary school in the southeastern United States. There are approximately 1,000 students and approximately 50 teaching staff members employed in this school. The focus of the study was limited to the elementary school level at one elementary school. Of these 50 teachers, 6% (three teachers) were male, 6% were African American, and 6% were Asian American. However, for the purposes of this study, demographics were not considered a variable necessary for comparison, nor were other variables such as educational level and years of experience considered. These variables were beyond the intended scope of the study.

The only inclusion criterion required of all participants in the study was that the teacher must teach math in the school. Special area teachers (art, music, physical education, etc.) were not included in the sample because they did not teach math directly and therefore did not fit the criterion. Thirty-seven out of 50 teachers were eligible participants. Out of the 37 possible participants, 31 teachers completed the survey, and a smaller sample of 15 participated in the observation portion of the research.

Instrumentation and Materials

The survey instrument used to determine the classroom practices of teachers was the *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform* (see Appendix C) developed by Ross et al. (2003). This 20-item survey was designed based on nine dimensions of mathematics reform identified by Ross et al.

(2003) from an extensive background review of 154 published studies. The survey was tested for scale reliability in two administrations, both with K-8 teachers. The first administration surveyed 517 teachers, and the second surveyed 2,170 teachers. The data were analyzed from each administration to determine the internal consistency of the survey items as a scale. In both cases, scale reliability was calculated at .81 (Cronbach's α; Ross et al., 2003). Therefore, internal consistency was established among the 20 survey items. Multiple school locations were used to provide an additional measure of validity. These results showed that this instrument is indeed a reliable and valid instrument and provided excellent data in this study.

Further, the instrument was analyzed for predictive and construct validity by using observations of those teachers who scored as both low and high reform on the survey. For predictive validity, Ross et al. (2003) used their research and literature to predict that students from schools with higher scores on the survey would have higher achievement than students from schools with lower scores on the survey. By using a mandated assessment that aligned with the curriculum, Ross et al. (2003) were able to correlate student achievement to the survey responses from teachers.

Construct validity of the instrument was determined by Ross et al. (2003) by analyzing teacher use of a particular textbook supporting the mathematics teaching espoused in their survey. Fourteen teachers who scored in the highest and lowest quartiles of the *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform*, nine high and five low, were interviewed about the use of their particular text in their teaching. Ross et al. interviewed these teachers to correlate how their use of the text might relate to their level of agreement on the survey. In general, teachers scoring high on the survey reported using the text to support their own ideas of teaching, much like a tool supporting their style. Teachers scoring low on the survey used the text as a primary resource while at times modifying lessons, activities, and assessments to be more conforming to traditional teaching practices (Ross et al., 2003). These results were based on interviews conducted with teachers who had indicated their use of the text via an additional survey. Based on the teachers' responses to textbook use and usability, Ross et al. were able to correlate the findings to the same teachers' implementation of mathematics reform. Because the survey was able to accurately distinguish teachers even when using the same text, construct validity was confirmed.

Administration of the survey occurred using SurveyMonkey, a commercially available Internet program. This program allowed for easier statistical analysis and disaggregation by survey item. Additionally, teachers at this location had used this program before. Participants were provided with a link to the survey and were allowed to complete the survey at a time convenient to them. A paper version of the survey was made available to any teacher who preferred to complete it using that method, although no teachers requested a paper version of the survey. Participant codes were assigned to ensure confidentiality and to ensure that teachers did not return surveys in both media.

To assist me, one additional individual served as an auditor for data collection. This was to ensure that I followed IRB guidelines. He did not handle or view any data, nor did he take part in any analysis. This individual was not part of the study itself. He was kept apprised of the status of the data collection to ensure that the data were handled properly. His experience and training (i.e., Master in Educational Administration degree) benefitted the data collection process in quality control, as did his knowledge of the location and teachers involved with the study.

For the survey, Ross et al. (2003) used a 6-point Likert agreement scale to capture the possible responses to each survey item, from *strongly agree* to *strongly disagree* Because there are both positively and negatively worded items, the level of agreement was reverse coded where appropriate. Each survey item corresponds to one of the nine *Dimensions of Elementary Mathematics Reform*. These dimensions describe nine distinct aspects of reform mathematics identified by Ross et al. For instance, Questions 4, 13, and 16 relate to Dimension 1, while Questions 1, 2, and 11 relate to Dimension 2. In addition to evaluating the responses to each question individually, calculating the average score of items related to each dimension created a constructed item score, indicating the level of agreement with the reform described in the dimensions. In other words, each participant has an average (or construct) score for Dimension 1, based on the combination of Questions 4, 13, and 16. Each of the nine dimensions' construct scores is a variable. The average of all participants' scores on an individual survey item and the combined items average score for each dimension can provide an indication of the entire sample's agreement with reform mathematics.

In addition to the survey, observations were completed to collect data to answer the research questions. Only those teachers who agreed to an observation were included in the participant pool. Fifteen teachers agreed to be observed, which was approximately half of all participants who completed the survey. In order to maximize the effective use of the teachers' and my time, the observations were unannounced and were conducted concurrently during the data collection from the survey. This approach allowed for an unscripted account of the teachers' instruction. Teachers at the focus school were aware of the school system's push for increasing student-centered learning. However, because the participants were familiar with me as their colleague and the researcher for this study, it was unlikely that they changed their regular instruction to be more aligned with school system requirements just to impress me. Although the presence of an observer in the classroom normally may impact how a teacher teaches, peer observation is commonplace in this school and often required, so the impact on instruction, if any, would have been minimal. This should have helped to mitigate any anxiety or stress that teachers might have felt during the observations for this study.

These observations served to clarify the results gathered from the survey. Several grade levels at this school departmentalize, meaning that classes are grouped according to teams and only a few teachers teach mathematics in a given term. Teaching assignments change from year to year. For this reason, only those teachers who were currently teaching mathematics during the term in which the data were collected were actually observed.

The observations were labeled according to the code provided to participants for the self-report survey. Observations were scored according to the *Rubric for Implementation of Elementary Mathematics Teaching Reform* (Ross et al., 2003). The observation protocol consisted of a paper copy of the *Rubric* with included space for field notes. This rubric allowed me to assess teacher performance on a spectrum, based on a progressive 4-point scale, ranging from Level 1 (traditional) through Level 4 (full implementation of reform; Ross et al., 2003, pp. 353-355). Each of the nine *Dimensions of Elementary Mathematics Reform* is represented in the *Rubric*. This rubric was initially developed to establish concurrent validity and then used as a construct validity measure for the development of the *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform* (Ross et al., 2003). Because each dimension can be assigned a numeric value, descriptive analysis of the quantitative data was possible. The scores from the rubric served as the variable for the observation portion of the study. For the protection of the teachers, confidentiality was strictly controlled by using codes and not teachers' names.

Data Collection and Analysis

The purpose of this study was to describe the use of reform mathematics instructional practices at the study school through teachers' self-report of current practices and classroom observations of teachers' practice of mathematics reform. The self-report data were collected by administering the *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform* (Ross et al., 2003). The teacher classroom observations were assessed using the *Rubric for Implementation of Elementary Mathematics Teaching Reform*, also created by Ross et al. (2003). The following research questions guided the study:

1. What do teachers self-report as their current practices in mathematics instruction related to using constructivist-based reform mathematics, as

measured by the *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform?*

2. What are the observed practices of mathematics reform, as measured by the *Rubric for Implementation of Elementary Mathematics Teaching Reform*?

Research Question 1 was a descriptive question designed to develop a baseline for understanding teachers' attitudes of teaching practices in the elementary math classroom. The total mathematics reform variable was calculated as the sum of the item scores for each survey participant. Additionally, descriptive statistics were calculated for each survey item on the self-report survey as well as for each construct of the nine dimensions. Research Question 2 was also a descriptive question regarding the observations of teaching methodologies used by the teachers. The scores on each dimension were averaged to determine an overall score for teacher practice. Descriptive statistics were calculated with IBM SPSS Statistics version 22.

Teachers responded to a 6-point Likert agreement scale on the *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform* (Ross et al., 2003). Although the individual survey items provide ordinal data (from *strongly disagree* to *strongly agree*), when the items are averaged for the total survey score and averaged for each dimension's construct score, those data become interval. The observation data were collected and recorded using a 4-point ordinal scale using the *Rubric for Implementation of Elementary Mathematics Teaching Reform* (Ross et al., 2003). The observation data were converted to interval data once the sum of all the dimension scores was calculated. Responses from the survey and ratings from the observational rubric were averaged to provide total scores for each participant.

Assumptions, Limitations, Scope, and Delimitations

A first assumption was that teachers, as professionals, were honest when completing the survey. A second assumption was that the threat to internal validity was adequately handled by a 6-point Likert scale. The main threat to validity was internal. A fixed-response survey may include the possibility of not capturing accurately the participants' true opinions. A 6-point Likert scale, however, provides enough range for participants to express their views adequately. This study was not designed to be comparative to other locations, communities, or populations; therefore, any external threats to validity were minimal, so no assumptions with respect to external validity were made.

Because this study was designed to be conducted at a single location, limitations included the number of participants and the population in general. With a total possible pool of only 37 teachers, the sample size was already small. An adequate number of participants, 31, participated in the survey, but only 15 participants chose to participate in the observation portion. During the observation portion of data collection, it should be noted that teacher performance may have been affected because teachers knew they were being observed. However, this consideration was mostly mitigated by the environment and culture of the school itself. Although they are not done as frequently as in the past, peer observations are commonly done in the school and are encouraged. Additionally, it should be noted that because only one brief observation was made of each participant, it is possible that a teacher may have regularly used reform mathematics strategies that were not observed during this particular window of observation, or vice versa (i.e., the teacher may not have regularly used reform mathematics instruction but by chance did so on the day of his or her observation). Good teaching necessarily requires multiple techniques, reform mathematics being just one. The socioeconomic characteristics of the families served and parental involvement may play roles in a teacher's instructional decisions, but these issues do not necessarily affect the purpose of the study. Data such as demographics, education level, and years of experience were also outside the scope of this particular study. The scope of the study encompassed all mathematics teachers in this school and their reported and observed teaching practice in the mathematics classroom. The only information needed was what and how teachers taught, not why they might teach using a certain methodology. The study was delimited by the staff of the single location being studied, in general, and by mathematics teachers specifically.

Protection of Participant Rights

Permission to conduct the study was obtained from the local school being studied. The principal of the school was in support of the overall scope and purpose of the research being undertaken. Participants were fully informed of all study procedures, and informed consent was obtained (see Appendix F). The researcher was available to answer any and all questions posed by potential participants. All survey participants were provided with a participant code to ensure confidentiality of responses, and only the researcher was privy to participant information. Participation was strictly voluntary, and participants were given an opportunity to opt out of either phase of the study. Even teachers who took part in only one component of the study contributed valuable information to the study results since both phases were being conducted independently of each other. Permission to conduct research was obtained from the Walden University Institutional Review Board, approval number 11-08-13-0045751.

Maintaining Credibility and Quality Control

In order to ensure the credibility of the research, a neutral research assistant, as described earlier, was used to facilitate all of the various components of the study. The researcher maintained regular contact with the research assistant during the entirety of the study. The assistant never came into contact with any actual data collected. Participant numbers were generated that were used for both survey and observation analyses to ensure confidentiality. Only the researcher had any access to research materials or non-coded data.

Findings

The purpose of this study was to determine the mathematics instructional practices of teacher in the study school through teacher self-report of current practices and classroom observations of teacher classroom practice.

The following research questions guided the study:

1. What do teachers self-report as their current practices in mathematics instruction related to using constructivist-based reform mathematics, as measured by the *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform?*

2. What are the observed practices of mathematics reform, as measured by the *Rubric for Implementation of Elementary Mathematics Teaching Reform*?

The first research question was designed to determine how teachers perceived their teaching philosophy and practice as it related to the parameters of reform mathematics. This determination was accomplished through a self-report survey. The second research question was intended to examine the use of reform mathematics through observations of their actual classroom teaching. Thirty-one of the 37 teachers of mathematics in the school participated in the online survey portion of the study while 15 teachers agreed to participate in the observation portion of the study.

Research Question 1 Results

Participants responded to the 20-item self-report survey using a 6-point Likert agreement scale. Possible responses were: 1 – *Strongly Disagree*, 2 – *Disagree*, 3 – *Somewhat Disagree*, 4 – *Somewhat Agree*, 5 – *Agree*, and 6 – *Strongly Agree*. Moreover, there were seven negatively worded items, and their responses were reverse coded so that that valence of the survey items were consistent prior to averaging survey items into constructed variables. Table 1 shows the descriptive statistics for the self-report survey.

Table 1

Descriptive Statistics of Participant Responses by Survey Item

Survey item	*N*	*M*	*SD*
1. I like to use math problems that can be solved in many different ways. (D2)	31	5.23	0.92
2. I regularly have my students work through real-life math problems that are of interest to them. (D2)	31	4.68	1.05
3. When two students solve the same math problem correctly using two different strategies I have them share the steps they went through with each other. (D6)	31	4.97	1.02
4. I tend to integrate multiple strands of mathematics within a single unit. (D1)	29	5.00	1.10
5. I often learn from my students during math time because my students come up with ingenious ways of solving problems that I have never thought of. (D4)	31	4.45	1.39
6. It is not very productive for students to work together during math time. [Neg] (D6)	31	5.32	1.05
7. Every child in my room should feel that mathematics is something he/she can do. (D9)	31	5.77	0.43
8. I integrate math assessment into most math activities. (D7)	30	4.63	0.85
9. In my classes, students learn math best when they can work together to discover mathematical ideas. (D6)	31	4.81	0.95
10. I encourage students to use manipulatives to explain their mathematical ideas to other students. (D5)	30	5.03	0.85
11. When students are working on math problems, I put more emphasis on getting the correct answer than on the process followed. [Neg] (D2)	31	4.06	1.06
12. Creating rubrics for math is a worthwhile assessment strategy. (D7)	31	4.39	0.96
13. In my class it is just as important for students to learn data management and probability as it is to learn multiplication facts. (D1)	30	4.23	1.07
14. I don't necessarily answer students' math questions but rather let them puzzle things out for themselves. (D3)	31	4.10	0.94
15. A lot of things in math must simply be accepted as true and remembered. [Neg] (D8)	31	3.19	1.05
16. I like my students to master basic mathematical operations before they tackle complex problems. [Neg] (D1)	31	2.81	0.87
17. I teach students how to explain their mathematical ideas. (D4)	31	5.19	0.60
18. Using computers to solve math problems distracts students from learning basic math skills. [Neg] (D5)	31	4.32	1.17
19. If students use calculators they won't master the basic math skills they need to know. [Neg] (D5)	31	3.77	1.15
20. You have to study math for a long time before you see how useful it is. [Neg] (D9)	31	4.94	0.96

Note. Neg = negatively worded item; means have been reversed scored. *D* = dimension (e.g., D2 = Dimension 2).

The results demonstrate a general positive level of agreement with an overall mean score of 4.61 (*SD* = 0.36) when the survey scores are averaged. All but two of the 20 scores fall between *M* = 3.77 to *M* = 5.77, indicating general agreement with reform mathematics because they are above the midpoint (3.50) of the 6-point Likert scale. The standard deviations ranged from 0.43 to 1.39. It is interesting to note that the highest standard deviation of 1.39 comes from Question 5, meaning that teachers' individual scores differed from each other more so on this question than on any other questions. Question 5 concerns whether teachers learn from their students.

There are a few notable outliers, however. Question 16 shows a mean score of 2.81 (*SD* = 0.87) and Question 7 has a mean score of 5.77 (*SD* = 0.43). Question 16 asked about teachers' desire to have students learn basic calculations prior to attempting more complex tasks. This is one of only two questions for which participants showed disagreement with reform mathematics tenets. A mean of 2.81 (*SD* = 0.87) indicates that teachers generally accept that students should focus on basic mathematical operations and memorizing math facts before they move to more complex mathematical ideas. Reform mathematics, however, allows for student discovery of problem solutions based on experience and for exploration of multiple methods for finding correct solutions regardless of specifically taught strategies.

Conversely, Question 7 with the highest mean score of 5.77 out of 6.00 (*SD* = 0.43), meaning it is the only question that individually approaches strongly agree. This question concerns students' comfort level in doing math. The wording of Question 7 does not lend itself exclusively to reform mathematics—"every child in my room should feel that mathematics is something he/she can do" (Ross et al., 2003, p. 349). While mathematics teachers should hope all their students would hold this sentiment, the wording of this survey item does not specifically relate ability to do math to reform mathematics. In other words, this survey item does not associate a specific instructional strategy to the student's confidence to do math.

The only other question with a mean score of less than 4.00, meaning somewhat agree, is Question 19 with $M = 3.77$ ($SD = 1.15$). This question deals with the use of calculators, asking if calculators impede mastery of basic skills. This score may indicate that teachers may want to focus their students' attention of learning mental math or algorithmic rather than relying on calculators. Still, a mean of 3.77 is leaning toward positive agreement, albeit at a minimal level.

Table 2 shows each question and its mean score along with its deviation score. The deviation score is the distance of the mean score from the midpoint of the measurement scale, which on a 6-point Likert scale is 3.5. A positive sign denotes that the level of agreement represented by the respondents' mean score is above the midpoint of the measurement scale. The two anchors on either side of the agreement scale's midpoint are somewhat *disagree* and somewhat *agree*, so the midpoint would represent *neither* disagree nor agree. Any positive deviation score, therefore, represents a measure of agreement with the reform mathematics tenet represented by the survey item, while any negative deviation score represents a measure of disagreement with reform mathematics tenet represented by the survey item.

Table 2

Deviation Scores from Mean of 3.50 of Participant Responses by Item Number

Survey item	N	Mean	Dev. Score
1. I like to use math problems that can be solved in many different ways. (D2)	31	5.23	+1.73
2. I regularly have my students work through real-life math problems that are of interest to them. (D2)	31	4.68	+1.18
3. When two students solve the same math problem correctly using two different strategies I have them share the steps they went through with each other. (D6)	31	4.97	+1.47
4. I tend to integrate multiple strands of mathematics within a single unit. (D1)	29	5.00	+1.50
5. I often learn from my students during math time because my students come up with ingenious ways of solving problems that I have never thought of. (D4)	31	4.45	+0.95
6. It is not very productive for students to work together during math time. [Neg] (D6)	31	5.32	+1.82
7. Every child in my room should feel that mathematics is something he/she can do. (D9)	31	5.77	+2.27
8. I integrate math assessment into most math activities. (D7)	30	4.63	+1.13
9. In my classes, students learn math best when they can work together to discover mathematical ideas. (D6)	31	4.81	+1.31
10. I encourage students to use manipulatives to explain their mathematical ideas to other students. (D5)	30	5.03	+1.53
11. When students are working on math problems, I put more emphasis on getting the correct answer than on the process followed. [Neg] (D2)	31	4.06	+0.56
12. Creating rubrics for math is a worthwhile assessment strategy. (D7)	31	4.39	+0.89
13. In my class it is just as important for students to learn data management and probability as it is to learn multiplication facts. (D1)	30	4.23	+0.73
14. I don't necessarily answer students' math questions but rather let them puzzle things out for themselves. (D3)	31	4.10	+0.60
15. A lot of things in math must simply be accepted as true and remembered. [Neg] (D8)	31	3.19	-0.31
16. I like my students to master basic mathematical operations before they tackle complex problems. [Neg] (D1)	31	2.81	-0.69
17. I teach students how to explain their mathematical ideas. (D4)	31	5.19	+1.69
18. Using computers to solve math problems distracts students from learning basic math skills. [Neg] (D5)	31	4.32	+0.82
19. If students use calculators they won't master the basic math skills they need to know. [Neg] (D5)	31	3.77	+0.27
20. You have to study math for a long time before you see how useful it is. [Neg] (D9)	31	4.94	+1.44

Note. Neg = negatively worded item; means have been reversed scored. *D* = dimension (e.g., D2 = Dimension 2).

From these data, Questions 15 and 16 are the only questions with means falling below the midpoint, indicating disagreement with reform mathematics. Question 15 indicates that teachers see mathematics as a discipline that is to be accepted as true, a static view of the subject. Question 16, as already mentioned, indicates that teachers want students to master simpler operations before moving to more complex tasks. Because the mean scores of these two questions fall below the midpoint of the scale, it signifies that teachers do have a more traditional, static view of math and expect that students need to master simpler operations before more complex ones. An additional seven questions have deviation scores of less than +1.00 from the midpoint, which signifies only slight agreement for those questions. Question 7 has the highest deviation score at +2.27, which shows that teachers have a strong level of agreement with this question, while the level of agreement on most other questions is much lower. As mentioned earlier, Question 7 asks about the teacher's view of students' comfort level with math and is not specifically related to reform math.

Research Question 1 Results by Dimension

Each of the 20 items on the self-report survey also corresponds to one of the nine *Dimensions of Elementary Mathematical Reform* (Ross et al., 2003) and delineates a specific aspect of reform mathematics. Ross et al. (2003) relied on research from the NCTM and numerous other studies to develop the nine dimensions were composed of one to three questions. The two dimensions comprised of only one question were Dimension 3, with a focus on student discovery, and Dimension 8, relating to teachers' view as mathematics as a discipline (Ross et al., 2003). Prior to calculating the average score of each constructed dimension variable, negatively worded items were reverse coded. The descriptive statistics for each dimension as reported through the self-report survey are displayed in Table 3.

Dimension 9 has the highest mean score of 5.35 (SD = 0.57). This indicates that teachers have a high level of agreement that student confidence is important when learning mathematics. Dimension 8 has the lowest level of agreement with M = 3.19 (SD = 1.05). This dimension was determined by only one survey item, Question 15. All but two of the dimensions have a mean score more than 4.00, indicating an overall trend of positive agreement.

Table 4 represents the deviation scores of the survey results as they relate to each dimension to illustrate a different level of agreement. As with the survey questions, the dimensions also show an overall positive level of agreement with M = 4.43. The deviation scores reinforce the strength of agreement shown by the mean scores. For example, Dimension 9 has the highest deviation score of +1.85, indicating its high level of positive agreement.

Table 3

Descriptive Statistics of Participant Responses by Dimension

Dimension / description	*N*	*M*	*SD*
D1: Program scope (Q4, Q13, and Q16) A broader scope (e.g., multiple mathematics strands with increased attention on those less commonly taught such as probability, rather than an exclusive focus on numeration and operations) with all students having access to all forms of mathematics.	31	3.96	0.69
D2: Student tasks (Q1, Q2, and Q11) Student tasks are complex, open-ended problems embedded in real life contexts; many of these problems do not afford a single solution. In contrast in traditional mathematics students work on routine applications of basic operations in decontextualized, single solution problems.	31	4.66	0.69
D3: Discovery (Q14) Instruction in reform classes focuses on the construction of mathematical ideas through student discovery contrasting with the transmission of canonical knowledge through presentation, practice, feedback, and remediation in traditional programs.	31	4.10	0.94
D4: Teacher's role (Q5 and Q17) The teacher's role in reform settings is that of co-learner and creator of a mathematical community rather than sole knowledge expert.	31	4.82	0.81
D5: Manipulatives and tools (Q10, Q18, and Q19) Mathematical problems are undertaken in reform classes with the aid of manipulatives and with ready access to mathematical tools (i.e., calculators and computers). In traditional programs such tools are not available or their use is restricted to teacher presentations of new ideas.	31	4.36	0.66
D6: Student-student interaction (Q3, Q6, and Q9) In reform teaching the classroom is organized to promote student-student interaction, rather than to discourage it as an off task distraction.	31	5.03	0.63
D7: Student assessment (Q8 and Q12) Assessment in the reform class is authentic (i.e., relevant to the lives of students), integrated with everyday instruction, and taps multiple-levels of performance. In contrast, assessment in traditional programs is characterized by end of week and unit tests of near transfer.	31	4.53	0.64
D8: Teacher's conceptions of math as a discipline (Q15) The teacher's conception of mathematics in the reform class is that of a dynamic subject rather than a fixed body of knowledge.	31	3.19	1.05
D9: Student confidence (Q7 and Q20) Teachers in the reform setting strive to raise student self-confidence in mathematics rather than impede it.	31	5.35	0.57

Table 4

Deviation Scores from Mean of 3.50 of Participant Responses by Dimension

Dimension / description	*N*	Mean	Dev. score
D1: Program scope (Q4, Q13, and Q16) A broader scope (e.g., multiple mathematics strands with increased attention on those less commonly taught such as probability, rather than an exclusive focus on numeration and operations) with all students having access to all forms of mathematics.	31	3.96	+0.46
D2: Student tasks (Q1, Q2, and Q11) Student tasks are complex, open-ended problems embedded in real life contexts; many of these problems do not afford a single solution. In contrast in traditional mathematics students work on routine applications of basic operations in decontextualized, single solution problems.	31	4.66	+1.16
D3: Discovery (Q14) Instruction in reform classes focuses on the construction of mathematical ideas through student discovery contrasting with the transmission of canonical knowledge through presentation, practice, feedback, and remediation in traditional programs.	31	4.10	+0.60
D4: Teacher's role (Q5 and Q17) The teacher's role in reform settings is that of co-learner and creator of a mathematical community rather than sole knowledge expert.	31	4.82	+1.32
D5: Manipulatives and tools (Q10, Q18, and Q19) Mathematical problems are undertaken in reform classes with the aid of manipulatives and with ready access to mathematical tools (i.e., calculators and computers). In traditional programs such tools are not available or their use is restricted to teacher presentations of new ideas.	31	4.36	+0.86
D6: Student-student interaction (Q3, Q6, and Q9) In reform teaching the classroom is organized to promote student-student interaction, rather than to discourage it as an off task distraction.	31	5.03	+1.53
D7: Student assessment (Q8 and Q12) Assessment in the reform class is authentic (i.e., relevant to the lives of students), integrated with everyday instruction, and taps multiple-levels of performance. In contrast, assessment in traditional programs is characterized by end of week and unit tests of near transfer.	31	4.53	+1.03
D8: Teacher's conceptions of math as a discipline (Q15) The teacher's conception of mathematics in the reform class is that of a dynamic subject rather than a fixed body of knowledge.	31	3.19	-0.31
D9: Student confidence (Q7 and Q20) Teachers in the reform setting strive to raise student self-confidence in mathematics rather than impede it.	31	5.35	+1.85

Dimension 1 has a mean of 3.85 (*SD* = 1.52), with a deviation of +0.35, making it the lowest positive deviation score. Questions 4, 13, and 16 make up Dimension 1. While Question 16 fell on the disagreement side of the scale, *M* = 2.81 (*SD* = 0.87), with a deviation score of -0.69, Questions 4 and 13 have a positive level of agreement, *M* = 5.00 (*SD* = 1.10), with a deviation score of +1.50, and *M* = 4.23 (*SD* = 1.07), with a deviation score of +0.73, respectively. As described earlier, each of the nine dimensions corresponds to a particular aspect of reform mathematics as determined by Ross et al. (2003). In this case, Dimension 1 refers to less focus on numbers and operations and more attention on less traditional concentrations such as probability. Questions 4 and 13 address this topic rather directly, while Question 16 references students mastering basic operations prior to attempting more complex tasks. Combined, these scores indicate that teachers do agree with overall concept of Dimension 1, incorporating multiple strands of mathematics (Ross et al., 2003), but they also believe that a mastery of basic arithmetic and math facts and operations is also important, as shown by the results of Question 16.

There is a positive deviation score, thus positive level of agreement, for each dimension with the exception of Dimension 8. Dimension 8 deals with the way teachers view math as a discipline. With a mean 3.19 (*SD* = 1.05) and a deviation score of -0.31, Dimension 8 is the only dimension with a negative level of agreement. Question 15 is a negatively worded item, so with the mean indicating “somewhat disagree” with reform mathematics, teachers seem to trend toward the belief that some things in math must be taken at face value and memorized. In some respect, this may be true in terms of memorizing math facts such as multiplication tables or formulas, but reform math leaves open the possibility of students solving problems through means that may not include a memorized formula. Unfortunately, there is no more clarification on this concept within the survey itself.

Research Question 2 Results

The observations were evaluated using a different instrument, the *Rubric for Implementation of Elementary Mathematics Teaching Reform* (Ross et al., 2003). This rubric utilized a 4-point rather than 6-point scale. Fifteen of the 31 teachers who completed the self-report survey agreed to be observed. I was the only individual who observed each of the 15 teachers, and only one time. Having multiple observations of the same teacher or having multiple observers observing the teacher only once would have improved the reliability of the observational data. The observational rubric used a scale of 1 – *Traditional* to 4 – *Full Implementation of Reform*. Instead of specific questions correlated to the dimensions, the rubric used verbiage to describe how much and what part of the dimensions was being utilized. Table 5 shows the descriptive statistics for the observations.

Table 5

Descriptive Statistics of Teacher Observations by Dimension

Dimension / description	*N*	*M*	*SD*
D1: Program scope A broader scope (e.g., multiple mathematics strands with increased attention on those less commonly taught such as probability, rather than an exclusive focus on numeration and operations) with all students having access to all forms of mathematics.	15	2.60	0.74
D2: Student tasks Student tasks are complex, open-ended problems embedded in real life contexts; many of these problems do not afford a single solution. In contrast in traditional mathematics students work on routine applications of basic operations in decontextualized, single solution problems.	15	2.53	0.83
D3: Discovery Instruction in reform classes focuses on the construction of mathematical ideas through student discovery contrasting with the transmission of canonical knowledge through presentation, practice, feedback, and remediation in traditional programs.	15	2.60	0.83
D4: Teacher's role The teacher's role in reform settings is that of co-learner and creator of a mathematical community rather than sole knowledge expert.	15	2.47	0.83
D5: Manipulatives and tools Mathematical problems are undertaken in reform classes with the aid of manipulatives and with ready access to mathematical tools (i.e., calculators and computers). In traditional programs such tools are not available or their use is restricted to teacher presentations of new ideas.	15	3.13	1.06
D6: Student-student interaction In reform teaching the classroom is organized to promote student-student interaction, rather than to discourage it as an off task distraction.	15	2.93	1.03
D7: Student assessment Assessment in the reform class is authentic (i.e., relevant to the lives of students), integrated with everyday instruction, and taps multiple-levels of performance. In contrast, assessment in traditional programs is characterized by end of week and unit tests of near transfer.	15	2.73	0.70
D8: Teacher's conceptions of math as a discipline The teacher's conception of mathematics in the reform class is that of a dynamic subject rather than a fixed body of knowledge.	15	2.67	0.98
D9: Student confidence Teachers in the reform setting strive to raise student self-confidence in mathematics rather than impede it.	15	2.53	0.64

Overall, the results of the self-report survey indicated a general level of agreement on all dimensions. These results are consistent with the observation data that yielded mean scores indicating teacher practices aligned more with reform mathematics than traditional teaching. The mean score of all dimensions on the observation instrument was 2.69. The midpoint of a 4-point Likert scale is 2.5, so the average teaching practice is more reform than traditional. All but Dimension 4 had mean scores that were higher than the midpoint of 2.5. Dimension 4's mean score was 2.47 (*SD* = 0.83), a negligible 0.03 points below from the midpoint. With a mean score of 3.13 (*SD* = 1.06), Dimension 5 addresses teachers' use of manipulatives and math tools, and it was the only mean score larger than 3.00.

The observations were also analyzed according to their deviation scores. With a 4-point scale, the midpoint is 2.5. Table 6 shows the deviation scores for each dimension. As previously mentioned, the lowest mean was Dimension 4 with a deviation score of -0.03. The highest score was Dimension 5 with a deviation score of +0.63. The high and low deviations scores were -0.03 to +0.63, a range of 0.66 on a 4-point scale.

Table 6

Deviation Scores From Mean of 2.50 of Teacher Observation by Dimension

Dimension / description	*N*	*M*	Dev. score
D1: Program scope A broader scope (e.g., multiple mathematics strands with increased attention on those less commonly taught such as probability, rather than an exclusive focus on numeration and operations) with all students having access to all forms of mathematics.	15	2.60	+0.10
D2: Student tasks Student tasks are complex, open-ended problems embedded in real life contexts; many of these problems do not afford a single solution. In contrast in traditional mathematics students work on routine applications of basic operations in decontextualized, single solution problems.	15	2.53	+0.03
D3: Discovery Instruction in reform classes focuses on the construction of mathematical ideas through student discovery contrasting with the transmission of canonical knowledge through presentation, practice, feedback, and remediation in traditional programs.	15	2.60	+0.10
D4: Teacher's role The teacher's role in reform settings is that of co-learner and creator of a mathematical community rather than sole knowledge expert.	15	2.47	-0.03
D5: Manipulatives and tools Mathematical problems are undertaken in reform classes with the aid of manipulatives and with ready access to mathematical tools (i.e., calculators and computers). In traditional programs such tools are not available or their use is restricted to teacher presentations of new ideas.	15	3.13	+0.63
D6: Student-student interaction In reform teaching the classroom is organized to promote student-student interaction, rather than to discourage it as an off task distraction.	15	2.93	+0.43
D7: Student assessment Assessment in the reform class is authentic (i.e., relevant to the lives of students), integrated with everyday instruction, and taps multiple-levels of performance. In contrast, assessment in traditional programs is characterized by end of week and unit tests of near transfer.	15	2.73	+0.23
D8: Teacher's conceptions of math as a discipline The teacher's conception of mathematics in the reform class is that of a dynamic subject rather than a fixed body of knowledge.	15	2.67	+0.17
D9: Student confidence Teachers in the reform setting strive to raise student self-confidence in mathematics rather than impede it.	15	2.53	+0.03

Dimension 5 represents the use of manipulatives in classroom instruction. Some of the observed practices included using real money to work through decimal problems and using tablet computers to play math games. Another classroom incorporated students calculating realistic distances from locations around the community on a map, such as the distance from the police station to the school. The study school receives district funding for math supplies, and the study school is also well funded through parent support and grant sources. As a result, teachers have access to a variety of manipulatives and technology for student and teacher use.

As previously mentioned, Dimension 4 received the lowest scores with a mean of 2.47 (*SD* = 0.83) and a deviation score of -0.03. This dimension concerns the teacher's role. Full implementation of this dimension would result in the teacher being more of a facilitator or "co-learner and creator of a mathematical community" (Ross et al., 2003, p. 348). Still, the aggregate score does trend toward implementation. More observations would likely have made this clearer and certainly made the observation score more reliable. By contrast, according to the survey results, Dimension 4 was third highest score with a mean of 4.82 out of 6.00 (*SD* = 1.12). Questions 5 and 17 correspond to Dimension 4. Of these two questions, Question 17 had the higher mean score of 5.19 (*SD* = .60). It is possible for this score to be elevated because expecting students to be able to explain their work, the content of Question 17, is not exclusive to reform mathematics, even if it is an important tenet of reform mathematics.

The observation scores tend to indicate teachers implement a reform approach to teaching mathematics, meaning the means of the dimensions tend to be closer to the full implementation side of the continuum illustrated by positive deviation scores. With virtually all means clustered near the 3.00 point, teachers do seem to be trending toward using teaching strategies in keeping with reform mathematics. It could also be a reflection of the current system-wide requirements of teaching. Still, there is ample room for growth before full implementation is reached. However, with the small sample used in this study, it is hard to make definitive conclusions. As with the survey scores, the small standard deviations indicated that the scores were clustered closely around the mean.

Conclusion

These data were pivotal in helping determine the teaching practices of teachers at the study school. The analyses provided information to answer the research questions about whether teachers at the study school are consistent in practicing in the classroom the philosophy that they profess in the self-report survey. The descriptive statistics of the self-report survey tend toward agreement with reform mathematics, although the mean scores do tend be closer to the midpoint of 3.5. Moreover, the descriptive statistics of the observations tend toward full implementation of reform mathematics.

The overall mean score for all survey questions combined was 4.54 and the overall mean score of the constructed items representing the dimension or reform mathematics is 4.43. Both of these were based on the 6-point Likert agreement scale with a midpoint of 3.5. For the observation data, the mean was 2.69, with the midpoint of the 4-point Likert scale of 2.5. The observation data indicate that even though there is a general tendency toward full reform mathematics implementation, there is room for growth when it comes to implementing reform mathematics or constructivist teaching strategies. By collecting and utilizing two different types of data, this study provided information on teachers' perceived practice as well as their actual practice. A targeted staff development program will help to move teachers toward a full implementation of reform mathematics techniques, as well as help in codifying common vocabulary and operational definitions.

Studies such as this provide a relatively simple and non-invasive way in which to obtain baseline data of current mathematics teaching practices and philosophies. The components are easily repeatable to determine any change or growth in the future. In this case, the results became the basis and background to design a staff development program. The program is discussed in Section 3.

Section 3: The Project

Introduction

Based on the literature review and the results of the study, it is evident that additional training is needed for teachers to have a common understanding of reform mathematics instruction specifically and constructivist teaching methodology in general. Although there was a general positive level of agreement during the study, there were areas that indicated a need for additional training. As indicated, the issue may be one of lack of communication or lack of understanding. In order to facilitate using more reform mathematics and the constructivist theory of teaching mathematics, additional training may be warranted to ensure that all teachers have the same understanding of the process. One method of training might involve peer training. As part of this project study, I proposed the implementation of a professional development plan.

The purpose of this professional development project is to establish a library of teaching videos, a Peer Observation Library, created by local teachers using local curricula and resources that can be used as a training resource (e.g., virtual peer observations of teachers modeling reform mathematics lessons). These videos are to be used as examples of proper reform mathematics techniques for professional development purposes. These videos will consist of teachers modeling reform mathematics or constructivist teaching techniques in their mathematics classroom. The teachers who will be initially chosen as the teacher role models for the videos are those teacher volunteers who demonstrate an affinity for constructivist teaching techniques. These teachers will be identified as those who exhibited at least a partial understanding of the constructivist techniques in the results of the research portion of the study, or the teachers will be trained specifically for this role.

In this particular school system, teachers are encouraged to expand their teaching techniques in keeping with what is described as reform mathematics. More of these activities are also being required by national standards such as the Common Core (CCSSI, 2015). These reasons could account for the general trend toward a positive level of agreement with reform mathematics indicated by the results of this study described in Section 2. Based on these results, however, a staff development program designed to increase teachers' awareness, understanding, and knowledge of reform mathematics, and constructivism in general, would be appropriate. Although teachers are generally positive about reform mathematics, giving them staff development so that they can be even more enthusiastic is analogous to how teachers are encouraged to motivate their students in the study school. Student test scores are generally high. Nonetheless, it is often stressed that teachers should encourage their students not just to meet standards, but to exceed them. The staff development program developed based on these results would essentially be doing the same thing for teachers. Because the results of the survey indicate that there is already a slight level of agreement, teachers would be given training that would ideally move them along the continuum from agreeing with reform mathematics to strongly agreeing with it because they see the benefits in that approach to teaching mathematics. The teachers' level of agreement with reform mathematics will be reassessed by re-administering the *Self-Report Survey: Elementary Teacher's Commitment to Mathematics*

Education Reform (Ross et al., 2003) as a culminating summative assessment of the staff development program.

Rather than a single, one-time development class or session, a longer term, sustainable program was developed to allow for continued professional development as faculty and situations change. Staffing at elementary schools can be fluid and can change from year to year. Student enrollment may increase or decrease the number of teachers needed, and transfers or retirements may occur. Any professional development program would need to be adaptive and reactive not only to the teachers, but also to the changing needs of the district. Creating a Peer Observation Library of locally created and produced videos spotlighting local teachers using local resources would be a way to expose teachers to new teaching techniques or refresh them with new ideas in a manner similar to peer observation of teachers demonstrating model reform mathematics lessons.

Description and Goals

Collegial interaction is an important aspect of staff development, including professional learning communities (Dufour, 2004, 2014; Giles & Hargreaves, 2006; Huffman, 2011; Lambert, 2002; Linder, Post, & Calabrese, 2012; Teague & Anfara, 2012; Wood, 2007). There are many ways in which teachers engage in continuing education, including workshops and other staff development opportunities. In keeping with the constructivist framework, Lambert et al. (2002) asserted that the interaction of teachers to construct their own meaning is important. Peer observation is one way in which teachers gain new ideas and insight from their fellow teachers. This professional development program is targeted at elementary mathematics teachers and includes an initial training workshop, followed by a series of peer observations in video format and concurrent collegial discussions. At the end of the implementation year, a summative evaluation will be administered to determine the success of the program.

Components, Timeline, and Activities

This staff development program (see Appendix A) consists of three major components. The first component is an initial training workshop provided during the preplanning period prior to the start of the school year. The second component consists of viewing several video-recorded lessons of peer teachers teaching mathematics lessons using reform mathematics and constructivist techniques. As part of this component, teachers will be required to assess each lesson according to the *Rubric for Implementation of Elementary Mathematics Teaching Reform* (Ross et al., 2003). The third component is monthly discussions held during regularly scheduled collaborative planning time.

The timeline for this professional development program is designed for one complete school year. The program timeline begins with an introductory workshop that will be delivered to the staff by me during regularly scheduled staff development sessions during the preplanning period prior to the start of the school year. The workshop includes modules that define reform mathematics and constructivism, including exploring the *Rubric for Implementation of Elementary Mathematics Teaching Reform* (Ross et al., 2003). Another module contains example lessons meant to compare and contrast reform mathematics lessons with nonreform mathematics lessons, as well as a description of the program, including requirements and timetables. Each module consists of an hour-long segment guided by a specific essential question (EQ). This workshop will be video recorded for future reference as a refresher or for any staff member who is unable to attend. In the remaining components of the program, teachers are to view peer observations in the form of recorded videos and to engage in collegial discussion and interaction based on these videos. These peer observation and discussion sessions will be a part of regularly scheduled weekly and monthly professional development and collaboration times already in place in the focus school's protocol.

The second component of the professional development plan is for teachers to view peer observation videos and critique them using the *Rubric for Implementation of Elementary Mathematics Teaching Reform* (Ross et al., 2003). All teachers are required to view a minimum of five video lessons over the course of the implementation school year. Local teachers who have volunteered to demonstrate lessons using the reform mathematics strategies will create these videos. A steering committee including a school administrator, at least two teachers, and I will ensure that the lessons properly demonstrate the techniques of reform mathematics and constructivism. The workshop video may be viewed, or re-viewed, as one of the five required videos.

The Peer Observation Library will necessarily begin small, with only a few videos. The intent is for the library to become a "living library" that, over time, will grow in scope, quantity, and quality. The initial pilot teachers will provide multiple videos over time, and other teachers will be able to contribute as they gain confidence in using reform mathematics techniques. The videos will be in the format of electronic video files, housed locally on school servers, and there will be physical DVD recordings that can be checked out to be viewed, and they will also serve as backup versions. Videos may then be made available via a secure online database to any teacher with an appropriate viewing device. Throughout the implementation year, I will maintain the recordings on school servers.

The third component of the program is a series of collegial discussions among the teachers as part of their regularly scheduled collaborative meeting times. These meetings will be in small groups by grade level, usually with an administrator in attendance. These discussions will be held on the fourth Thursday of each month. A list of guiding questions will be provided to facilitate these discussions (see Appendix A). These questions will include comparison and contrast of the scored rubrics of the lessons and finding aspects of the lessons that each teacher will commit to incorporating into his or her own lessons. These types of requirements, embedded within the existing framework of the staff development protocol, are consistent with the requirements of past staff development initiatives. The school and district require time spent on collaborative planning, for which professional learning units are issued. The content of this collaborative planning is flexible, and it is often spent analyzing student data, engaging in collaborative lesson planning, and addressing other staff development topics. The time spent on these project requirements will be included as part of this protocol. A summative evaluation will be conducted at the end of the school year by readministering the *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform* (Ross et al., 2003), the survey that was used to provide baseline data for this study and for comparing the results of the teacher classroom observation data.

Project Goal, Learning Outcomes, and Target Audience

The goal of this professional development program is for teachers to increase their use of reform mathematics and constructivist teaching techniques by providing training resources to all teachers. The specific target audience is elementary teachers of mathematics. The program will be beneficial to those who are either unfamiliar or uncomfortable with reform mathematics or constructivist teaching techniques, but it will be equally beneficial to those teachers looking for methods to improve their teaching techniques.

Learning outcomes associated with this goal include increasing teachers' knowledge of reform mathematics and constructivism, use of shared or common vocabulary, and increased interaction between teachers via peer observations and collegial discussion. Time is a precious commodity in the world of education, especially during the school day. Planning time is needed for regular lesson planning, often for multiple subjects in the elementary setting, as well as for collaborative work between teachers and administrators. Job-embedded staff development is an important tenet, according to Learning Forward (2015). Peer observations are an excellent way to share collegially among the teaching staff but are often difficult to arrange (Darling-Hammond, 2013).

Having teachers make video recordings of themselves that other teachers can view as their schedules permit (even after regular school hours or at home) creates virtual peer observation opportunities. The term *virtual* is defined as collaboration that is not face to face (McConnell, Parker, Eberhardt, Koehler, & Lundeberg, 2013). As a bonus, the teachers who are video recorded can be available to answer questions or otherwise interact with viewers at prearranged times, or even by less formal means such as e-mail. This easy availability is an aspect of tailor-made video recordings that cannot be easily duplicated with commercially produced lesson videos. The connection of the viewer to the presenter, material, and setting becomes more personal when the resources are local (Reeves, 2009).

This project is designed to be implemented and completed within one school year, although it is sustainable and infinitely expandable. Videos can be added or deleted as necessary, with the flexibility to respond to changing requirements or needs of the teachers, school, or school system. The custodial requirements of maintaining the library can be taught, even with a changeover in staff.

Rationale

The findings of this study indicate that teachers' perceptions and practices of reform mathematics are on the positive side of the scale, but there is room for improvement. This can be accomplished through professional development in the area of reform mathematics. According to the literature, there are benefits to increasing the use of reform mathematics teaching techniques (Hiebert et al., 2005; Kamii et al., 2005; Kroesbergen & van Luit, 2002; Martinez, 2001). For the format of the professional development program, collegial interaction is often considered an excellent way to perform staff development (Dufour, 2004, 2014; Giles & Hargreaves, 2006; Huffman, 2011; Lambert, 2002; Linder et al., 2012; Teague & Anfara, 2012; Wood, 2007). Additionally, the integration of technology is increasingly used in education (Knight, 2014a, 2014b). For these reasons, a professional development program was developed that incorporated the use of technology and fell within existing protocol of staff development in the school district. This professional development program addresses a need that was identified from the study findings.

In the school system where this research was conducted, technology integration is a required component of both teaching resources and staff development. The study school has several computer labs, in addition to available technology in each classroom. Teachers and students have access to both laptop and tablet computers in each classroom as provided by school and PTA funds. In addition to the technology equipment provided by the school, many teachers and students use their personal technology equipment, ranging from personal computers and tablets to smartphones. With this technology, access to video recording is readily obtainable, both for viewing and creating. Teachers can record lessons for viewing, either for themselves or for other teachers. Technology provides opportunities for peer observation on demand when time cannot be made for live observation. These observations are in a medium that allows actual demonstration of practice and ideas, as opposed to written media such as articles or books. This type of video project is also applicable to other content, not just mathematics.

With so much technology access, the creation of videos is much more accessible to all teachers at the study site. Video recording technology has become much more accessible to both teachers and students. Videos can be made from a tablet or smartphone (Knight, 2014a, 2014b). The video files can then be uploaded to a website or cataloged on a local server. Files could even be copied onto CD, DVD, flash/USB drive, or other portable media storage.

In regard to mathematics instruction, or any content instruction for that matter, teachers can read an article, a book, or even a website to get ideas. However, these media do not allow the teacher to see the technique in action. Some teachers may not know what reform mathematics instruction looks like in practice, or perhaps they do not know if they are using it properly in their classroom. Commercially produced videos can be helpful but may not always address a local school site's specific needs completely because they are made for a broad audience. The purpose of creating a locally produced video library is to allow teachers to have a series of peer observations—the ability to see their colleagues at work demonstrating their personal ideas or techniques, while using local materials and curricula (Reeves, 2009).

Perhaps the most attractive aspect of this project is that it is expandable to incorporate or include many different staff development goals. What has been started as a plan to increase the use of reform mathematics teaching techniques could become a medium to demonstrate project-based learning in social studies, record science experiments, or even provide lecture presentations from local staff. Instead of, or in addition to, purchasing video libraries published professionally, these videos spotlight local teachers using local resources that other teachers can readily access. Even better, the teachers who are video recorded can be available for questions or to provide help for teachers who want or need it.

Review of the Literature

The Walden Library's Thoreau metasearch was again widely used for this literature review. Search keywords and phrases included *professional learning community(-ies)*; *staff development*; *virtual*; *video*; *social media*; *wiki*; *coaching and education*; *teacher development and video*; *peer observation*; and *professional learning network*. Sources were limited to those referring to the United States educational system, though some others were included that may have presented relevant information. Additional emphasis was placed on new and emerging technologies and their effects and uses for staff development and assessment.

Teaching the Teachers

What about the teachers? How will teachers come to know and understand the philosophy behind reform mathematics or constructivism? Whereas different teacher education programs may teach constructivist methods, there is no established national standard for incorporating this teaching methodology in teacher education programs. According to Lambert et al. (2002), constructivism in leadership is essentially no different than constructivism in learning, and both adults and children benefit from this type of learning. In short, educators can learn new ways of teaching, or they can expand their knowledge and practice in ways similar to teaching the strategies of reform mathematics to children.

Professional Educator Development

The professional development of teachers can take many forms. The obvious one, of course, is attending graduate school to attain a higher-level degree or by taking other continuing education courses. However, teachers need development on a small as well as large scale. The form of this development is dependent upon the needs of not only the teacher but the students and the school community as a whole.

Learning Forward (2015) is an organization dedicated to facilitating staff development standards and opportunities. It highlights the fact that teachers need daily interaction and reflection to sustain their personal growth as well as the growth of their students. Learning communities are one way to accomplish this.

Professional Learning Communities

Professional Learning Communities (PLC) have become a way that teacher development is addressed in schools (Dufour, 2004, 2014). PLCs are systems of collegial interaction that provide teachers with personal and professional development. There are a multitude of ways that staff development is addressed, including learning teams, committees, and other groups (Dufour, 2004, 2014; Giles & Hargreaves, 2006; Huffman, 2011; Lambert, 2002; Linder et al., 2012; Teague & Anfara, 2012; Wood, 2007). At the heart of these communities is collaboration—teachers working together to benefit themselves and their students. Rather than a top-down approach to leadership, collaborative models stress the need for individual teachers to take initiatives to affect leadership and change in their schools (Barth, 2001; Dufour, 2004, 2014; Huffman 2011; Lambert, 2002; Patterson & Patterson, 2004; Teague & Anfara, 2012; Wood, 2007).

Darling-Hammond and Richardson (2009) provided a solid research-based background of PLCs. They first delineated the theoretical and foundational basis of how successful professional learning looks. They described strong professional learning as being focused on student learning “integrated in school improvement” (Darling-Hammond & Richardson, 2009, p. 47), and activities that actively engage teachers with hands-on experience. They then explained how PLCs, as a system of development, accommodates these best practices for school communities (Darling-Hammond & Richardson, 2009).

Teague and Anfara (2012) provided an up-to-date, succinct presentation of PLCs. They began with a short history of PLCs, followed by the vision of PLCs, and then ended with the barriers to successfully implementing them. Some of the key words Teague and Anfara used to convey the vision of PLCs include: “shared”, “supportive”, and “collective” (Teague & Anfara, 2012, pp. 60-61; also Tobia & Hord, 2012, p. 20). Some of the barriers of successful PLCs include change, or the resistance to it, and sustaining the movement. Teague and Anfara concluded that while teachers need to be open to collaboration, principals and leaders should provide the necessary support for “developing and sustaining professional learning communities” (p. 62).

Chappuis, Chappuis, and Stiggins (2009) postulated another description of the concept of PLCs, calling them Teacher Learning Teams (TLT). While the underlying theory is very similar to PLCs in general, Chappuis et al. expanded the requirements even further, explicitly stating that in order to be successful, a successful TLT “requires that teachers commit to working and learning between team meetings” (p. 57). An investment, or buy-in, by the stakeholders is necessary to make the system work. The authors discussed the need for adequate preparation, material, and overall support from school leaders.

Finally, in a recent article, Kagle (2014) espoused the need for PLCs at the preservice level. Kagle argued that PLCs for education students provide them a way to essentially “act as apprentices” (p. 21) in the process. If new teachers entered the workforce with a solid understanding of what a PLC is, the learning curve for collaboration would be much shorter, ultimately making it possible for teachers to develop effective PLCs in the workplace more quickly.

Virtual Staff Development

The word *virtual* has taken the meaning of a type of electronic collaboration or another form of collaboration that is not face to face (McConnell et al., 2013). This type of collaboration can take many forms, such as teleconferencing (McConnell et al., 2013) or wikis (Kim, Miller, Herbert, Pedersen, & Loving, 2012), and even social media (Davis, 2011; Gunawardena et al., 2009; Holzweiss, 2013; King, 2011; National Association of Elementary School Principals, 2011; Trust, 2012). This change from merely using data to creating, networking and collaborating with the use of the Internet is often referred to as Web 2.0 (Cordell, Rogers, & Parker, 2012; Davis, 2011; Gunawardena et al., 2009).

Many different platforms exist, from file sharing to multiple user websites or wikis. A wiki is essentially an interactive, web-based model that contributors modify and collectively add content to build an interactive repository for whatever subject is intended (Kim et al., 2012). Other platforms include noneducational sites such as Twitter or Facebook (Davis, 2011; Gunawardena et al., 2009; Holzweiss, 2013; Kim et al., 2012; King, 2011; National Association of Elementary School Principals, 2011; Trust, 2012;).

A complete explanation of the various websites and other media came from Gunawardena et al. (2009). Apart from defining what “social networking” is (Gunawardena et al., 2009, pp. 4-5), sites were categorized by their type, such as networking or publishing. Gunawardena et al. (2009) approached the study as an investigation of how Internet collaboration allowed participants to evolve into a “community of practice (CoP)” (p. 6).

Perhaps one of the more innovative modes of virtual learning is the use of social media. Trust (2012) described a multitude of available platforms for what is referred to as Professional Learning Networks (see also Flanigan, 2012; Cordell et al., 2012). Just a few of the platforms discussed include RSS feeds, Edmodo, Classroom 2.0, Facebook, and Twitter. RSS feeds are essentially a way that website news feeds are directed to a single source, such as your website to be viewed all at once in one location (p. 133). Trust (2012) described other social media outlets such as Facebook and Twitter and explained the difference between real-time applications for instant collaboration, like video conferencing or chatting, and “asynchronous” sites such as discussion boards.

Holzweiss (2013) discussed the merits of a site called Edmodo. Edmodo is essentially an educational site built to resemble Facebook (Holzweiss, 2013, Trust, 2012). While her approach came from the perspective of a school librarian, her points resonate across education (see also Cordell et al., 2012; Hughes-Hassell, Brasfield, & Dupree, 2012). Holzweiss (2013) pointed out various communities within Edmodo itself, including publishers, other libraries, and teachers—essentially networks within networks.

Edmodo is safe for use with students as well as other teachers, enabling wide-ranging application and connection.

Coaching

One of the ways collaboration is encouraged is through the use of coaches. Coaching is a process where a teacher receives support, guidance, and assistance from another educator who is trained in specific techniques (Feger et al., 2004; Herll & O'Drobinak, 2004; Keller, 2007; Neufeld & Roper, 2003; Richard, 2004; Richardson, 2008; see also Leat, Lofthouse, & Wilcock, 2006). Some of the assistance provided by coaches may include lesson planning, observation, and advice. A coach is often an expert in a particular content area, such as mathematics. Observations are usually followed by a conference to allow the teacher and the coach to discuss the session. Sometimes a coach will model a lesson for the teacher to observe, while other times the teacher will be observed by the coach (Lipton & Wellman, 2007). These sessions are used to provide immediate feedback and allow the teacher to reflect on the session with the guidance of the coach. While it may seem that the teacher is being evaluated, a coach need not be a critical evaluator. In the spirit of collegial interaction, a coach can be a safe person with whom a teacher may converse without fear of criticism (Feger, Woleck, & Hickman, 2004; Herll & O'Drobinak, 2004; Lipton & Wellman, 2007).

While research has shown that coaching has tangible benefits, school systems often have trouble justifying the hiring of coaches (Keller, 2007). With funding at a premium, superintendents and principals require hard evidence to show the need for a coach. Because of this, the role of a coach varies greatly from school system to school system. Some coaches have regular classrooms while others see students only rarely (Keller, 2007; Richard, 2004). Having a coach with at least some regular teaching workload helps to justify spending money for the position, that could very well have been used to hire a regular teacher instead.

Darling-Hammond (2013) provided an extensive background in what is called Peer Assistance and Review (PAR). The PAR system was designed in Toledo, OH, and subsequently adopted in districts across the country. Darling-Hammond provided specific case studies and examples of how the program works and its outcomes. Essentially, experienced master teachers are chosen to serve, or mentor, a group of teachers in need of assistance, both as beginning teachers and veterans (Darling-Hammond, 2013). These mentors work on specific aspects of teaching from classroom management to lesson planning. In many ways, these mentors are acting as coaches. Many teachers complete the program and move on to successful careers, while others do not, some even being dismissed from their positions (Darling-Hammond, 2013). Still, these are full-time positions, and not all districts have resources to allocate for these services.

Teachers learn from other teachers. A teacher’s personal sphere of influence, especially from other teachers nearby, is potentially more effective in impacting professional practice than any commercially created material (Reeves, 2009). Reeves (2009) cited many examples of districts that produced their own materials and videos of teaching within their system to support their teachers. Not only is it more cost-effective, Reeves (2009) called it more “credible” and “authentic” (p. 85). Technology is expanding such that creating these videos is much easier than ever (Knight, 2014a, 2014b). Knight

(2014b) dedicated an entire book on this premise, including the use of video to expand the practice of coaching. In Grant and Kline's (2010) study, teachers piloting new curriculum resources were video recorded, and those locally produced videos served as a focal point for analysis and discussion by the entire group. An analogy to studying video as a reflective practice is that of sports coaches reviewing film of their teams' games and practices, and those of their opponents (Bambrick-Santoyo, 2013; Cross, 2012; Knight, 2014b).

Research-Based, Data Driven

Another standard of Learning Forward (2014) is that staff development should be research-based and data driven (see also Hirsh & Hord, 2012). Schools use standardized tests to compare students to a normed reference. This norm can be national, state, or even system referenced. The NCLB (2002) legislation requires that student achievement and progress be measured by standardized tests. Analyzing the data provided by these tests allows teachers to modify instruction to correct weaknesses, as well as design lessons that tap into the strengths of students. Staff development initiatives are also designed based on the results of these analyses (Hirsh & Hord, 2012; Learning Forward, 2015).

Receiving staff development is important when content-specific issues arise, especially with elementary school teachers because often elementary teachers have less training in one content area or another, such as science or math (Desimone, Smith, & Ueno, 2006; Feger et al., 2004). Targeted staff development opportunities help address these issues. Having content-specific staff development allows teachers to gain confidence as well as knowledge. Student achievement can be affected positively as a direct result of these teacher improvements. An innovative program in Washington state, called the Partnership for Reform in Secondary Science and Mathematics (PRiSSM), is providing content-specific training for middle and high school teachers (Slavit, Nelson, & Kennedy, 2010). The PRiSSM program was “designed to develop teachers as leaders of content-based professional learning communities” (Slavit et al., 2010). Elementary teachers are required to teach all subjects in most cases. This sometimes results in teachers teaching subjects, such as math, that they are less passionate about. Content specific training can help remedy this.

How and Why Do Teachers Teach?

If teachers are continuing their education through on-site staff development using constructivist training techniques, then students should benefit from those same techniques being used in the classroom. This study addressed the needs of staff development in the area of reform mathematics and constructivist techniques by establishing a baseline of two things: (a) How much teachers know about reform mathematics, and (b) How much they employ it in their math classrooms? A similar study was conducted in Australia (Demant & Yates, 2003) during which teachers were asked their opinions about DI. One statement in particular stands out, “The results indicate a high level of support for the direct instruction construct, especially in those teachers who appeared to be aware of what the term refers to within contemporary research” (Demant & Yates, 2003, p. 488). The key to this statement is the fact that teachers were aware of the methodology and the theory. Another important note is that there was one item that demonstrated the most contention. The item read, “Direct instruction is a highly effective teaching method with all students" (Demant & Yates, 2003, p. 488). The results showed that respondents were divided in their opinions. This shows at least some acknowledgement that multiple techniques should probably be used depending upon the situation and the student.

A case study by Vacc and Bright (1999) followed two pre-service teachers during their student teaching programs. Each teacher was trained in a method called "Cognitively Guided Instruction" (CGI; Vacc & Bright, 1999, p. 90). CGI is a method where teachers assess student thinking and adjust instruction accordingly. This instruction in mathematics most often takes the form of various problem solving activities. Students are led through discussions and questioning to facilitate their understanding. The authors acknowledge that "a single model of a 'CGI teacher' does not exist. Instead, teachers use CGI in a manner that fits their own teaching styles, knowledge bases, and beliefs, as well as the needs of their students" (Vacc & Bright, 1999, p. 90). This position is aligned with the earlier acknowledgment that constructivist theory does not truly have a set methodology. It also aligns with NCTM (2000) recommendations.

The first student teacher held a positive belief in CGI and demonstrated positive use of it during her final student teaching segment, as measured by survey, observation, interview, and personal journal entries. By contrast, the second student teacher held a belief first that "memorization of facts was the framework for learning mathematics" (Vacc & Bright, 1999, p. 101). Progressing through the CGI program, however, she changed her belief to a more positive view of questioning and of assessing student thinking. Her final review, though, showed different information. Although she used some questioning within the classroom lessons and indicated she thought it was her most important role, “she appeared to focus more on whether the students’ answers matched the responses she was expecting” (Vacc & Bright, 1999, p. 102). She did not lead students into discussions of their responses, nor did she appear to be assessing anything more than correctness. In this case, her practice did not match her stated belief. It might be the case that she did not quite fully understand the philosophy behind CGI. This situation illustrates even more the importance of staff development in the philosophy of the teaching method to be learned.

Finally, Inch (2002) introduced the term the Accidental Constructivist. His background is in applied mathematics and college teaching. According to Inch (2002), he began his career teaching with a lecture style, though including some interaction with his students. He described in detail his evolution into a constructivist perspective. In short, he interacted with his students, used problem solving and group work, and assigned class projects instead of final tests. It was not until Inch attended a conference that included a discussion of the issue of constructivism that he realized that he had developed into a constructivist teacher. He was not trained as a teacher, so he was not necessarily aware of the different theories of instructional delivery. Nonetheless, he stood by his self-proclaimed status as a constructivist and said that he learned constructivism through a conference and discovered he already found himself using the philosophy. He noted that he discovered for himself constructivism in a constructivist way. The nature of his collegiate teaching required teaching the same course over and over, and “change was necessary just for my own mental health” (Inch, 2002, p. 112). He also ran into a problem of having to teach a course that he was not very familiar with the subject matter. He engaged his students to actively participate not only in their education but his as well. This approach may have beneficial consequences in the realm of increasing instructor job satisfaction and, thus promote longevity in teaching because each new group of students will provide a unique teaching experience for the instructor.

Project Description

Potential Resources and Existing Supports

The resources needed for this project are currently available in the study school. No special curriculum materials need to be purchased. Any materials used by the teachers who will be video recorded can be locally obtained or duplicated. The technology infrastructure of this school has a strong foundation and multiple media sources are available. Many tools that record videos are available in the school, including but not limited to multiple types of video cameras, computers, and tablet computers. Additionally, personal devices owned by teachers can be used and the video files shared, although this is not required since school-owned equipment is readily available. The school has a local server capable of storing the video files, including a dedicated back-up system, plus the means to make physical backups of the videos. Multiple staff members are available who assist in technology integration and use, and they are ready to aid teachers in the use of technology tools to record videos. School administrators consistently advocate for the use of technology to support teaching and learning.

Potential Barriers

If this project is successful, the program may have the potential of growing quite large. While the initial implementation may be quite manageable, an expansion of the program would necessitate some additional coordination for all components to work well. For example, the file system and database must be well maintained to adapt to new input and materials. Teachers may present additional barriers. For example, not all teachers are comfortable with using certain technology. It is also possible that there will not be a sufficient number of teachers who agree to be video recorded for this Peer Observation Library. Some teachers may not agree with the constructivist philosophy underlying reform mathematics, although they may still find useful teaching strategies within the program. Even though the training may be required staff development for the teachers at the focus school, if teacher attitudes do not support constructivism, then minimal learning is likely to occur. Finally, the school must maintain accessibility not only to appropriate technology, but also assistance with using that technology. While this is not an anticipated concern at this school, it should be noted if the program is to expand to other school sites.

Proposal for Implementation and Timetable

Implementation of the Peer Observation Library will begin in August, near the beginning of the school year. A steering committee will be created prior to the start of the school year that will include administrative personnel, the researcher as the program coordinator, and at least two teachers. A minimum of five volunteer pilot teachers will be identified early and specifically instructed or trained in the expectations for their lessons.

These teachers will be providing not only the first videos to be included in the library, but will also be providing the video examples that all future videos will be modeled after. These pilot teachers, along with the steering committee, will carefully evaluate each of the first set of videos to ensure the quality of not only the video but of the content and technique of the lesson. Once the first set of videos is approved and uploaded, more can then be created and added to the library. The steering committee will meet as needed to evaluate new videos.

Before implementation officially begins, I will lead an introductory workshop to be conducted during the study school's pre-planning time. This pre-planning occurs prior to the beginning of the school year and will provide a foundation for all teachers prior to the actual start of the school year. The workshop will be video recorded for future reference by existing staff, training for new staff, or for those staff members unable to attend the original session. This workshop will include:

- An overview defining reform mathematics and constructivism,
- A thorough discussion of the *Rubric for Implementation of Elementary Mathematics Teaching Reform*, including target areas based on the study results,
- A discussion of the current view of math at the school,
- A comparison of descriptions of reform mathematics lessons with non-reform mathematics lessons, and
- A description of the overall program and required elements.

Once implementation begins, teachers will be required to view a minimum of five video lessons over the course of the school year. These requirements will be embedded within the existing staff development protocol described earlier. Teachers may include a reviewing of the introductory workshop as one of their required videos. Monthly discussions and review will be required during regularly scheduled grade level meetings. These discussions will occur on the fourth Thursday of each month. The project will be evaluated in May, at the end of the school year. The summative measure will be a re-administration of the initial *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform* (Ross et al., 2003). The results of this readministration will be compared to the original administration to determine any change in teacher attitudes.

Roles and Responsibilities of Student and Others

I was solely responsible for collecting and analyzing data to obtain baseline information for this study, and I will be the program coordinator for the project. I will also be required to upload and save files, conduct data entry, and I will ensure technology access for all teachers as well as overall quality control. The responsibilities of this project begin and end with the teachers. While the students are the ultimate benefactors of this project as their teachers develop their knowledge and skills, they hold no responsibility for the project. Recording video and taking pictures of students are allowed by the school district for staff training purposes.

Project Evaluation Plan

The goal of the project is to increase teachers' use of reform mathematics or constructivist teaching techniques. Therefore, a goal-based evaluation is necessary. As a summative measure, the initial survey, *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform* (Ross et al., 2003), will be re-administered near the end of the school year following initial implementation, and the results compared to the baseline created in this study. This re-administration of the survey will be used to evaluate the effectiveness of the program. The goal shall be deemed to have been met if the results of the summative survey show that the level of agreement is increased toward "Strongly Agree" when compared to the results of the initial survey. The same analysis will be performed on the post-project implementation data that was completed on the baseline data, consisting of average scores for each question and each dimension. Based on the results of the post-project implementation survey, a determination can be made whether to continue the program, make changes to the program, or to discontinue it.

Project Implications Including Social Change

The local school district is committed to providing continuing education to its teachers in the area of mathematics to keep them on the progressive edge of teaching. This project has the potential to provide a much-needed vehicle for staff development that is adaptable to the current and changing needs of the teaching staff. It is expected that teachers who complete this staff development program will gain personal insights into their own teaching beliefs and practices. Moreover, having seen in videos and discussed with colleagues models of best practices in teaching mathematics, it is expected that even some improvement in teaching practice will occur and this will result in improved student academic performance in mathematics. If the program is successful in the study school, there is the potential for the program to have widespread impact at other schools within the district. The district is quite large with several schools and students attending those schools, so the possibility of impacting many students through this project is very real. Once news of the success of the program spreads through the district, local school administrators could duplicate the program with their own staffs with minimal effort since the design, videos, and materials will have already been developed

Local Community

The underlying foundation of constructivist learning is rooted in realistic problem solving. Giving students (and teachers) a foundation that is applicable not just in mathematics but in all aspects of life is invaluable. Standards of education are steadily moving toward national standards, such as the Common Core (CCSSI, 2015). Standardized testing is moving toward application and performance-based assessments. With experience in constructivist learning, students not only grow intellectually, but they can show this growth on standardized measures. The success of our students echoes through the community, strengthening community bonds, garnering respect, and even having a positive economic impact. As a result, the community may become even more invested in the success of its students, and the cycle continues and momentum grows.

Far-Reaching

Educators should provide young students with a background in developing problem solving skills, ultimately giving students an increased chance of success in the "real world." This change starts within a teacher's own local sphere of influence. As the teachers prodigies' grow and leave the academic environment to create spheres of their own, that influence spreads.

This project is one that is sustained and maintained by the local needs of its teachers and students. The stakeholders are not just the students, but also the teachers themselves. The primary focus of this study and project is local, but even though this specific study is not necessarily applicable to other locations, its basic premise is. Other schools or even districts can be shown how to implement a virtual library. Perhaps the needs of other schools are not in mathematics but in literacy, science, or social studies. The idea driving the video library can be adapted to fit any content area. However, an instrument to identify the needs of a district or school would be required to determine a focus and starting point.

Conclusion

This study used a self-report survey and observations to determine teachers' attitudes and practices in the elementary math classroom as they relate to reform mathematics and constructivist teaching techniques. The goal of this project is to effect change in teachers' attitudes and practices toward reform mathematics teaching. A descriptive analysis showed that there were favorable attitudes toward and practices of reform mathematics, but that there was room for growth with a couple of areas indicating a negative agreement. A staff development program consisting of an introductory workshop and peer observation videos was created to improve reform mathematics and constructivist attitudes and practices at the study school. Teachers develop their teaching and learning philosophies early in their career during their teacher education courses. A single staff development session or workshop may not provide the necessary long-term exposure to effect systemic change. However, the method of peer observation provided in this project will allow teachers to develop a greater understanding of what reform mathematics is over time and provide ideas for how they can implement reform mathematics themselves in their teaching.

Section 4: Reflections and Conclusions

Introduction

This project study was designed to identify teachers' teaching practices as they relate to reform mathematics and constructivist techniques. Although the school district advocates use of teaching practices that align with such techniques and does provide some staff development in them, there is no formal method to determine whether teachers embrace them or use them in their daily practice. Formal observation and evaluation protocol does not guarantee that teachers spend the mandated time in math instruction, nor does it provide an accurate, long-term way to view math instruction occurring in classrooms. An anonymous self-report survey was used to allow teachers to express their attitudes on teaching practices. A series of observations were also performed with a smaller sample of teachers to validate the results of the surveys. These results provided the basis for designing a staff development program that teaches reform mathematics techniques and encourages teachers to increase their use of those practices.

The same self-report survey employed to gather baseline data will be used as a summative evaluation to measure the success of the program. The results of the data analysis indicated that most teachers were supportive of constructivism. However, the information still provided a baseline, that indicated that more reform mathematics and constructivism in their math classrooms was needed. Designing the staff development program also presented new challenges. Educational delivery of staff development programs continues to change, especially in the area of technology use. Throughout the course of this project, I gained insight into the complexities of staff evaluation and nuances in teaching philosophies and practice. Designing the staff development program developed my appreciation for the relevance of staff development and the flexibility in the delivery of the development, particularly when considering the continuing evolution of technology and its integration in education.

Project Strengths

One strength of this project is in its administration. A self-report survey, especially an anonymous one, is an easy and quick way to determine teachers' beliefs and practices (Allen, 2011; Stemhagen, 2011). The relative ease of administration, particularly of the surveys, was the first strength of this study. Using available computer technology made the dissemination of the surveys and collection of the data very straightforward. Because collecting self-report survey data through the Internet allows the respondent to complete the survey when it is convenient for him or her while taking as much time as necessary, this mode of data collection is flexible. Moreover, once the survey is set up online, it can be easily readministered and used to collect summative data after the program implementation is completed. The survey can also be repeated annually as the program continues. Observations are perhaps a stronger, more reliable way to determine teachers' practices but are difficult to manage over the long term. A series of observations, however, was included in the program so participating teachers could learn how to identify actual reform mathematics practice.

The survey data were analyzed using descriptive statistics (e.g., means, standard deviations, and deviation scores), and the results of both individual survey items and the constructed variables of the dimensions were evaluated. The scores were averaged to provide an overall picture of teacher agreement with reform mathematics. Additionally, each survey item corresponded to a particular dimension of reform mathematics as determined by Ross et al. (2003), providing another lens through which to view the results. The observations were scored according to the same nine dimensions. This multifaceted approach to collecting more than one source of data and analyzing the data through two different lenses (e.g., individual survey item responses and constructed variables) provided a more holistic view of the data.

The next strength of this study stems from the project itself. Everything designed and planned in the project can insert or embed itself directly into existing staff development protocols and procedures. This makes for a seamless integration for teachers already accustomed to existing procedures, as well as those who are not necessarily receptive to reform mathematics or to attending additional professional development. The project, a professional development program, was designed based on the results of the study, and it is meant to encourage teachers' use of reform mathematics and constructivist techniques. The project begins with a training workshop meant to give teachers an operational understanding of reform mathematics and constructivism in order to provide a common understanding and vocabulary. The main focus of the project is a series of peer observations meant to provide examples of reform mathematics and constructivist teaching. Because of time and funding constraints, these observations were meant to be viewed in video format. Using video lessons as a teaching tool allows more flexibility because teachers can "attend" their staff development sessions on demand without the complication of scheduling a common viewing time, missing class time, or providing for class coverage. This on-demand approach respects teachers' time and allows for more flexibility, increasing the accessibility of the program.

Technology in most schools in the United States is ubiquitous, which means the use of video recording is very easily accomplished (Knight, 2014a, 2014b). Locally producing the videos ensures that the content and the materials are relevant to the teachers and can be shared and reproduced without copyright infringement (Reeves, 2009). Additionally, teachers who demonstrate lessons on the videos can be available for discussion or for answering questions. Commercially produced videos can sometimes be purchased, but there is no guarantee that the content or materials will be identical to those used by the study school; sharing the videos outside the study school may violate the purchase agreement; and those teachers on the video may not be available to discuss or answer questions about the lesson. By including teacher reflection and discussion in the staff development design, collegial interaction and collaboration can reinforce the ideas of reform mathematics, and ideas can be exchanged. Again, the accessibility of the program components adds to the strength of the implementation of the staff development program.

Recommendations for Remediation of Limitations

The first limitation encountered in this project was the limited number of participants on which the decisions for the project were based. Because the study was limited to a single location, only 37 participants were available, of which 31 participated and returned a completed self-report survey. The observations were likewise limited in number, with only 15 participants being observed. With such a low number, the reliability of the results is questionable, but the data analysis yielded valuable insights nonetheless. Additionally, the research methodology using a convenience sample of limited scope does not allow for generalization outside the study school. Expanding the study to more locations would have yielded many more participants and would have allowed for a greater understanding of reform mathematics teaching practices throughout the district, but it would have made implementation of a staff development program more difficult. Each school creates its own culture, and staff development may look different from one location to another. It is more effective to design the staff development program to be tailored to the culture and needs of one school, and then, if the program is effective, modify the program as necessary to meet the needs of other schools that choose to implement it. Although the Peer Observation Library may be applicable to all schools within the district, if not, it could easily be tailored to the needs of each school location separately.

While a self-report survey is a quick and easy method of gathering data, it is possible that teachers may report themselves higher on the scale in the desired direction (Allen, 2011). The results did indicate general, overall positive agreement. In this case, however, the results still warrant the staff development because the observational data indicated that there still is room for improvement in reform mathematics teaching practices. In the future, additional formative measures may need to be developed to evaluate specific aspects of the program, such as the quality of the videos and the content of the lessons. The most immediate limitation is the quantity of videos available. For the program to be successful, several videos of teachers demonstrating model reform mathematics lessons will need to be produced. In the beginning, this quantity may be limited, but over time, the library ideally will continue to grow so that there will be demonstration lessons on a broader range of mathematics topics. It is possible that getting volunteers to create the demonstration videos may be difficult, but this problem is not anticipated. One way to address this would be to create a sufficient quantity of peer observational videos prior to beginning the staff development program. However, this would result in a delay in starting the program. It is possible to purchase videos that will address the needs of the program and include them in the library, but that would require additional funding and could negate some of the positive aspects of the peer observations, such as the focus on local teachers, local resources, and access to the lesson providers for collegial interaction.

Using peer observations in a staff development program is only one way to promote teachers' increased use of reform mathematics and constructivist techniques. Commercially produced videos can be obtained, but there are some potential drawbacks, as have been mentioned already. A more traditional staff development program, such as a workshop or lecture, could also be developed. Teacher role playing during a workshop could provide a collegial means of interaction to introduce or reinforce constructivist techniques. However, peer observations, even in virtual format, provide a look at actual teacher practice and student reaction and interaction in real time. Role playing and lecture cannot reproduce this completely.

Recommendations for Alternative Approaches

Based on the findings of the study, some form of professional development is warranted. The problem was essentially defined as follows: Teachers may not be using reform mathematics or constructivist teaching strategies to the degree desired by the district, and there is no specific measure available to determine the extent to which teachers may or may not be using them. This problem was addressed by a self-report survey and a sample of observations. A measure could have been obtained strictly through observations, perhaps through multiple observations of each teacher; the results would have been more accurate but obtained at great cost in terms of time and inconvenience. Another way that these data could have been obtained was by training administrators to make specific observations of teachers' practices within their existing observational protocol for teacher evaluation (if they were not already familiar with this process); however, that might have required further permission from the school district, among other concerns.

The professional development itself could have taken many different forms. Rather than a year-long program like the one developed for this project study, a single, one-time workshop could be offered as training for teachers, delivered live or via recording. Another variation would involve holding smaller development sessions over the course of several months covering the same material, perhaps expanded in detail. In any of these alternative scenarios, a smaller quantity of teacher-made videos could be used and presented en masse to larger groups of teachers with discussion to follow in one session. All of these formats would allow for the delivery of material and for a general training opportunity for teachers. However, without peer observation in some form, the training would be more theoretical training in nature, with less concrete application. Some form of role playing might mitigate that somewhat, but concrete models provide a better means of personal connection to the source material, as well as means of comparison to gauge the success of the lesson reproduction (Reeves, 2009).

Scholarship

Scholarship is at the heart of this endeavor. What started as a single question evolved into an epic journey. What began as an exploration into collaborative action research turned into a years-long pursuit of understanding of constructivism in education, particularly in mathematics. The problem with constructivism, as I learned, is its lack of specific definition (Duffy & Cunningham, 1996; Hennig, 2009; Simpson, 2006). Throughout the literature review process, I grappled with philosophy, practice, and generalities related to constructivism. As a philosophy, constructivism makes sense, but applying it to mathematics proves more difficult to narrow down. It was particularly amusing for me to read how constructivism in mathematics compared to unicorns (Stiff, 2001). In order to successfully approach my problem, I had to focus on a specific set of defined parameters, namely reform mathematics as defined by Ross et al. (2003).

Once I could define my parameters more succinctly, I could better tailor the search for literature. Still, the underlying philosophy of constructivism proved a challenge. The philosophical underpinnings of constructivism may be traced back many years; even the modern era of education can trace elements back to Dewey and Piaget. The search required the use of many keywords beyond just *constructivism* and *reform* *mathematics* (see Section 1). Walden's Thoreau metasearch provided access to many databases for education as well as other disciplines. Other search options were required as well, such as searching the databases of the NCTM and others that were not included in the Walden databases. Even general Internet searches yielded useful resources.

Today's modern global society, connected by technology, is bound together economically and socially, if not physically, with modern travel. Through the review of international studies, comparisons have been made between education in the United States and education in other countries around the world. It is natural to want one's country, work team, and family to succeed. Understanding how others succeed can affect one's own educational evolution. It was eye opening to see how other countries, such as Japan, embrace education and an emphasis on student-centered learning.

Technology was also at the heart of the design of the staff development project. This research allowed me to broaden my views on adult education and staff development within and without the school. Emphasis is placed always on collaboration and collegial interaction, often described as PLCs (Dufour, 2004, 2014; Learning Forward, 2015). Increasing time constraints have made face-to-face interaction more difficult, and more emphasis has been placed on virtual interaction. Technological advances in just the last few years have changed the way that education is delivered not just to adults, but also to students. Technology is advancing at an unprecedented pace. Continuing study of these advancements will be necessary to remain current and relevant in relation to staff development. Being a scholar means not only being well versed in the past, but also being able to look to the future and remaining current on emerging and developing trends in education.

Project Development and Evaluation

Teachers attend many types of staff development over the course of their career. The number of workshops, conferences, and meetings attended cannot easily be counted. Each type of staff development program has both positive and negative aspects. I wanted to design a program that could address the concerns of the study school and, at the same time, be respectful of teachers' time and needs. Being a teacher in the classroom myself, I can empathize with these concerns. I tried to use this knowledge as I conducted my research and plotted my ideas. I knew that a staff development program was the most logical method to expose teachers to constructivism and to provide the necessary training to teach them how to use it themselves.

Regardless of the format of staff development, it is important that it be based on research and driven by data (Learning Forward, 2015). This is especially true in terms of the technological aspects of the program. The field of education changes rapidly in response to changing technologies. Teachers need to be responsive and reflexive in relation to these changing needs, as well as changes in society. Even with all of these technological and societal changes, much about the foundational principles of education remains constant. Staying current regarding research but grounded in the past is very important.

The climate at the study school is highly supportive of peer observation, and administrators require teachers to do collaborative planning and have other collegial interaction. Increased use of available technology is also highly encouraged for both teachers and students. My goal was to design a program that uses technology in a way that accommodates these aspects while at the same time acknowledging, respecting, and preserving the valuable time of teachers. The idea of the Peer Observation Library was the result.

Designing the staff development program was certainly an ongoing process. Initially, I had considered a virtual program without the need for the traditional workshop. As I proceeded to flesh out the details of the library, I came to realize from reading the research literature that there was a real possibility that teachers may not fully understand the meaning or definition of reform mathematics or constructivism. That meant I needed to design some form of training module to address this and front load material before the peer videos would be truly useful. Rather than record a lecture to be included in the library, I felt that a short training workshop would be the most appropriate way to address the initial training. Even though it may be considered a more "traditional" setting, the face-to-face collegial interaction based on the concept of PLCs allows for an organic give and take for the participants and also a forum to address questions and concerns directly as part of the workshop. Nevertheless, this initial workshop will be recorded for future review and included in the library.

Evaluation of the project was straightforward. Using the original survey to gather post-implementation data to compare to the initial findings provides a direct comparison to determine if the program has been successful in changing teachers' attitudes about reform mathematics. Even though self-report surveys have the possibility of overreporting (Allen, 2011), they are still considered reliable measures. They are also relatively easy to administer and analyze, maximizing the time of the teachers and the researcher. Looking forward, if the project were to continue or to expand into other content areas, new or additional assessments would probably need to be developed that can more accurately address the needs of the staff.

Leadership and Change

As mentioned throughout, change in education is continuous. It is often based on the changing needs of society and on new and emerging technologies. Being a leader means being responsive to this change, or even anticipating it. The definition of a leader in this respect does not mean the person necessarily "in charge." A leader is one who encourages their peers. A leader is one who puts themselves at the forefront of continuing their own learning. A leader not only embraces these changes, but becomes the change agent themselves.

I believe that apathy and stagnation in any endeavor take the joy out of it. Education is not like sitting in a cubicle completing a mundane set of daily tasks. Each day comes with surprises, as children are certainly unpredictable. Each year teachers gain a new crop of personalities, strengths and weaknesses, and challenges to overcome. What worked in class last year may not work this year or even next year. Change is inevitable. I believe that those teachers who accept and embrace the change, the ones who are flexible enough to accommodate and assimilate that change, those are the leaders. The best leaders are those who lead by example. I hope that my example helps to inspire teachers to discover more about alternative teaching styles, to make greater use of technology, and to continue their own education. Research into PLCs and other collegial interactions has reinforced for me how important it is for teachers to interact and to share, even if it is in a virtual manner.

Analysis of Self as Scholar, Practitioner, and Project Developer

I have always been the studious type. Whether it is reading meaningless trivia or completing a specific task or assignment, I enjoy the research aspect of learning. Perhaps that is why I became a teacher. Pursuing a doctorate has always been a logical step for me, and I am glad I have taken that step. The hardest part for me as a scholar has been to focus on this specific area of research. I had to learn to move away from generalities and narrow in on a specific area. I began with a general search for the meaning of constructivism and discovered such a variety of meaning. In a sense, the way constructivism is often described is how I was sometimes described. I will always have this passion for learning, but through the course of this degree I have learned how to take a larger body of research and knowledge and pull out the essence of a specialized component and make it my own.

Recognizing myself as a scholar also helps me to be a better leader in my school. Learning about statistics alone has been extremely helpful in understanding aspects of data analysis that before I relied on the word of others. I now better understand how district and school leaders use data to affect school change, and I can better participate in the process. Even viewing basic classroom data through this new lens gives me a new perspective not only on district assessments but every day classroom assessments as well.

I have learned to look forward to new trends in education through research, and I plan to continue this habit moving forward.

I have probably learned most about myself as a practitioner. As I discovered and learned about constructivism, I found that I had a strong affinity for the philosophy of constructivism in general. From there I needed to focus on a single content area, so I chose mathematics because I felt that other teachers with whom I came into contact might not have felt as strongly as I did about constructivism in math. That required that I look at myself as a teacher and analyze my own practices. To be honest, I discovered that I probably did not apply constructivist principles as well as I thought I did. Even when I focused in on the reform mathematics parameters, I still had to acknowledge that I, too, needed to grow. I believe I have grown, and with this growth I can appreciate what other teachers are going through and empathize with them.

It is my students who I hope will gain the most from my growth and my research. Each time I learn something new I try to incorporate it somehow into my classroom. It is my hope that my fellow teachers also become so inspired by the new ideas presented in the staff development program. I believe I respond positively to new ideas, and I want my students to learn to respond positively as well. I have a habit of telling my students why I do things. I call it letting them in on my “teacher tricks.” It is my hope that by letting them in on my processes as a learner and teacher, they will come to internalize those practices themselves as well.

It is my growth as a practitioner that truly impacted the development of my project. I myself was going through many of the same processes that I will be asking my fellow teachers to undergo. I kept asking myself, "How would I react if I was a teacher in this study/staff development program?" Developing a staff development project requires being both reactive and proactive. A leader anticipates the needs of his colleagues. I knew that a survey would be relatively quick and easy for teachers to complete, and it is something they are used to doing. I was fortunate to be able to find a survey instrument that addressed the needs I was researching rather than creating my own. This allowed me to focus on the development of the staff development project that became the Peer Observation Library. I first imagined what type of staff development program would be well received in my school. I believe that a successful project is one that keeps its recipients' needs in mind. Having teachers buy into any program is integral to its success.

The Project's Potential Impact on Social Change

At its heart, this study was meant to apply to the local level, the study school. Baseline data were collected at a single location, and the project developed to apply to that specific location based on the analysis of the baseline data. Each school develops its own climate and culture, from the school mascot to the personalities of the students. Interactions between teachers, students, and parents create a unique atmosphere. However, each school and each teacher is responsible for teaching standards proscribed by the district and state, and even national standards like the Common Core (CCSSI, 2015). By determining the degree to which the faculty of the study school already agreed with the reform mathematics philosophy, I provided the local focus to this research.

Rather than creating a program comprised of a single, one-time development class or session, a more comprehensive, long-term, sustainable program was developed.

Staffing at elementary schools can be fluid and can change from year to year. Student enrollment may increase or decrease the number of teachers needed, and transfers or retirements may occur. Any staff development program would need to be adaptive and reactive not only to the staff but also the changing needs of the district. Creating a library of locally created and produced videos spotlighting local teachers using local resources is a way to expose teachers to new teaching techniques, or refresh them with new ideas in a manner similar to peer observations.

Although this is a local study, the essence of the study can be repeated in any elementary school. While the results may be very different, they can be used to create a staff development program tailored to that school. Likewise, the idea of a library of locally produced videos being used as peer observations could be created independently of any formal data collection. In essence, while the results of the data analysis cannot be generalized to any other population, the study itself can be repeated in other settings. The Peer Observation Library, at least in the general sense, can also be created in other locations and applied in multiple content areas.

This study can also be important in other, more far-reaching ways. In research alone, the importance of student-centered learning and its application in the elementary math classroom is highlighted in this study. Other schools can be encouraged to carry out their own studies or staff development to increase the use of reform mathematics and constructivism. In a less direct way, as teachers move on to other schools or become leaders and principals themselves, they can take with them the knowledge and practices they received from participating in this study. They will contribute to their new school's climate as they spread their influence there. Perhaps some of these teachers will choose to investigate or research more about reform mathematics and constructivism on their own as well.

Implications, Applications, and Directions for Future Research

I believe this project has several aspects that lend itself to future application and research. The first is in reform mathematics specifically, and also constructivism in general. Although student achievement data were not included as part of this study, it is a natural extension. Student data are generated yearly through several standardized testing formats. An analysis could be performed to determine how much of an impact the move to reform mathematics might have had following implementation of the Peer Observation Library project. An analysis of this sort has the potential of providing additional support and validity of the staff development program, especially for any teachers who may not fully agree with the philosophy behind reform mathematics. Using a more rigorous approach and correlating objective student performance data to an increased use of reform mathematics and constructivism would also make the findings worthy of publication to add to the existing literature on mathematics reform.

If one considers the philosophy of constructivism more generally, success in the area of mathematics may also encourage teachers and administrators to consider a focus on improving teaching and learning in other content areas. The idea of the Peer Observation Library is flexible enough to accommodate recording teachers demonstrating model lessons in other academic content areas. It would be necessary to have a tool, such as a survey, to assess baseline performance, but the staff development infrastructure would already be in place.

Future research, as applied specifically to this study, would entail expanding the study and repeating it on a larger scale. The school system in this large suburban area has 134 schools arranged in 18 clusters. Each cluster contains the main high school, and all feeder middle and elementary schools. The data collection could be expanded to include multiple schools, entire clusters, or even the entire system. More participants would yield a much more robust and complete picture of teacher attitudes toward reform mathematics. If warranted, a Peer Observation Library could be created to include demonstration lessons provided from teachers at more than just a single school, or perhaps each school could maintain its own library and network together with other schools. Having the support of more schools and the district could provide additional funding and technology, as well as increase the number and variety of available peer observation videos.

On a personal note, I would like to further research aspects of constructivism in other content areas. Because I relate to the constructivist philosophy, I believe that a holistic approach in all content areas would aid in planning and instruction, and make it easier to accommodate the needs of a broad range of students as well. By continuing my research on constructivism, I hope to be able to expand the Peer Observation Library to accommodate other content areas.

Conclusion

This project provided a vehicle to measure teachers' practices in the elementary math classroom and create a staff development program to increase teachers' use of reform mathematics. While it was limited in population and scale, it still provides teachers with a way to explore the ideas presented in reform mathematics. Even for those teachers already well versed in reform mathematics, or constructivism in general, the Peer Observation Library allows for increased opportunity for peer observation. The collegial interactive portion of the program increases dialog about reform mathematics and the sharing of additional ideas. The strengths of this study are that the recommended staff development program is directly applicable to the teachers at the study location since it is based on data garnered from the study school, and it has the potential of affecting other schools as well. Teachers who may not embrace the philosophy still have the benefit of additional peer observations, collegial interaction, and exposure to new research. The staff development program makes use of current technology and the program is flexible enough to accommodate new technology in the future. Above all is the underlying theme of relationships and interactions between teachers, as well as between teachers and students. Through interaction comes understanding and curiosity, increasing the bond between colleagues. Leadership and social change begin in these relationships.

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Appendix A: The Project

Outline and Agenda for the Introductory Workshop for the Peer Observation Video Library

Module 1 – Theoretical Foundation

EQ: What is reform mathematics? What is constructivism?

I. Topic overview – 20 min.

A. Define (discovery, student-led, inquiry-based, etc.)
B. Stove example
C. In math class (manipulatives, open ended problem solving, creativity, groups)

II. Dimensions (D) of Elementary Mathematics Reform and the Rubric for Implementation of Elementary Mathematics Teaching Reform – 30 min.

A. What differentiates one level to the next?
B. Where would you rate yourself?
C. How difficult would it be to implement in your classroom?
D. Pros/Cons about the philosophy

III. Wrap-up – 10 min.

Module 2 – Focus on Reform Mathematics

EQ: What would reform mathematics look like to us?

I. Reform mathematics and constructivism at our school. – 20 min.

A. What would/does reform mathematics/constructivism look like at our school?
B. How much reform mathematics is going on currently at our school?
C. Is there any connection to this philosophy and the End-of-Grade Testing?

II. Existing resources – 30 min.

A. What resources do we have that could help us?
   1. Manipulatives (SuperSource; Hands-On Standards; Frameworks)
   2. Exemplars
   3. Hands-On Equations
   4. Other eClass resources?
B. How can technology be used to implement reform mathematics?

III. Wrap up – 10 min.

Module 3 – Lesson Analysis; 60 min.

EQ: What are some basic examples of reform mathematics or constructivist lessons?

Compare and contrast several brief lesson descriptions; Reform Mathematics, or not? – 30 min.

Lesson #1 - On Monday, Ms. Jones is introducing the topic of multiplication to her 2nd graders. She hands out a list of times tables and tells her class that they should start memorizing these tables. She also tells them that the first quiz on the 0's, 1's, and 2's will be this coming Friday, and there will be a new multiplication quiz every Friday for the rest of this quarter.

Ms. Jones next passes out a set of index cards to each one of her students. She tells the class that they are going to make their very own flash cards. She then instructs them on how to put the problem on one side and the answer on the opposite side and nothing else. Their homework is to finish the flash cards using 0's, 1's, and 2's. When the students return on Tuesday, the math lesson is to use their flash cards with their friends and practice. She tells the students if they behave and stay on task she might let them decorate their cards.

Lesson #2 – Mrs. Rogers next door is also introducing multiplication. When math class starts, she notices that Tina has already taken out her math supplies and is waiting patiently for Mrs. Rogers to begin. Mrs. Rogers begins to chant: "2-4-6-8 who do we appreciate? Tina!!!" Tina and the rest of the class look at her very puzzled. Mrs. Rogers tells the class that from now on, they will use that chant to celebrate anyone "caught being good".

Mrs. Rogers starts the lesson by asking her students if they like cookies. She tells them she loves cookies and loves to bake her own cookies. She wants to make cookies for the class and she has this special recipe. This recipe says that you have to have two teaspoons of flour for every cookie she wants to make. She tells the students she wants their help to make the recipe easier for her. She says, "It takes too much time to count out how many teaspoons of flour I need. Can you help me by making a chart that tells me how many teaspoons of flour I need for every amount of cookie I might make? I usually only make about 12 at a time."

The students run up for chart paper and supplies and begin to make their chart in groups. Charlie raises his hand and asks, "Don't you ever make more than 12 cookies?" "Yes, sometimes I do Charlie, especially if I am going to a birthday party." "But Mrs. Rogers", Charlie chimes in, "we have 25 students in our class. How many teaspoons will you need for all of us?"

"I don't know, Charlie," says Mrs. Rogers. "Why don't you add that many to your chart and find out?"

"2-4-6-8 who do we appreciate? Charlie!!!" yells Mrs. Rogers. "3-6-9 Oh, yeah we're doin' fine!"

Finally, Sarah calls out, "Aren't we just counting by 2's?"

"Why don't you ask me that tomorrow," says Mrs. Rogers.

<u>Lesson #3</u> – Mr. Smith is teaching his 5th grade class about Geometry, quadrilaterals and triangles. He asks if anyone can define these words. He calls on several students who give him correct answers. Mr. Smith then walks to his computer and spends the next several minutes defining all of the shapes while projecting his notes on the screen for the students to copy down. He then projects up a picture of a flow chart naming all of the different types of quadrilaterals and their attributes. He asks the students to copy down the chart into their notebooks. After a few minutes he changes the picture to a similar one about triangles. He tells them they need to memorize these charts for the test next week.

<u>Lesson #4</u> – Mr. Ramirez is also teaching geometry. His students are divided into groups of 4. Each group has two brown paper bags and a box of manipulatives on their table. He starts class by putting on a blindfold and stumbling around the class, eliciting laughter. Without taking off the blindfold, Mr. Ramirez says that there are so many people in the world who are blind, maybe even born blind. "How would you describe these shapes to someone who has never seen them?" he asks.

He tells the students to open the first paper bag; each one contains a particular shape (some are pattern blocks, some are tangrams, or other created shapes, etc.). The task for each group is to put their hand into the bag, without looking, and describe what they feel in every way they can think of.

He then tells them to open the other bag, containing two shapes. They are to do the same thing, but this time they are to say how the two shapes are similar and different – again without looking. All of these thoughts they write down in their math notebooks.

After this is done he asks them to take the shapes out of the bags and add any more descriptions they want to their notebooks.

The next activity is to open the box of shapes and to sort them into groups, or families according to their similar characteristics. Then they are to put them into an order based on how many different characteristics they have, from least to greatest (also relying on prior knowledge).

The next day in class, Mr. Ramirez shares his version of the family "tree" (flow chart) and asks the class to compare theirs with his.

Module 4 – Exploring Peer Observation Video Library

EQ: What will the professional development program look like?

I. Description of the Peer Observation Video Library – 20 min.
- A. What is the endgame?
  - 1. "Living" library of teacher-created video lessons demonstrating reform mathematics/constructivism
  - 2. To allow for peer observation when coverage is not available
  - 3. Wide variety of content, strategies, and teacher models
- B. How would it start?
  - 1. Peer Observation Video Library, Steering Committee
    - a. Director, Administration, and two teachers
    - b. Approval of Videos
    - c. Maintain database
  - 2. Volunteer teachers to create the first set of videos
  - 3. Videos added as teachers become comfortable

II. Requirements of the Program – 20 min
- A. Teachers must watch 5 videos over the course of the school year.
  - 1. You may do this during collaborative planning with your grade level.
  - 2. You may do this by yourself during regular planning times, before/after school, or at home.
  - 3. You may watch the video recording of this Workshop (being recorded now) as one of your required videos.
- B. Critique videos using *Rubric for Implementation of Elementary Mathematics Teaching Reform.*
- C. Monthly discussions will be included during collaborative planning; Grade level leaders will include in monthly Team Logs.
- D. OPTIONAL: Record one of your own lessons and critique using the *Rubric*, or ask a colleague to score it. This DOES NOT have to be submitted for the Library. This is for your own benefit as personal reflection.

III. Program Evaluation – 5 min
- A. In May, the *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform* will be re-administered. The results of this administration will be compared to the original administration.
- B. These results will be anonymous as before.

IV. Wrap up – 10 min

Guiding Questions for Small Group Discussions for the *Peer Observation Library*.

Note: It may be helpful to have the have the lesson(s) available for viewing highlights during the discussion.

1. What video(s) did you watch (teacher, grade level, content, etc.)?
2. How was the lesson scored on the *Rubric for Implementation of Elementary Mathematics Teaching Reform*? (Compare and contrast multiple rubrics, if available.)
3. How does this lesson compare to how you may have approached the lesson?
4. Name at least three things you took away from this lesson that you will try and incorporate into one of your future lessons.

Appendix B: Dimensions (D) of Elementary Mathematics Reform

Dimensions (D) of Elementary Mathematics Reform

D1: Program scope
A broader scope (e.g., multiple mathematics strands with increased attention on those less commonly taught such as probability, rather than an exclusive focus on numeration and operations) with all students having access to all forms of mathematics.

D2: Student tasks
Student tasks are complex, open-ended problems embedded in real life contexts; many of these problems do not afford a single solution. In contrast in traditional mathematics students work on routine applications of basic operations in decontextualized, single solution problems.

D3: Discovery
Instruction in reform classes focuses on the construction of mathematical ideas through student discovery contrasting with the transmission of canonical knowledge through presentation, practice, feedback, and remediation in traditional programs.

D4: Teacher's role
The teacher's role in reform settings is that of co-learner and creator of a mathematical community rather than sole knowledge expert.

D5: Manipulatives and tools
Mathematical problems are undertaken in reform classes with the aid of manipulatives and with ready access to mathematical tools (i.e., calculators and computers). In traditional programs such tools are not available or their use is restricted to teacher presentations of new ideas.

D6: Student-student interaction
In reform teaching the classroom is organized to promote student-student interaction, rather than to discourage it as an off task distraction.

D7: Student assessment
Assessment in the reform class is authentic (i.e., relevant to the lives of students), integrated with everyday instruction, and taps multiple-levels of performance. In contrast, assessment in traditional programs is characterized by end of week and unit tests of near transfer.

D8: Teacher's conceptions of math as a discipline
The teacher's conception of mathematics in the reform class is that of a dynamic subject rather than a fixed body of knowledge.

D9: Student confidence
Teachers in the reform setting strive to raise student self-confidence in mathematics rather than impede it.

(Ross et al., 2003, p. 348)

Appendix C: Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform

Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform

Please indicate your level of agreement with the following statements.

1 – Strongly Disagree
2 – Disagree
3 – Somewhat Disagree
4 – Somewhat Agree
5 – Agree
6 – Strongly Agree

<=Disagree - Agree=>

		1	2	3	4	5	6
1	I like to use math problems that can be solved in many different ways.						
2	I regularly have my students work through real-life math problems that are of interest to them.						
3	When two students solve the same math problem correctly using two different strategies I have them share the steps they went through with each other.						
4	I tend to integrate multiple strands of mathematics within a single unit.						
5	I often learn from my students during math time because my students come up with ingenious ways of solving problems that I have never thought of.						
6	It is not very productive for students to work together during math time.						
7	Every child in my room should feel that mathematics is something he/she can do.						
8	I integrate math assessment into most math activities.						
9	In my classes, students learn math best when they can work together to discover mathematical ideas.						
10	I encourage students to use manipulatives to explain their mathematical ideas to other students.						

11	When students are working on math problems, I put more emphasis on getting the correct answer than on the process followed.						
12	Creating rubrics for math is a worthwhile assessment strategy.						
13	In my class it is just as important for students to learn data management and probability as it is to learn multiplication facts.						
14	I don't necessarily answer students' math questions but rather let them puzzle things out for themselves.						
15	A lot of things in math must simply be accepted as true and remembered.						
16	I like my students to master basic mathematical operations before they tackle complex problems.						
17	I teach students how to explain their mathematical ideas.						
18	Using computers to solve math problems distracts students from learning basic math skills.						
19	If students use calculators they won't master the basic math skills they need to know.						
20	You have to study math for a long time before you see how useful it is.						

*Adapted from:

Ross, J. A., McDougall, D., Hogaboam-Gray, A. (2003). A survey measuring elementary teachers' implementation of standards-based mathematics teaching. *Journal for Research in Mathematics Education*, *34*(4), 344–363.

Appendix D: Observation Protocol—Rubric for Implementation of Elementary Mathematics Teaching Reform

Rubric for Implementation of Elementary Mathematics Teaching Reform				
Dimensions	Level 1 Traditional	Level 2	Level 3	Level 4 Full Implementation of Reform
D1: Program	Only those students who have mastered basic operations have opportunity to learn higher math Limited to algorithms and facts, especially for numeration.	All students had turns as leaders but leadership was limited to low level functions; equal access to all math activities but these were mostly low level math	All students explained how to operate computer programs that involved high level math; teacher provided model of how to explain program; all students attempted rich problems but scaffolding support was somewhat limited Five strands covered with enough frequency to assign grades each term	All students explained math concepts to class; use of scaffolding (tools, peers, task difficulty) to enable all to complete high level math problems; utility of peer support increased by training students in how to explain ideas Five strands covered with some cross strand activities.
D2: Student tasks	Students encouraged to follow a particular procedure to solve particular problem type.		Multiple strategies for obtaining a single solution e.g. different methods of counting; integration of math tasks with other subjects, especially reading; use of materials of high interest to students (e.g. Smarties) in problems	Assigns real life problems with multiple solutions (e.g. tracing a route from students' home city to Ottawa)

D3: Discovery	Transmission of accepted knowledge, focus on teacher-defined procedures and cues each step; teacher controlled agenda – student questions postponed if not compatible with lesson agenda; only direct instruction of software used		Focus on student thinking by giving students time to mull over problems and asking them to elaborate responses; use of exploration activities in math software; models discovery process for students; balances discovery with closure	Focus on student thinking with open ended questions, wait time, follow up probes to elaborate student ideas, assigns think aloud tasks and has student guided discussions; not dismayed if lesson ends without closure; begins topic with discovery activities; balances discovery and direction; discovery followed by directive activities to clarify student understanding of concepts; usually provides closure.
D4: Teacher's role	Teacher is sole knowledge expert; student leadership is limited to low level tasks like getting materials; students share solutions to center activities; teacher models preferred solution strategies	Student expertise is acknowledged; teacher shares some control with students; students are assigned leadership roles for training others in center activities; they participate in making a rubric for small group work and use it to self-evaluate their behavior		Creation of math community is main goal; presents self as co-learner to students' shares role of teacher by identifying student teacher for the day, having students present to the whole class, and having students create math problems that other students solved; models math language, computer use, and math reasoning; reflective about own practice and shares teaching experiences with other teachers

D5: Manipulatives and tools	Manipulatives and tools not available	Students infrequently use manipulatives but can use computer to write about math and calculator to explore multiplication concept	Develops tasks that required student use of manipulatives; teacher use of manipulatives in demonstrations; activities to bridge between concrete and abstract representations of math ideas; recognizes that manipulatives might conceal lack of concept understanding; did not use the computer as a tool	*Students have access to manipulatives and tools to solve problems*
D6: Student-student interaction	Student-student interaction is limited; treated as misbehavior	Teacher assigns individual tasks that are completed in group setting; some encouragement of help seeking and giving	Teacher assigns interdependent tasks; student leadership roles require students to train peers; student tasks do not require giving explanations; peer learning norms supported by cooperation rubric	Teacher creates opportunities for students to learn from peers by establishing mixed ability groups, training students in leadership skills, assigning interdependent tasks, and requiring students to explain math ideas to others
D7: Student assessment	End of week/unit tests of near transfer	Assessment integrated with instruction; limited variety in methods (e.g. portfolio but not performance assessment); correct/incorrect rather that multi-leveled feedback	Assessment integrated with instruction; considerable variety of methods such as self, performance, and collaborative assessment, and classroom observations but some useful methods omitted; includes real life problems; use of Ministry and classroom rubrics to make criteria known.	Assessment uses real life situations, variety of methods, integrated with instruction, multiple performance levels, criteria and procedures are known to students

D8: Teacher's conception of math as a discipline	Fixed body of knowledge that has to be learned in an inflexible sequence	Some math topics are more linear than others; some try	Math can be learned in many different sequences; there are similarities that unite all math strands; mathematicians deal with practical problems	Math can be learned in many different sequences; there are similarities that unite all math strands; math truths change over times; mathematicians deal with practical problems
D9: Student confidence	Focus on achievement	Teacher celebrates student mastery of procedures; tasks selected to ensure student success; procedural direction for students who were not successful	Class celebration of student conceptual understanding; worth of student thinking recognized by teacher listening; tasks selected to ensure student success	Rewards based on conceptual understanding; established norms to reduce behavior that threatens the esteem of other students; jigsaw to confer status on less able students; recognizes students as mathematicians; tasks selected to ensure student success

(Ross et al., 2003, pp. 335-355)

Appendix E: Permission to use *Self-Report Survey: Elementary Teacher's Commitment to Mathematics Education Reform* and the Rubric for Implementation of Elementary Mathematics Teaching Reform

From: "John A. Ross" <ja.ross@utoronto.ca>
To: Mark Turner <mark.turner@waldenu.edu>
Date: Wed, 18 Sep 2013 07:23:53 -0400 (EDT)
Subject: Re: Reform Mathematics Survey
Dear Mark,

Permission granted. Best of luck on your study.

John

Dr. John A. Ross,
Professor Emeritus,
Curriculum, Teaching, and Learning,
University of Toronto,
29 Crystal Springs Dr.
Peterborough, ON K9J 6Y3
Tel: 705-742-4069
www.oise.utoronto.ca/field-centres/tvc.htm

Quoting Mark Turner <mark.turner@waldenu.edu>:

Dear Dr. Ross,

My name is Mark Turner and I am a doctoral candidate at Walden University here in the United States. My research study deals primarily with understanding ways that the teachers in my elementary school teach mathematics. My goal is ultimately to design a staff development program that will help increase their use of reform techniques. I am writing you to ask permission that I may use your survey instrument, *Self-Report Survey: Elementary Teachers' Commitment to Mathematics Education Reform* from *A Survey Measuring Elementary Teachers' Implementation of Standards-Based Mathematics Teaching* (2003), published in the Journal for Research in Mathematics Education, on which you were the lead author. I would also like to use the observational rubric, Rubric for Implementation of Elementary Mathematics Teaching Reform from the same study as well.

I will be happy to discuss any of my study with you if you have any questions. Thank you for your time. I look forward to your response.

Sincerely,
Mark Turner

Appendix F: Consent Form

CONSENT FORM

You are invited to take part in a research study of *reform* teaching (or constructivism) in the elementary mathematics classroom. The researcher is inviting all teachers who teach mathematics to be in the study. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part.

This study is being conducted by Mark Turner, who is a Doctoral candidate at Walden University. You may already know the researcher as a teacher, but this study is separate from that role.

Background Information:
The purpose of this study is to determine the teaching practice and philosophy of teachers in our school as it relates to teaching Mathematics.

Procedures:
If you agree to be in this study, you will be asked to:

- Fill out a survey, which has 20 items, and should only take 10-20 minutes to complete, via internet or paper copy.
- Allow for a possible short observation of a mathematics lesson in your classroom

Voluntary Nature of the Study:
This study is voluntary. Everyone will respect your decision of whether or not you choose to be in the study. No one at [redacted] Elementary, [redacted] Schools, or Walden University will treat you differently if you decide not to be in the study. If you decide to join the study now, you can still change your mind later. You may stop at any time.

Risks and Benefits of Being in the Study:
There are no risks involved in completing the survey or taking part in the observations. If there is any stress or discomfort experienced by you at any time you may halt your participation without any consequence.

This study will help to inform decisions for future staff development opportunities.

Payment:
There is no form of payment nor any additional compensation for participating in this study.

Privacy:
Any information you provide will be kept confidential. The researcher will not use your personal information for any purposes outside of this research project. Also, the researcher will not include your name or anything else that could identify you in the study reports. Data will be kept secure by password protected files, accessible only by the researcher. Data will be kept for a period of at least 5 years, as required by the university.

Contacts and Questions:
You may ask any questions you have now. Or if you have questions later, you may contact the researcher via telephone, at [redacted], or via email, at [redacted]. If you want to talk privately about your rights as a participant, you can call Dr. Leilani Endicott. She is the Walden University representative who can discuss this with you. Her phone number is 1-800-925-3368, extension 1210. Walden University's approval number for this study is **11-08-13-0045751** and it expires on **November 3, 2015.**

The researcher will give you a copy of this form to keep, upon request.

Statement of Consent:

I have read the above information and I feel I understand the study well enough to make a decision about my involvement. By signing below, I understand that I am agreeing to the terms described above.

Printed Name of Participant ______________________

Date of consent ______________________

Participant's Signature ______________________

Researcher's Signature ______________________