

# Differentiating Instruction to Close the Achievement Gap for Special Education Students Using Everyday Math

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**BOSTON COLLEGE**  
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Educational Administration

DIFFERENTIATING INSTRUCTION TO CLOSE THE ACHIEVEMENT GAP FOR  
SPECIAL EDUCATION STUDENTS USING *EVERYDAY MATH*

Dissertation  
By

VANESSA CONSTANCE BEAUCHAINE

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of the requirements for the degree of  
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## ABSTRACT

Differentiating Instruction to Close the Achievement Gap for

Special Education Students Using *Everyday Math*

by

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Dissertation Director: Dr. Robert J. Starratt

This case study examined teacher collaboration and teacher change while in the process of differentiating instruction in the area of mathematics in an elementary school. The project included a two-tier professional development opportunity for the staff. Professional development sessions focusing on specific mathematics skills were offered in lieu of traditional faculty meetings and thirteen, teacher volunteers in grades K-3 participated in bi-monthly study groups. The study describes the journey of the thirteen teachers as they identified successful strategies for differentiating instruction to meet the needs of all learners. The study explored how job-embedded professional development offered teachers the resources and support to meet together during the school day to engage in dialogue about their students' progress, difficulties encountered when teaching specific concepts and skills, and proactively planning in order to differentiate instruction effectively. The study focused on collaboration as a method for learning together in an adult learning environment and improving current teacher practices.

The research was qualitative with the school principal as both researcher and participant-observer of the study. Data instruments used for the participants involved in this study were pre- and post-implementation surveys of the entire staff, semi-structured

interviews of the thirteen teacher volunteers, observations of meetings, teachers' reflective journals, and field notes.

Findings indicated that there was an increase in the teachers' use of differentiated instruction in the area of math. While teachers most often differentiated lessons by ability, teachers experimented with differentiating by interest as well as addressing the students' varying learning styles. In addition, teachers found that the embedded study groups were valuable in helping them to collaborate with their peers and improve their practice in teaching mathematics to all learners.

In a profession where continual renewal is necessary, it is essential for educators to be provided with adequate time to review current practices, reflect on the strategies that are most successful, and refine their craft in order to provide opportunities that will maximize student thinking and learning.

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## CHAPTER ONE: OVERVIEW OF THE STUDY

### I. Introduction

In the inclusive environment of the American education system, every student is guaranteed a free and appropriate education through the Individuals with Disabilities Education Act (IDEA, 1997). Every student who is diagnosed with a disability is entitled access to the general education curriculum and is afforded the same benefits as their peers without disabilities. In addition, publicly funded schools are subject to the accountability provisions in the No Child Left Behind Act (NCLB, 2001) where school districts need to make Adequately Yearly Progress (AYP) both in the aggregate and in the disaggregated sub-groups on the state tests. While each district's composition is different, most, if not all, have a special needs population to consider.

In this particular New England state, the special education subgroup in many districts is not showing the same relative growth in the scores as the aggregate according to the Composite Performance Index (CPI). In North Edison (fictional name), there is also a notably smaller improvement in the math scores of the special education subgroup than for the same group in language arts. The trend begins in elementary school and continues throughout the scores up through the high school level on the 10<sup>th</sup> grade test series.

Since the students with disabilities in North Edison are able to make adequate improvement in language arts, it is vital to understand why the same is not true of their performance in mathematics. In order to prepare our students to compete in a global society and to lead productive lives, educators need to learn strategies that will improve

students' acquisition of math skills. It is no longer enough to perform simple rote calculations; students need to develop higher order thinking skills and develop problem solving strategies to think flexibly about math concepts.

It is vital that districts continue to individualize instruction for students with disabilities. However, special educators will need to receive the same professional development as their general education counterparts in order to understand where their students need to be headed. In addition, they will need training in breaking down the grade level standards to account for various entry points in order to be able to differentiate instruction and to design assessment tasks that will be challenging and will also serve to drive future instruction.

## II. The Problem

The problem, as revealed through the Spring 2006 State Comprehensive Assessment System results, was the presence of an achievement gap between the regular education and special education students particularly in the area of math. There was a need to discover what was impeding the progress of students with special needs in the area of math. Although State scores showed a "high" performance relative to the state Composite Performance Index (CPI) with a CPI of 80.6, compared to the state CPI of 68.7, the special needs subgroup scores revealed a significant achievement gap when compared to the students without disabilities with a CPI of 54.8. Overall, students with special needs did not score as low in English Language Arts (ELA) as they do in the area of math. It was necessary to employ an innovative plan to help to close the gap between

these two groups and to answer the following question: What is it about math instruction that influences a wider achievement gap than the language arts instruction?

The adoption of Everyday Math for the 2005-2006 school year also highlighted an additional problem with the inconsistency between the Individualized Education Program (IEP) goal development and the new program. The IEP goals of students with special needs did not necessarily reflect the “secure” skills aimed to be mastered through Everyday Math. Special Education teachers may need additional professional development in how to adapt the way they had written IEP goals so that they can work on goals that are common to the classroom **and** developmentally appropriate for the students. In addition to the alignment of the IEP to the goals of the program, district, and the state, both the regular education teachers and the special education teachers needed to analyze student work carefully to determine where the successes and the pitfalls are in order to target specific areas that will yield overall improvement in the performance of special education students relative to their peers taught strictly through regular education instruction.

The ultimate goal of the project was to improve the collaborative teaching model so that the needs of all learners would be met effectively by differentiating the instruction in the classroom. Teachers have had some training in how to differentiate instruction, but additional support was needed in the area of mathematics. Since teachers in the elementary grades are responsible for teaching all areas, it is difficult to have an in-depth background in each one. However, since math skills are cumulative, what is done at the elementary level is of the utmost importance. Teachers need to have a deep

understanding of the mathematics in order to analyze student work with a critical eye. Only then will teachers be able to make sense of how the student is perceiving the material and be able to develop subsequent lessons that will correct misperceptions and solidify true understandings. By building teachers' capacity to analyze student errors and facilitate new understandings, teachers may be able to teach the Everyday Math program, efficiently and effectively to *all* learners.

Princeton Elementary School (PES) had recently adopted the *Everyday Math* program as part of a district-wide initiative. *Everyday Math* is referred to as a "spiraling" program where students are exposed to a variety of skills and concepts in real world settings and understanding is developed over time by revisiting skills frequently at various levels of difficulty as opposed to practicing one skill or concept repeatedly until it is mastered. This philosophy is counter to the background of many teachers working with special education students whose experience informs them that students can only master one skill at a time.

One of the benefits of using the *Everyday Math* program with students with disabilities is that it raises the expectations for these students. The authors believe that students develop better mathematical understanding through a richer curriculum. Currently, in the high-stakes testing environment in which North Edison exists, teachers feel the pressure to drill skills and concepts that the students will be tested on. As a result, the special education students are not benefiting from the system's adoption of the program and are instead being taught through supplemental programs, which consist of

the former textbook and teacher-created materials that are not necessarily based on current research.

There are a certain number of core content standards that *all* students should have experienced by the end of their schooling. Thurlow, Elliot, and Ysseldyke (2003) refer to this attainable goal in the discussion around creating broad standards so that students at all levels can work toward the same common goal. If this happens, then our nation will develop a more cohesive guaranteed and viable curriculum for our nation's children. The goal of this project was to enable teachers to make use of the rich experiences within the *Everyday Math* program while differentiating the instruction to meet the needs of all learners. In order to accomplish this, teachers needed to have an acute understanding of the math concepts in order to break down tasks effectively, they needed to have a wide variety of strategies to facilitate their students' understanding based on their analyses of the students' errors, and they needed to develop a network of teachers akin to a medical team that could diagnose a students' issue, plan a strategy to help the student improve, and consistently assess and reassess their progress at different entry points.

The "guaranteed and viable" curriculum of a school as explained by Marzano (2003), is simply the content that every teacher is expected to teach to the students matriculating through the school. In addition to providing the opportunity to learn (OTL) the material, time is the essential element to ensure that the curriculum is viable. If there is content that is expected to be taught, but time is not afforded to teach the content, then there can be no guarantee that there will be ample opportunities for students to learn the content, demonstrate understanding, and generalize the learning over time. By

establishing a few broad standards that all students can work on at some level of complexity, there can be a viable and guaranteed curriculum for *all* students. Without the pressure of needing to assess students with disabilities on grade level standards, educators, administrators, and policymakers may have excluded students with disabilities from valuable learning experiences that students without disabilities would have received. In addition, the requirements imposed on educators in terms of ensuring that *all* learners have opportunities to learn have had two positive outcomes. First, the special education teachers have had to become familiar with the grade level learning standards (Zatta & Pullin, 2004). Second, the regular education teachers have had to learn different ways in which to modify their instruction or provide accommodations to certain students so that they can all have equal opportunities to learn the content (McDonnell, 1997).

### III. The Response to the Problem

In response to the problem, the researcher aimed to provide the structures including time and common grade level planning sessions to promote the collaborative teaching model. The researcher also provided additional professional development to deepen teachers' understandings of the math concepts they were teaching as well as improve their ability to analyze the student work in math and then use that data to drive their instruction. This project was designed to improve the learning of the struggling math students whether they are receiving special education services or have been brought up to the Instructional Support Team (IST) due to their lack of effective progress in math. The researcher aimed to help teachers step away from parallel and "drop-in" models of inclusion for math instruction and encourage more collaboration.

The district had implemented the newest edition (2007) of the Everyday Math program for the 2007-2008 school year in grades K-3. Within this spiraling program, there were already signs that students with and without disabilities were struggling to gain the “secure” skills, or skills that should be mastered at one particular moment in time. While the program moves from one topic to another quickly, many special needs students require re-teaching and over-learning (additional practice beyond initial success) to secure new skills. While many students may retain a partial understanding from an experience on one day to develop that same concept or skill at a later point in time, other students do not have the strengths in memory or processing to succeed with that approach solely. In addition to students with an IEP or a 504 plan who have a diagnosed disability, there are other students who struggle within the regular classroom for whom additional strategies such as re-teaching, over-learning, or alternate presentations are necessary.

In addition, the students’ IEPs need to reflect developmentally appropriate goals and provide sufficient opportunities for the students to learn the grade level curriculum so they can eventually transition out of special education. In the past, students struggling in math had been receiving extra instruction from the Learning Specialist or a paraprofessional and focused primarily on the developmental goals found in the IEP. At times, the instruction received was on different topics than the students were exposed to with the regular classroom teacher. With the adoption of the Everyday Math program, the development of the IEPs needed to target the basic building blocks of math in the order presented in the program. This was to ensure a continuity of program between the classroom teacher and the special needs teacher. While it is a spiraling program that



“exposes” students to many skills before they are ready to master them developmentally, the teachers are targeting the mastery of “secure” skills for *all* students. This was to ensure that the “guaranteed” curriculum was expected to be mastered by all students.

In order to provide improved or additional opportunities to learn for the special education and at-risk population, there was a new position, an Elementary Math Specialist, who began working with the teachers in the district as a math coach for the 07-08 school year. Working in conjunction with the Math Specialist and the Director of Curriculum, Instruction, and Professional Development in the district, faculty meetings were transformed into hour-long professional development sessions. The professional development sessions focused on the specific learning difficulties that the students possess (cognitive, emotional, physical), their learning style (auditory, visual, kinesthetic), and the best practices for underachieving math special education students.

The goal of this initiative was to ensure that the focusing on the “secure” skills at each grade level would allow students with special needs to move forward with their study of mathematics with the necessary building blocks firmly in place. A byproduct of this study would be an increase in data-influenced instruction in math. Since teachers would be targeting on just a small number of skills, they would be more apt to carefully analyze the errors students were making and could redirect and reinstruct before misperceptions are cemented.

### *Theoretical Rationale*

There are several areas of research and theory that support the rationale behind this study: equity for special needs children, math acquisition, analysis of student work, collaborative teaching, adult learners, and embedded professional development. Since the performance of students with special needs was closer to the performance of regular education students on the MCAS in the Language Arts area, math acquisition is one area that requires further study. Teachers need to understand the types of mathematical errors that are made as well as the best practices for addressing these deficiencies with students of varying learning styles. In order to do that effectively, teachers need to be able to analyze student work. Additional information about what teachers need to look for when they are reviewing student work was needed before they can diagnose what the problems in the learning process were on a given activity. Teachers were encouraged to work together in collaborative teaching models so it was necessary to understand the models that have been effective in the past not only for the collaborative teaching itself, but also for the embedded professional development that was planned to prepare the teachers. Understanding the elements of adult learning was imperative in order to plan the sessions as well as supporting the teachers as they went through the various stages of unrest while undertaking this change in the way they teach mathematics.

#### IV. The Study – Research Design

In order to plan the professional development opportunities efficiently to meet the needs of the staff, the researcher surveyed the regular education and special education

staff first and inventoried the types of training the teachers were given before they started teaching inclusion classes. During the 2007-2008 school year, the special education teacher and regular education teacher looked at the student work together in order to drive their instruction. The teaching teams looked at the concepts and skills that students consistently performed well on and the strategies that were employed that worked well for all learners. Teachers also looked at the concepts and skills that students had difficulty mastering. The teachers called on the expertise of the Elementary Math Specialist to collaborate with the team to determine additional teaching strategies that may be employed to help students acquire the skills and concepts they have not yet mastered as needed.

#### *Research Questions*

1. What did teachers learn about math content and pedagogy to help special needs children meet standards-based proficiency in math?
2. What were the most helpful components of the professional development program that promoted teachers' learning?
3. Which of the newly employed strategies did teachers perceive worked the best?
4. What were the challenges of implementing the embedded professional development?

### *Research Design*

This was an evaluative case study, which assessed the effective components of both the process as well as the outcomes of the project. This was a qualitative inquiry study concerned with understanding the intricacies of the teaching and learning process as it pertained to the acquisition of math skills for students with special needs. As Merriam states, “Qualitative researchers *are interested in understanding the meaning people have constructed.*” (Merriam, 1998, p. 6.) As teachers seek to uncover the meaning that their students have constructed, teachers must also seek to uncover the meanings that they have constructed themselves about what their students need to learn in mathematics, the best practices for teaching the essential concepts and skills, and the most effective way for the students to demonstrate their understandings. Since a large component of the project dealt with the teachers’ meta-cognitive practices, it was essential to use a qualitative research design. This allowed the researcher as a participant-observer to have an “insider’s perspective” and enabled the researcher, as the primary data collection instrument, to interpret the progress as seen through teacher self-reflection, collaborative dialogue, and classroom observations by the researcher.

### *Sample*

Although it would be ideal to include the entire teaching staff in the professional development portion of this project, only the data collected through staff members with professional status was used. The North Edison district is on a four-year evaluation cycle. Although none of the feedback provided would influence the evaluation process,

the researcher sought volunteers who were not being formally evaluated first. The only participants in the study were professional status staff. Non-professional staff could still participate as part of the collaborative team process to review student work, but their feedback was not sought for the study.

This case study consisted of two samples: a small volunteer sample (13) of educators and the whole faculty (23) for purposes of comparison in one primary school and is therefore not indicative of a large population. However, this case study documents which strategies were implemented successfully with positive student outcomes and evidence of growth in this particular school, with these particular students, presenting with specific needs and may be able to be studied further in schools with a similar student population. Another advantage of conducting a small case study is that the researcher is able to delve deeply into the thought processes and collaborative efforts of the teachers involved with greater facility than if the researcher was merely surveying a large population. Additional cross-case analyses may reveal additional trends when comparing the data among grade level teachers, cross grade groupings, special education teachers and regular education teachers, as well as comparisons among teachers with varying levels of experience.

The effectiveness of this project will be assessed in several ways. Each year students need to complete the “End-of-the-Year” assessment. The researcher will be tracking the students’ progress in math over time.

This dissertation was designed as a case study that researches a collaborative team approach in analyzing student work and differentiating instruction in math to meet the

needs of all learners including those with special needs. During the faculty meetings, the staff met in grade level study groups. The design of the study groups was similar to that of the Developing Mathematical Ideas modules created by TERC (Technical Education Research Centers, 1996) where student work is analyzed and relevant research articles are shared, strategies are tried in the classroom and then reflected upon between study group sessions. In order to understand the problem fully, it was necessary to include research of both the effective strategies to teach math to struggling students as well as the professional development aspects that would assist the teachers. Additional research was also needed regarding how specifically the acquisition of math skills occurs differently from the acquisition of language skills, the effectiveness of various strategies, analyzing student work, the collaborative teaching model, and professional learning communities.

## V. Research Methodology

The researcher studied the effects of teachers using collaborative teaching approaches to analyze student work, and plan cooperatively after being provided with sufficient training and common planning time. The study will assess whether or not this model can provide the support needed to help lessen the achievement gap between regular education and special education students.

There were three phases in this case study: initial interview, on-going reflective response journals and periodic observations, and an exit interview. The first was an initial interview before teachers begin their professional development. This served as a data-gathering step to focus the professional development to best meet the needs of the current staff and student population.

During the second phase, participants were required to keep a reflective response journal. Through the use of the journal on a regular basis, the teachers were able to track which strategies were effective with which students, which strategies did not work well and why, and what their next steps were in preparing subsequent lessons. Participants retained their journals as a record of the events in their class that could be shared and possibly replicated in other classes as the project progresses. In addition, the researcher participated in the study group sessions as well as periodically observing in classrooms.

The final phase was in the form of an exit interview. There were two components to this phase. The first part required individual interviews about the teachers' individual findings throughout this project. The second part entailed reporting out to the participants as a whole as far as the overall success of the project and its implications for the following year.

The data from the teacher interviews, study group sessions and journals were triangulated with the assessment data, the researcher's leadership journals and field notes.

## VI. Overview of the Study

Chapter Two will provide a review of the literature related to the study focusing on the areas of math acquisition, child development, analysis of student work, differentiated instruction, collaborative teaching, adult learners, and embedded professional development. Chapter Three will explain the design of this case study including the research design and methodology, the description of the purposive sample, data gathering procedures, as well as the methods for analyzing the data and reporting the findings. Chapter Four will present the findings of the study. This chapter will include

the results from the two surveys administered to the staff, the two interviews of the members of the study groups, the reflections journals of the teachers as well as the researcher, and the classroom observations. Chapter Five will summarize the findings and include a discussion of how the findings relate to the relevant literature. This final chapter will also include recommendations for further study as well as potential practice and policy recommendations.



## **CHAPTER 2: REVIEW OF THE RELEVANT LITERATURE**

### Introduction

In Chapter One, the historical and legal contexts in which this study takes place were established. Chapter Two will explore the ethical and professional responsibilities related to the work that the teachers and principal at Princeton Elementary School will be engaged in. The remaining areas to be addressed in Chapter Two are focused on the goal that every student should be literate in reading and math. In order to understand the intricacies of this study, the development of mathematical understanding, for both typical and atypical children, needs to be explored. The actual process of analyzing student work and student thinking needs to be studied as well in order for educators to understand what it is that they need to look for as they are teaching. Once the students' feedback can be analyzed, further information regarding differentiated instruction needs to be reviewed in order to ensure the acquisition of the essential skills within the "guaranteed and viable" curriculum for all students.

In addition to the elements affecting the teaching process from teacher to student, there are several additional areas to be reviewed regarding the learning and development of the teaching staff. The characteristics of the collaborative teaching model will need to be studied and applied to the setting in North Edison. As the instructional leader of the school, the researcher will need a solid understanding of the characteristics of and successful practices for adult learners as well as the creation of embedded professional development opportunities.

Finally, the overarching theories of leadership will be reviewed in order to provide a reflective framework for the researcher carrying out this study. Theories of idea development, organizational structures, and the change process need to be understood in order for the researcher to reassess the progress of the project at each stage of its implementation.

### Ethical Context

Educators are bound by the professional ethics of the National Education Association (NEA) to protect the, “freedom to learn and to teach and the guarantee of equal educational opportunity for all.” (NEA, 1975). Educators are expected to, “help each student realize his or her potential as a worthy and effective member of society. The educator therefore works to stimulate the spirit of inquiry, the acquisition of knowledge and understanding, and the thoughtful formulation of worthy goals.” (NEA, 1975.) The stimulation of the spirit of inquiry is necessary for the development of mathematical concepts and is supported by the research of Piaget (1965) and Vygotsky (1978) and a social constructivist approach to learning. The constructivist approach will be described in greater detail later in this chapter.

The Council for Exceptional Children (CEC) lists additional principles for special education professionals. Teachers in these roles need to commit to developing, “the highest educational and quality of life potential of individuals with exceptionalities”. (CEC, 1983). They, like regular education teachers, are expected to “strive to advance their knowledge and skills regarding the education of individuals with exceptionalities”.

As an instructional leader, this researcher is bound by certain ethical expectations and professional standards. According to the American Association of School Administrators (AASA, 2007), an ethical educational leader should make the well-being of students the core value of all decisions. In addition, school administrators need to commit to continually seek to improve “through research and continuing professional development”. While the administrators need to seek actively opportunities for personal and professional growth, the need to provide for the well-being of the students in furthering their educational pursuits requires that the administrator actively seek ways in which to improve the teaching and learning within the school. There is an expectation that in addition to serving “each and every child”, the leader is responsible for each and every staff member that will affect each and every child. As an instructional leader then, it is this researcher’s duty to seek ways in which the instruction and learning of mathematics can be improved in order to close the achievement gap between regular education and special education students in this particular school in North Edison.

### Ethical Leadership

Beyond the code of ethics and professional expectations are three virtues of ethical leadership. The three virtues as defined by Starratt (2004) are responsibility, authenticity, and presence. An ethical leader has responsibility as a human being and a member of society, but also has certain responsibilities or duties through appropriation as an educational administrator. The leader has a responsibility to the students, staff, and parents, as well as to the local, state, and federal government as she fulfills obligations set forth in laws and regulations. While many responsibilities involve carrying out duties to

prevent harm to others, the responsibility of an ethical leader is also to be proactive and through foresight, learn from the experiences so that the future may be at least as beneficial, if not more so, to all parties than the present. The ethical leader in this way will care for and nurture the health of the organization.

Starratt explains the authenticity of an ethical leader as, “ The human challenge of connecting oneself to a wider whole, of finding one’s life in dialogue with this wider whole, of discovering that the deepest character of all beings is their relationality, their participation in the larger life around them.” (Starratt, 2004. p. 70.) The authenticity is apparent when the leader puts others before himself and upholds his integrity as well as the integrity of the organization. Authenticity prescribes that there must never be an *immoral* means to a moral end. The ethics of authenticity (Starratt, 2004, p.81) entail that there is “authenticity for all” and that there must be support for authentic teaching and learning all with the primary focus being on the learning. David Perkins, in his book *Smart Schools*, explains the importance of this virtue when he asserts that schools should keep the focus of student learning as the core element in any school improvement and emphasizes that it is not merely enough to “teach” or expose the students to a vast fund of discrete knowledge, but that the “good learning” happens when students are provided authentic opportunities to engage with the school content thoughtfully. (Perkins, 1992, p. 34).

The third virtue of an ethical leader is presence. This presence is not simply a physical presence in a particular place in space and time with others, but being present in mind. At full awareness of oneself and others, the ethical leader can either *affirm*,

*critique or enable.* (Starratt, 2004, p.82) This virtue is critical especially during a time of change within an organization. Accepting others' points of view, being able to identify strengths and weaknesses in arguments and performances, and providing the support so that individuals are able to take the necessary risks to move the organization forward. There is also a mutuality implied with presence. The ethical leader ensures that the organization moves forward as an entity rather than propelling the work of individuals in tangential relationships to the organization's vision.

The three virtues of ethical leadership guide the researcher's choices. With an identified achievement gap between the regular education students and the special education students in the area of math, the researcher has a responsibility to address the deficit and find ways to reinvent how math is taught and to provide the support necessary to implement the changes. Through the study groups, the researcher and the teaching staff have the opportunity to monitor the progress. The authenticity of all involved and their genuine desire to do what they can to improve the situation will enable the participants to honestly assess what is working and what is not working throughout the year. Finally, the virtue of presence guides the researcher to be an observer-participant and work in earnest alongside the teachers as one cohesive unit along the path towards the vision of having every child achieve to the proficient level.

### Professional Expectations in Mathematics Education

Looking more specifically at mathematics education, there are a number of professional expectations related to the subject. The National Council of Teachers of

Mathematics lists six principles of the teaching of mathematics that should guide educators: (a) equity, (b) curriculum, (c) teaching, (d) learning, (e) assessment, and (f) technology. (NCTM, 2000.)

*(a) Equity*

The equity principle requires high expectations and support for all students. For students who struggle with acquiring mathematical concepts, teachers must not lower their expectations, but instead must be able to provide the appropriate support and approach to teach mathematics to meet the individual needs of each child.

*(b) Curriculum*

The teacher's role within the curriculum principle is described by Brumbaugh, Moch, and Wilkinson as follows, "You (the teacher) will be one rung of their (the students) ladder of learning and you must help them deepen and extend their understanding of mathematics." (Brumbaugh, Moch & Wilkinson, 2005, p. 3). While arithmetic functions have often been associated with the main objective of mathematics teaching in the elementary grades, the complete mathematics curriculum must consider all of the strands of mathematics and must not be broken apart into separate unconnected parts that children learn in isolation. Mathematics is an entity comprised of multiple forms of relationships and patterns that build upon themselves in an interconnected matrix.

*(c) Teaching*

The teaching principle requires the teacher to have a deep understanding of the mathematics content and pedagogy. Teachers need to be able to decipher what children

know, what they need to learn, and they also need to be able to provide only the necessary supports to guide the students so that they learn the concepts well. By providing only the *necessary* supports for the students to learn the concepts, teachers can continue to challenge the students to deepen their own understanding as they construct meaning for themselves throughout the given learning opportunities.

*(d) Learning*

Following from the preceding principle, students must be afforded opportunities for active engagement in learning new mathematical concepts. Rather than a behavioral approach to mathematics where a given stimulus produces an expected response, the students' exposure to new experiences must be built upon prior knowledge that they can access to make sense of the new material. In order to fully understand a new concept, the students must be able to make connections and observe interrelationships rather than learning a series of rote steps they are to perform robotically.

*(e) Assessment*

The assessment principle explains that the assessment practices should provide feedback for both the teachers and the students about the learning of important concepts. Rather than viewing assessments as purely summative measures, both formal and informal assessments throughout the course of study can be formative and provide information that will guide future instruction. As students are documenting their thinking on tasks as they are learning, the feedback provided can help them become reflective learners, working backwards towards the original question posed in order to develop a greater understanding of where they need to revise their work. These formative

assessments also inform the teachers of the students' thinking and enable them to plan the next lesson to guide students towards a deeper, more complete understanding of the concepts.

*(f) Technology*

While students need to understand how to perform basic calculations, the use of technology, such as calculators and computers, allow for additional investigations into mathematical concepts. In one respect, technology aids students by allowing their energy to be devoted to more higher level thinking tasks such as logical reasoning and problem solving skills. Rather than being used as a quick way to find an answer, calculators can aid students in investigating patterns that would be too time consuming to reproduce on paper and may foster the students ability to make conjectures about patterns with larger numbers and encourage experimentation.

### Cognitive Development and Acquisition of Mathematics Concepts

The work of Piaget (1965, 1970), Chapin (2006), Baroody (1987), and Ginsberg (1983) provide a foundational understanding of how typical children develop their understanding of mathematical concepts. The progression of concepts and skills that children develop begins with the concrete immediate physical experiences of the child and gradually builds towards the abstraction of the concepts described by the common symbolic language of mathematics. (Piaget, 1965.)

Baroody explains that there are two general theories of learning: absorption theory and cognitive theory (Baroody, 1987, p. 7). If mathematics learning is viewed



through absorption theory, then there is a vast amount of facts and figures that need to be learned discretely. Through associations, students perform a variety of responses to a set group of stimuli. Simply saying, “2+4” would elicit “6” as the expected response. (Baroody, 1987, p.8). Absorption theory suggests that students will learn these associations passively. By repetitive practice, students would be expected to memorize these associations and would be able to apply these associations with or without true understanding. It is assumed, in absorption theory, that learning accumulates over time. By learning the simple associations, and adding to associations learned previously, one is expected to then use these basic associations to solve more complex problems. If the associations are presented clearly and children have “sufficient” practice, then “all but atypical children should proceed efficiently and uniformly toward mastery.” (Baroody, 1987, p. 9). In order for students to learn, or, in reality, demonstrate rote memory skills, proponents of absorption theory believe that it is through external motivators that teachers can coerce students to learn the associations. Through a series of rewards and punishments, whether it is a class sticker chart or some other extrinsic reward, teachers provide multiple opportunities for practice of the basic associations that are expected of children along a continuum of development.

Contrary to absorption theory, the key to cognitive theory is understanding relationships. While some individuals may claim to have a “photographic” memory where they can visualize an image of a certain object, figure, or event, and see it with accuracy to a great detail as if they were looking right at it, memory does not typically function in this way. (Baroody, 1987, p. 10) Instead of relying solely on our memory to

be able to aid us in recalling a wide variety of discrete facts, by relating a new situation to previous experience and by looking for patterns, we are able to make sense out of a greater number of situations and problems, than simply by relying on memory alone. Cognitive theory promotes an active approach to learning as opposed to the passive approach of absorption theory.

Children, even as young as five, are able to construct knowledge by building a relationship between the new information and existing knowledge (Baroody, 1987, p. 10). This new knowledge can be constructed either through assimilation or integration. Through assimilation, Baroody explains, a person can make an association with the new material by accessing their prior experience. Integration entails building a bridge between two small bits of information to increase understanding. For example, a child who has the “practical” knowledge that she has five fingers on each hand and that she has ten fingers altogether yet who needs to count out the problem  $5 + 5 = \underline{\quad}$  each time she sees it, has not yet integrated these two small bits of information. Once she can, her practical knowledge of the number of fingers she has would enable her to know the answer to the  $5 + 5 =$  problem without having to count each time (Baroody, 1987, p.11). While children and adults may construct new meaning by assimilating or integrating new information with the old, it is a process that can take time; it often requires more time than teachers are traditionally given with a set curriculum and set of materials to “cover” by year’s end. By encouraging students’ exploration of the concepts through hands-on, active lessons as they construct knowledge and make sense of the world around them with “invented” mathematics explanations, children are more apt to learn the

relationships. Unlike absorption theory, cognitive theorists would purport that, “learning can be its own reward” (Baroody, 1987, p. 12).

Traditionally, theories of associationism, or connectionism, such as Thorndike’s were along the lines of the behaviorist approaches like that of Skinner, where one “practiced in” the desired behaviors or responses, and “practiced out” the undesirable ones. This translated to a classroom approach where teachers taught mathematics at the elementary level with an approach more akin to absorption theory where facts were taught with a “drill and kill” philosophy and seemingly endless computational practice filled the math lessons each day of each year throughout the elementary grades. In a subject that is one “ongoing problem-solving process”, simply recalling facts correctly is not enough. (Baroody, 1987, p. 15). Children need to be facile and flexible thinkers to recognize patterns and generalize them to new situations.

Jean Piaget proposed congruous tenets in his book, The Child’s Conception of Number (Piaget, 1965). Piaget’s theory includes six principles of teaching. First, number concepts must be taught when they are useful and meaningful to the child and when the child’s logic has progressed to that particular point. (Piaget, 1965, p. 9). In order for children to construct meaning, the learning of number concepts has to be relevant to them in their own lives. Discussing numbers and encouraging counting activities as they arise is more beneficial at the early stages of development than setting aside a particular time for math when it suits the teacher. This principle is more difficult for public school educators today since the state and federal guidelines specifically state what needs to be taught at a given time. This principle is more in line with the

philosophy behind the Montessori programs, which allows students to have more of a choice in what they will learn about and study.

The second principle is to use language that elicits logical quantification and the accurate comparison and representation of the samples given. (Piaget, 1965, p. 19). As children are building their knowledge of numerical concepts as well as their strategies for comparing groups, teachers need to remember that certain children, while they may not have built up their strategies for counting are nevertheless able to determine appropriateness of quantities. Kamii and DeVries (1976) share an example where children are asked to find *enough, too many, as many, more, or less* and can perform the task successfully where they need to figure out for themselves how to go about solving the problems as opposed to being told to “count” by the teacher. In addition, since children need confidence in order to take risks to problem solve for themselves, by having the teacher *tell* the child what to do, the child no longer is truly discovering a strategy and the task may result in the child making a mistake which will only make the child more reticent for the next task.

Piaget’s third principle is to encourage children to demonstrate the logic by manipulating the objects even if the child is “moving” the objects in his mind. (Piaget, 1965, p. 37). This principle, akin to the preceding one, encourages the constructivist model of learning mathematics. By simply focusing on a single set of objects, students’ only way to work with the objects is to count them and to give the total amount when asked. However, if children are involved in comparing sets there are multiple ways that children need to exercise their quantifying ability. They may be asked to determine the

equality of the sets, which yields three answers (one is more, one is less, they are the same) or better yet, children have the opportunity for growth by replicating a set. Doing so requires them to use one to one correspondence independently and it also requires them to make a judgment as to when they need to stop “adding one more” (Kamii & DeVries, 1976, p. 16).

While Piaget proclaimed that children should move objects to compare sets, not all manipulatives or hands-on materials are valuable to the development of the concept of number. Kamii and DeVries explain that Cuisenaire rods, for example, provide an additional source of external feedback for the child that is counter-productive in building number sense. In concept, the materials provide a visual for children to understand that one exists in the number “two” and one and two exist in the number “three” since the children see the continual addition of one block as they count. However, there is not a need for a child to use judgment to determine if one has *more* or *less*; instead, the child needs only to view the stair-like design to determine if he or she is correct in determining the answer.

The fourth of Piaget’s principles is to require children to verify an answer to prove the soundness of their logic (Piaget, 1965, p 31). By giving children the opportunity to agree or disagree with a peer’s response, or a teacher’s response, the children are motivated to either revise and rethink their answer if they and their peers have conflicting answers or they may assert their ideas and prove their thoughts to their peer. Either way, they are involved in the thinking process. If educators are the only source of feedback, the students rely more on reading the teacher’s facial expressions for

approval or disapproval. The children must have the opportunity to reflect on their own thinking and to determine for themselves if they are right or not.

David Perkins said, “Learning is a consequence of thinking.” (Perkins, 1992, p.8). Piaget’s fifth principle is to “figure out how children are thinking.” While there are times when children guess blindly, if they are exerting effort in to determining an answer, then an error is a result of faulty reasoning. Rather than simply providing a correct response or showing the child how they should have performed the task or operation according to the teacher, the teacher’s role in determining where the student’s thinking went awry is critical.

According to Piaget, there are three levels at which students demonstrate their reasoning: intuitive, spatial, and logical. (Piaget, 1965, p. 186). Intuitive thinkers may have a general understanding of what the overall concept is such as taking away a counter or dividing counters evenly among people, but they may be deceived that one group has more if the counters are spread out in one group and are close together in another group even if they contain the same exact number of counters. Spatial thinkers have solid one to one correspondence and would divide counters by creating two equal sets side by side one another. Logical thinkers would partition the quantity and alternate between parties until all of the counters were distributed.

Finally, Piaget’s sixth principle is to continue to encourage children in a general way to put all kinds of objects, events, and actions into relationships and to build on what is learned from what they have already experienced. (Piaget, 1965, p. 25). Children are able to understand various hierarchal relationships and if a child is not yet developing

number concepts, rather than directly teaching them, encouraging the building of relationships between real things in their own lives will enable the child to grow in his or her ability to make connections in a more global way in preparation for the number concepts to follow at a later time.

While both Baroody and Piaget mention that it takes time to learn the concepts in a meaningful way, as educators, we are not to simply wait for them to arrive. Educators must analyze how students are thinking about a particular concept and through various, and varied opportunities, promote situations where children will gain meaningful knowledge that will take them to the next level of understanding.

Educators need to be analyzing their students' thinking by listening to what they say, reading their facial expressions, and observing the steps they take while solving a problem. The language of mathematics often raises the stake in the students' ability to learn the concepts. As Schwartz suggests, "language acquired in a meaningful context, sets the stage for conversation that can further the movement along the path from intuitive to conscious knowledge" (Schwartz, 2005, p. 47). Students demonstrating a concept physically have a better chance to remember the experience if the teacher associates the correct terminology at the time that the student is going through the experience. This is why it is so important that math is an active learning process. When teachers do provide active opportunities to learn the math content children's ability to acquire the new learning increases. (Schwartz, 2005, p.48). The math content that children are expected to master, however, must also be coordinated with the inquiry process children use to acquire new mathematical ideas. Teachers need to meet young

students when they have only the intuitive knowledge that they have gained through sensory stimulation. “The younger the children, the more they depend upon all of their senses for collecting information to feed their thinking” (Schwartz, 2005, p. 51)

While there may be times that teachers feel the need to be “information-givers” of new information, in order to assist students in building learning through conscious knowledge, they need to be deeply involved in thinking. Teachers need to “select strategies for instruction on the basis of the function they intend the strategy to serve” (Schwartz, 2005, p. 50). However, if we want students to discover ideas for themselves, then the teachers need to be facilitating the discovery by raising questions and supporting the inquiry process.

Schwartz outlines the path by which students are able to process mathematical information and build their understanding. Initially students are still trying to gain understanding through their senses and discover ideas. The students are still learning at a *concrete* level by manipulating objects in a three-dimensional world. Only after enough experience with the three-dimensional objects can pictures or symbols of those objects take their place in a *representational* manifestation of the concept. Eventually, children move towards the *abstract* by creating mental images they can use as a reference without needing to represent the idea pictorially or with actual objects. (Schwartz, 2005, p. 53)

While students’ experiences move from the concrete to the abstract, their acquisition of new concepts and skills moves from the known to the unknown (Schwartz, 2005, p. 54). Children will compare something new to something they already have experience with. Vygotsky’s “zone of proximal development” and Piaget’s



“equilibration” both express the process through which children seek a balance between what they know, understand, and are able to think about, and the new information.

Behavioral psychologists, such as Skinner, would call this incremental learning.

At the same time children are moving from the concrete to the abstract, and from the known to the unknown, they are also moving from the simple to the complex (Schwartz, 2005, p. 55). While children should be presented with problems with fewer objects to manipulate or fewer variables involved, there needs to be some element with which the child is able to become engaged with a choice of some sort to be actively thinking about the concept. For example, asking a child to replicate a similar pattern with different objects is a different task than asking the student to copy a given pattern. This idea of replicating versus copying is one of Schwartz’s three rules that define the progressions of learning strategies that children use (Schwartz, 2005, p. 56). The other two rules include the notion of children moving from *exploration* of a concept to *experimentation* in applying the concept and the accumulation of facts about the world around them that leads children to draw conclusions. (Schwartz, 2005, p. 55-56).

When educators are considering how their students are acquiring new mathematical skills, they need to also be cognizant of which of the developmental skills children have already attained. Initially, a student may be able to demonstrate rote counting skills just as she is able to recite simple nursery rhymes. By hearing the words in order repeatedly and by imitating the sounds they hear, students are often able to recite the number words with relative ease. However, demonstrating the concept of counting requires other foundational skills. Children initially build their mathematical

understanding around the concepts of sets (Schwartz, 2005, p. 62.) Children can create sets of objects, they can compare sets, and they can organize sets. During this initial stage, if the set of objects looks different, the child is not sure if the number of objects has changed. Other skills that children need to acquire before counting include:

- “clustering” objects either by choice (favorites) or by experience (these pieces belong with this game);
- “pairing” objects such as putting two mittens together;
- “sorting” objects and deciding which belong and which do not; and
- “classifying” objects into categories. Schwartz gives the example that pots and pans would be separated from forks and knives, because pots and pans are used for cooking and forks and knives are used for eating. (Schwartz, 2005, p. 64).

As children grow towards being able to count, they have established a certain set of understandings. They have a solid idea of what objects go together to comprise a set and can compare sets visually by noticing which has more, less, some, or a lot. (Schwartz, 2005, p. 65). This leads into familiarity with number words and rote counting. Once children understand that the number of objects within a set does not change even if the arrangement of the objects does change their number sense begins to emerge. This is cemented more firmly still once children understand that an “empty” set does not contain any objects. Counting with one to one correspondence becomes more automatic at this stage until children are able to count the members of a set only once.

This last stage requires that students are able to plan how to count efficiently and accurately.

Once children can count efficiently and accurately, they can be exposed to various computational skills. Schwartz (2005) identifies several critical points in the development of computational strategies. The first is, “simple computation up to 10 with and without props”. Through repeated manipulation of the props, children are able to identify the relationships between the two smaller entities that are combined and the new group that is formed. The second is the ability to “exchange based on equivalency”. Initially, children can understand trading in two small beans, for example, in exchange for one large one or in terms of money, five pennies can be traded for a nickel, or in terms of our base ten system, 10 ones can be traded for one set of ten. The third critical point is “interval counting”. Children at this stage of development are able to place objects or numbers in order based on their membership to a certain set such as beginning multiples of 1, 2, 5, or 10. Often termed “skip-counting” children learn this rote skill much akin to the way they learn to count at first. As students become familiar with the patterns or tricks of particular multiple sets, their rote counting takes on greater meaning. The fourth critical point of development is to be able to “problem solve” simple, real-life situations. Children at this stage are able to determine how materials are manipulated in the “story” and can calculate an answer to the posed problem. The fifth stage extends the problem solving and is exhibited when children are able to compute “using written symbols”. At this stage, children begin to experiment by inventing and using algorithms as well as collecting and interpreting data related to a problem. Finally, students at the

sixth critical stage of development are able to compute addition and subtraction problems using numbers first up to 20, then 30, 50, and 100. (Schwartz, 2005, p. 71).

### Teaching Strategies That Work

Rather than “reinventing the wheel” each time there is a need for an innovative solution to make sure that students are learning, it is important to look at the successful strategies that are already in place. First, educators must understand the importance of establishing a classroom environment where “thinking” is valued. There needs to be an emphasis on problem solving as a distinct goal and also as a means to understanding new concepts. In addition to these larger goals of establishing a “thinking” classroom of problem solvers, educators must realize that students possess differing learning styles. Sometimes, the same strategies that can reach a student in the English Language Arts (ELA) area can also assist them in understanding mathematical concepts. ELA programs that stress the importance of small group guided instruction and are supported through the Gradual Release of Responsibility Model (Pearson & Gallagher, 1983.) are helpful for students gaining reading and writing skills. Small group guided math instruction then is one strategy that can be overlooked as an effective way to differentiate the instruction to meet the needs of learners of varying abilities.

#### *Overall Classroom Climate and Thinking Environment*

As Schwartz (2005) documents, adults can teach children at three different levels: discovery, practice, and application (Schwartz, 2005, p. 93). Depending on where the students are in their learning of a given topic, whether it is being introduced for the first

time or whether the students are practicing their learnings towards understanding, teachers need to be “leading, feeding, or seeding”. (Schwartz, 2005. P. 93). If teachers are *leading*, then they are involved in transmitting information either through the spoken word, written word, or by modeling through their actions what the students are expected to know, be able to do, and think about. *Feeding* is the type of support that teachers supply when students have begun to grasp a concept and teachers are needed to provide the correct terminology to reflect what the students are learning and doing. *Feeding* also includes the validation of the relationships that students are making to strengthen their connections. It involves the teacher listening and watching the child intently to supply only the information that is necessary for students to continue along their journey of discovery without telling them too much so as to circumvent the discovery process. *Seeding*, on the other hand requires the teacher to set up particular situations where children will explore and discover patterns and relationships on their own. The teacher who is *seeding* is an observer of the student’s process of learning. Depending on what the child discovers or does not discover, the teacher revises or extends their plans regarding the next step in instruction for that particular skill or concept.

Whether the teacher is involved in leading, feeding, or seeding, it is imperative that there must be authentic interactions between the teacher and the student. Each must participate honestly where “the questioner is seeking information that he or she does not possess” and “the information giver assumes that the persons to whom he or she is giving information do not possess the information”. (Schwartz, 2005, p. 112-113.) In the classroom climate where authentic interactions exist, there is a collaborative nature to the

learning process. All of the participants are a part of the planning and the thinking and the contributions of each member are valued to add to the collective “ecology of thought” (Costa, 2008, p. 23). As the students encounter the new information and begin to make sense of it the teacher needs to be aware of the children’s thinking and must either *validate* their thinking by encouraging the students to test their notions, *review* the thought processes the used, or *challenge* and *extend* the ideas by applying them to more complex situations. (Schwartz, 2005. P. 117). Most importantly, throughout this process is the need to value process over product; in this environment, teachers value the thinking that causes the children to assert responses as opposed to valuing only the expected answers themselves.

Stone (2007) collected some of the strategies that had worked for teachers of mathematics. Within the collection, the teachers cite the importance of students to connect what they are learning to real-life situations and being involved personally in the problems that are presented (Stone, 2007, p. 28-30, 72). The social-constructivist view akin to Vygotsky explains the importance of encouraging students to work in pairs or groups, because, “Two heads are better than one”. (Stone, 207, p. 48). One teacher advised to, “Make Math fun...learn the tricks and stories that will help reduce math anxiety” (Stone, 2007, p. 72). It is important not to underestimate the part that the “emotional brain” plays in our acquisition of new skills and concepts.

### *The Learning Brain*

Jensen (1998) explains that while the right hemisphere is activated for higher level mathematics and problem solving skills, it is the left hemisphere that is activated for the

novice in these areas. The left hemisphere also notices positive emotions faster and is more active when positive emotions are present. Therefore, in order for the novice mathematician to learn more effectively and more efficiently, mathematics must be connected with positive emotions. (Jensen, 1998, p. 8). Ongoing brain research indicates that there is overlap with all of the lobes and that both the left and right temporal lobes are responsible for hearing, memory, meaning, and language (Jensen, 1998, p. 9). In the classroom, students need to perform all of these functions in order to learn mathematics. As the brain is stimulated, either by an internal stimulus such as a “brainstorm”, or an external stimulus such as a puzzle, the stimuli are sorted and processed and the basis for future memories are structured. (Jensen, 1998, p. 13). Educators need to be aware of the types of stimuli that are provided or encouraged and the variations with which students will respond to the stimuli.

The brain can be activated by either novel or familiar activity based upon the expected outcome and purposes for the stimuli. For example, repeating earlier learning make the pathways in the brain more efficient. Practice, or exercising the brain, involves students doing what they already know how to do (Jensen, 1998, p. 13). *Stimulation*, however, involves students in something new such as visiting a place, solving new problems, etc. These new experiences create more beneficial electrical energy in the brain as long as it is understandable by the student. By providing multi-sensory stimuli, the pathways are formed quickly and can form memories that will be more likely to be accessed later. (Jensen, 1998, p. 13). After all, memory is the most closely linked evidence that something has actually been learned.

Jensen makes a distinction between the brain and the mind, “The brain is what we have; the mind is what it does. In other words, the ‘mind’ is not a thing; it’s a process.” (Jensen, 1998, p. 15). Sometimes, skills and concepts can be learned and remembered, but our behaviors may not exhibit the learning. Since our behaviors are affected by our emotional states as well as our memories, teachers need to keep providing additional learning opportunities that allow students to create additional pathways and connections to be able to figure things out more efficiently rather than relying on a single approach and one right answer (Jensen, 1998, p. 16).

Jensen explains that the goal is to create “enriching environments”. (Jensen, 1998, p. 30). The first necessary step is to eliminate the negativity such as finger-pointing, embarrassment, and humiliation that will hinder the brain activity. Once the threats are eliminated for students, then the teachers can provide challenging experiences being careful to balance the level of difficulty to present just enough challenge to keep students interested without becoming bored, but keeping the task itself within the students grasp. In addition, the teacher needs to provide purposefully novel tasks to maintain students’ engagement. (Jensen, 1998, p. 32) By maximizing student feedback through challenging activities that require higher level thinking skills such as projects, and critical thinking activities where there is specific, multi-modal and timely feedback for students, the students feel valued and the brain releases endorphins and dopamine increasing the feeling of pleasure associated with the tasks. (Jensen, 1998, p. 33). This positive association will increase the activity in the left hemisphere which will then enable the students to learn more.



Jensen explains the various stages of development of the brain associated with typical student output as explained by Hannaford (1995). (Jensen, 1998, p. 35). At age 1-2, the brain is capable of concrete problem solving tasks. At ages 4-7, the brain experiences a “spurt” of dendritic branching in the right brain. Then, between the ages of 9-12, there is a spurt of growth in the left hemisphere. Finally, between the ages of 11-13, students are ready for more “complex abstractions”. (Jensen, 1998, p. 35). Jensen also mentions that students should be exposed to many ways in which they can solve a problem rather than relying on a sheet of paper (Jensen, 1998, p. 35). By allowing students to access their problem-solving capability through multiple avenues such as Gardner suggests through his Multiple Intelligences theory, students are more apt to feel capable. As students feel more and more capable, their body chemistry changes and they experience learning as a positive enterprise.

Jensen also explains the environmental conditions that can make it possible for teachers to engage their students’ attention more adeptly (Jensen, 1998, p. 48). First, teachers should incorporate choices into the activities such as choosing their partners, projects, processes, working environment, or resources. Secondly, teachers need to provide relevant problems related to the students on a personal level by incorporating the familiar such as family, neighborhood, current life stages or personal interests. The third condition that can improve students’ engagement rates is providing engaging opportunities to learn rather than passive ones. Tasks can be engaging by activating emotion such as debates, or by incorporating physical activity, or by using learner-imposed deadlines or peer pressure (Jensen, 1998, p. 48).

The brain as the “meaning maker”, also explained by Jensen, informs educators about how our students create understanding. Meaning making is a complex process that can be influenced by several factors: relevance, emotions, context, and patterning. (Jensen, 1998, p. 92). He notes that when teachers focus solely on lecturing, they are discounting the importance of us as social beings whose brains grow within social environments. (Jensen, 1998, p. 93). He cites that cooperative learning where talking, sharing, and discussing are encouraged, all critical components that can be highly brain-compatible when used properly. This principle can apply well to both the learning of our students as well as the learning of our teachers.

Since emotions play a powerful role in our brain’s ability to function well, educators can purposefully engage emotions to make learning more meaningful. For example, providing an opportunity to eliminate negative feelings such as mind-calming exercises or reflection time prior to beginning a lesson can prepare the mind for upcoming stimuli. (Jensen, 1998, p. 94.) To further stimulate positive emotions, Jensen explains that incorporating movement can be effective as well. The importance of the “stakes” involved such as peer support or collaboration, choice, and learner-devised deadlines can elicit additional positive emotions that increase motivation as well as the provision of novel tasks or environments which have a renewing effect on the learner. Jensen also explains that apprenticeships such as reading buddies or multi-age environments and opportunities to “think big” such as completing more complex projects all evoke emotions which contribute positively to student learning. (Jensen, 1998, p. 95).

Positive memory and recall strategies need to be employed that do not contribute to

performance deficits, lowered self-image, and a reduction of effort on future tasks (Jensen, 1998, p. 109). Instead of a “drill and kill” approach, there are strategies that can be directly taught to children successfully. Declarative strategies such as rhymes, visualization, mnemonics, peg words, music, and discussion can aid in recall that rely on other memory pathways than the repetitive “exercising” of drilling information. (Jensen, 1998, p. 109). For students aged 6-9, this means only requiring 1-3 items at a time whereas children aged 10-17 can handle up to 7 chunks. In addition, visual “mind-maps” or graphic organizers can help to organize thoughts conceptually rather than memorizing discrete bits of information. (Jensen, 1998, p. 109). He emphasizes the importance of the positivism again by stressing the importance of attitude; instead of referring to “forgetting” or a deficit in memory, educators should reinforce that students simply remember information later than they wanted to. (Jensen, 1998, p. 110).

#### *Authentic Assessments*

Another positive change is the incorporation of more *authentic* assessment tasks throughout the curriculum. The need for teachers to develop a portfolio with examples of students’ progress will force teachers to create assessments that provide for more real world experiences. Choate and Evans (1992) list other benefits as well. Teachers will also need to provide multiple opportunities to perform in order to show growth over time. If assessment is embedded within instruction as opposed to a separate task, the students will reap the benefits of greater instructional time. The other benefit that will improve the curriculum for students with disabilities is the requirement of self-assessment. Having students evaluate their own progress will increase their awareness and begin to

help the students build self-monitoring strategies.

### *Differentiated Instruction*

Tomlinson (2001, 2003), like Elbow, believes that there needs to be balance between addressing the needs of the students and being true to the “requirements of the curriculum” (Tomlinson & Eidson, 2003, p. 3). The teacher is guided by her sensitivity to the four different elements in the classroom: whom she teaches, what she teaches, where she teaches, and how she teaches. (Tomlinson & Eidson, 2003, p. 4). The teacher needs to understand the differences accounted for by gender, culture, and varying talents as well as the student’s prior experience. She also needs to be aware of what the students are expected to know and be able to do during a particular year in school at a particular grade. This includes being able to determine what skills the students missed and need to master as well as determining how best to challenge students and extend their thinking. “To do less would reinforce existing gaps in their learning and magnify their sense of frustration and futility.” (Tomlinson & Eidson, 2003, p. 5) This is precisely why differentiating instruction in order to teach mathematics to struggling learners is so important.

The teacher must also be mindful of the classroom climate. A class that is flexible where it is not a race to finish first and where there is not just a single set of benchmarks will create an environment of acceptance where students feel more comfortable taking risks. Without taking risks and experimenting with new ideas, students are not able to construct meaning for themselves. Teachers need to establish

ways to enlist students; efforts by attending to both the needs of the group as well as the needs of the individuals. (Tomlinson & Eidson, 2003, p. 6)

There are several defining characteristics of a differentiated classroom. There must be a strong link between assessment and instruction throughout a unit of study rather than a single summative assessment at the end of a unit. Continual formative assessments allow teachers to plan additional learning opportunities for students to refine their understandings. Learning goals are clear to both teachers and the students. Within one lesson with specific essential skills as the objective, teachers can provide a variety of opportunities for students at different levels of complexity. In addition to altering portions of the lesson's tasks, teachers in differentiated classrooms will teach with a flexible grouping model in mind. Through whole class, small group, and individual settings, students may be grouped either homogeneously or heterogeneously according to their readiness or interest. Within the differentiated classroom, the teachers have made it clear to the students that their ideas are important and that they have valid contributions to make to better the class as a whole, but also to better himself.

Teachers who create a differentiated classroom believe that by differentiating, one creates opportunities for "respectful work" (Tomlinson & Eidson, 2003, p. 8). Most importantly, this is meaningful work that focuses on the essential skills that every student is expected to master, but at varying levels of complexity. The classroom where there are respectful work opportunities available for everyone in a classroom where, "Drill, practice, and toe repetition do not mark struggling students," and where, "Advanced learners are not indicated by tangential tasks." (Tomlinson & Eidson, 2003, p. 8).

Tomlinson and Eidson talk about differentiation as “a way up” and never “a way out”. With this in mind, teachers should never underestimate the potential of a learner. (Tomlinson & Eidson, p. 8). Differentiation cannot simply happen while the teacher is teaching. Differentiation is a proactive approach which requires purposeful planning to account for the variance among the needs, interests, and abilities of the students beyond on-the-spot modifications. (Tomlinson & Eidson, p. 9) Although a teacher’s with-it-ness to be able to make judgments about where students are in their thinking and to facilitate deeper understanding, more proactive planning will increase the likelihood that such situations will occur where students are becoming confident reflective learners who can make sense of the world around them.

### *Planning for Differentiated Instruction*

In order to plan effectively, there are three areas that the teacher needs to consider: student characteristics, curricular elements, and instructional strategies. (Tomlinson & Eidson, p. 9). There are several aspects within each category. It is not necessary for teachers to consider each and every element for every lesson. Instead these are realms to consider in order to differentiate instruction in a variety of ways for a variety of purposes with a variety of approaches.

#### *Student Characteristics*

There are three elements within the area of student characteristics that can have an impact on how the teacher plans appropriate instruction: readiness, interest, and learning profile (Tomlinson & Eidson, p. 9). Student readiness addresses what the student already knows; this includes the prerequisite skills necessary in order to apply the new skill as

well as the background knowledge that will enable the student to be able to make the needed connection between the known and the unknown. The new task or concept must be just beyond the student's independent ability in order to provide the appropriate amount of challenge to learn something new as well as not being too far beyond their current skill level in order to prevent frustration.

In addition to readiness, teachers consider a students' interest. Students are more apt to be motivated to begin, continue, and complete a given task if it piques their interest. In addition to considering student's subjects of interest, teachers can also consider the students interest in terms of the types of curricular adjustments teachers might make. For example, if a student is interested in music, then writing a song that explains the process of the different operations, place value, or the value of coins may be more engaging.

The third student characteristic is the learning profile. By considering the students' learning profiles, he teachers accounts for auditory, visual, tactile, and kinesthetic learning preferences through multi-modal instruction. In addition to the ways in which students process information most effectively, teachers need to account for memory issues, expressive difficulties and other weaknesses as well as the students' strengths. Many students have difficulty with language processing, for example, can perform spatial tasks such as those found in geometry with relative ease. Capitalizing on this area of expertise when grouping the students builds on student strengths rather than focusing on the weaknesses.

### *Curricular Elements*

There are an additional three elements teachers consider when making adjustments with the curriculum for lesson plans. Teachers can adjust the lessons by the content, process, or product. One example of adjusting the assignment by the content was given earlier with the example of incorporating music into the learning opportunities centered around new mathematical concepts. Another example of adjusting for the content would be to assign tasks around a particular concept such as estimation and have students explore estimation with different numbers to meet them at their current level of functioning. While it is usually preferable to have the students all learning the same skills and concepts at the same time, but varying them only slightly such as these prior examples, there are times where it is not possible to teach the same skill at the same time. There are times when the gap between students' readiness is so large that it is not possible. Tomlinson & Eidson (2003, p. 10) give the example of having to teach telling time in a classroom where two students have not grasped basic number concepts. In this case, it is not possible to teach how to tell time to everyone, because these two particular students do not yet have the prerequisite skills they need.

Process denotes the way in which students will experience the new skill or concept. Effective lesson activities will address the key concepts and promote understanding by the students' active engagement in learning tasks. (Tomlinson & Eidson, 2003, p. 10). By differentiating the process, the teacher plans activities to allow students to explore the concept, make predictions and generalizations about the new skill or concept in order to truly understand it.



By differentiating by the product, teachers allow students to demonstrate their understanding in a variety of ways. Earlier, when considering student interests, a student who enjoyed music was allowed to write a song instead of carrying out rote procedures of the four mathematical operations. This teacher in addition to accounting for the student interest, was also differentiating by the product. The goals of the varying products are the same; the students who write a song or explain their understanding in traditional forms, still have to summarize the process and demonstrate their understandings, but the differences in product allow the students to capitalize on their individual strengths.

### *Instructional Strategies*

Teachers have endless opportunities to vary their instructional strategies. While there are many times teachers may choose to use whole class instruction deliberately, as an introduction to a topic, for example, it is not the only option. Small group instruction as well as individual conferencing can be crucial in order to provide the necessary supports for students to stretch their thinking. Within these small groups, they may be grouped homogeneously or heterogeneously by ability such as for guided reading groups, or by interest such as for literacy circles. In addition to instructional groupings, learning centers where students explore concepts either through collaborative groups or independent investigation provide for additional opportunities to vary the modes of instruction. Last, but not least, teachers may choose to vary the materials used whether it is a particular type of paper chosen (plain paper, lined, graph paper), a graphic organizer (problem solving template, or lattice multiplication matrix), or manipulatives.

### *Why Differentiate Instruction?*

In today's inclusionary setting, teachers have mixed-ability classrooms where one lesson, simply will not fit all, all the time. Tomlinson shares a number of typical classroom scenarios where there are a number of responsibilities that teachers must address through their planning. (Tomlinson, 2003, p.1). If a student learns more quickly than the suggested pace, then the teacher has a responsibility to that student to adjust the pace as well as the scope of the lesson. If a student has difficulty learning certain concepts, then the teacher has a responsibility not only to move the student ahead, but there must also be some system in place to provide the student with opportunities to fill the gaps. If a student is struggling to learn English, then the teacher has a responsibility to teach not only the content, but to also further the student's understanding of the language. While it would not be a good practice to generalize about all students of a particular gender or culture, it is important to broaden the available learning modes to encompass some commonalities of learning differences of the different cultures and also take into consideration commonalities between the learning styles common to many boys or to many girls. Finally, in those situations where a student has lost her eagerness to learn, the teacher needs to consider ways in which the student can reconnect with the joy of learning in order to succeed in the future.

In addition to the learning differences students have, it is important not to underestimate the impact of other factors on learning. Tomlinson (2003) points out that teachers need to also consider how a student's affect, self-esteem, and emotional stability, or instability, can affect their ability to learn. Tomlinson also describes the type of

learning environment as the “weather” in the classroom (2003, p. 4). A positive, productive classroom where the learning of all students is respected is identified by the mood of the class—a seriousness of purpose with celebrations of success and a shared sense of responsibility. With all of these responsibilities, it is clear that teachers are forced to think proactively about each and every student and their unique situation as opposed to gearing a lesson for the majority of students with average ability and simply hope for the best. Those who are called to teach have a moral obligation to call on their own resources, as well as looking to the resources of other specialists within the school, to provide as many productive learning opportunities for students as possible in order for the students to become productive members of society.

Differentiating effectively means to teach responsively, not reactively, but proactively. Tomlinson explains, “We teach responsively when we understand the need to teach the human beings before us as well as to teach the content with which we are charged...We are no longer teaching if what we teach is more important than who we teach or how we teach.” (2003, p. 10). While there is a need to teach the curriculum as the teachers are charged to do, they cannot teach as though it is only the curriculum responsibilities they are charged with; they are truly charged to teach the **students**. Students come to school seeking to gain certain fulfillments from learning in school: affirmation, contribution, power, purpose and challenge. (Tomlinson, 2003, p. 16). Students long to be accepted, to feel that people have faith in their ability, and to feel that their ideas matter. Beyond feeling accepted as they are, students need to feel that they can contribute to their learning community. By focusing instruction around student

strengths, students can see how they can contribute to the class and help the class as a whole succeed. Students begin to believe that they can, indeed, make a difference. There is also a sense of power that emerges within a student when she sees the usefulness of what she is learning and knows how to make purposeful choices that will lead her to success not just for the task at hand, but for future lessons as well. There is a power in her knowing how she learns best. The purpose of learning needs to be clear so that the student understands her own purpose. She must see the significance and feel that what she is learning is meaningful and connected to her world. (Sergiovanni & Starratt, 2007, p. 105). There must also be a challenge present for the student. The students' successes will feed their desire to learn more.

How the teacher responds to the students' needs will determine the vigor with which the students continue to learn. The teacher responds through invitation, opportunity, investment, persistence, and reflection (Tomlinson, 2003, p. 28). The teacher needs to convey a genuine interest in the students' thoughts and needs. She needs to value and respect the students as unique contributors to the class as a whole. The teacher, by providing, learning opportunities, leads the students to new possibilities within the world that they did not know of before. The specific roles they create for their students will help further the work of the class as a whole. The teacher needs to demonstrate to the students that her work is important. There is power in students seeing that the teacher will continue to conceive additional opportunities to further the learning. The teacher's persistence in trying many approaches to enable students to grasp a single concept demonstrates the unending support that teachers will provide when students are

not successful. The persistence is seen through the understanding that learning is not a race, but a journey that each finishes at her own pace. Finally, the teacher's reflective practices of observing and listening to the students and seeking their input about the learning itself, makes the partnership between teachers and students effective and successful. The reflection is important. It is not enough for the teacher to state that she taught the material, she must be able to see the learning and thinking of the student. If it is not present at the expected levels, the teacher has an obligation to the student to reflect on why and develop a plan for the next learning opportunity.

The teacher develops the new plan by considering the curriculum and instructional practices. The curriculum and instruction must be important, focused, engaging, demanding, and scaffolded (Tomlinson, 2003, p. 59). In order for authentic learning experiences to occur, the lesson must be grounded in knowledge and skills that are important to know and be able to do. In addition, the objectives needs to clear and focused so that students and teachers alike understand where these particular concepts and skills fit into the bigger picture of what students need to know, be able to do and think about. Teachers need to engage the students in the task so the lessons need to be connected to real-life applications and the work must pique the students' interest, engaging their curiosity to keep them motivated. The instructional design of the activities also need to be demanding enough to perpetuate student learning forward, consistently building on what they learned previously. In doing so, teachers must scaffold the learning opportunities carefully to account for the variances in student learning styles.

Differentiated instruction, according to Tomlinson, suggests that struggling learners should be viewed as “at promise” versus “at risk (2001, p. 12). With its roots held firmly in ongoing formative assessments, teachers use differentiated instruction practices to provide the multiple approaches struggling students need in order to gain access the general education curriculum. Planning to differentiate instruction keeps the teachers focused on creating student-centered lessons. It is a way of life for teachers who use their knowledge base and creative techniques to reach out to each and every learner.

### *Multiple Intelligences*

The work of Howard Gardner on multiple intelligences is helpful for teachers as they plan to differentiate both for student interest and to differentiate the content, process, and products of the lessons. While schools have typically valued the linguistic and logical-mathematical intelligences, Gardner promotes five additional “intelligences”: *musical, bodily-kinesthetic, spatial, interpersonal, and intrapersonal*. (Gardner, 1999, p. 41-43). Gardner argues that people have a blend of these different intelligences and that the challenge is to establish the best ways in which to utilize the strengths within each unique person. The appeal to educators is that if a student is not able to grasp a skill or concept presented with an emphasis for just one preferred intelligence, multiple intelligence theory provides alternative avenues for teachers to try in order to help students grasp the concepts and with greater understanding.

## Collaborative Efforts Towards Improvement

### *Adult Learners*

It is important to understand the development of the adult learner when planning any staff development. Sprinthall and Thies-Sprinthall (1983) summarize previous cognitive development models including the Freudian model, claiming that, “the major pattern of growth for adults is set by the age of six” after which humans become merely reactive. (Sprinthall & Thies Sprinthall, 1983, p. 14). The work of Hunt and Perry in the late 1960s and early 1970s focused on understanding development by defining what learning is, defining what knowledge is, and then defining what the learner’s role is within the learning process. (Sprinthall & Thies-Sprinthall, 1983, p. 17). Recent studies show that there is a relationship between the cognitive-development stages and the behaviors exhibited. For example, a teacher who functions at a higher cognitive-developmental level will be more flexible and more likely to be able to be responsive to the students’ needs. Hunt includes responsiveness as one of the “New Three R’s”; the other two traits are reciprocity and reflexivity.

In order for teachers to embody these three traits and learn more themselves, it is important to understand that “adults do not regress cognitively, and it may be possible to restart the developmental motor, so to speak, to nurture further growth”. (Sprinthall & Thies-Sprinthall, 1983, p. 22). Sprinthall and Thies-Sprinthall summarize Hunt’s generalizations and explain that an adult’s current level of functioning, is “a person’s preferred style”, but that there is still potential for growth. Sprinthall and Thies-Sprinthall also lay out guidelines for an instructional model for teachers and include six

elements: (1) providing role-taking experiences, (2) Consider the *qualitative* aspects of the experiences making them neither too high or too low for the learner, (3) Allow for thoughtful reflection, (4) Provide a balance between experience, discussion, reflection, and teaching, (5) Programs need to extend over a period of time (at least a year), (6) Personal support and challenge must both exist. This echoes the Piagetian principle of equilibration discussed previously. (Sprinthall & Thies-Sprinthall, 1983, pp. 28-30).

### *Embedded Professional Development*

In “Embracing Contraries in the Teaching Process”, Elbow (1986) explains how there are a number of paradoxical ideas that occur in the teaching profession. One of these contradictions is the idea that teachers are either committed to their students *or* to their subject. He cites later, however, that there is really only one direction for teachers to pursue and that is excellence and quality. There are a number of ideas that Elbow explains that teachers need to believe in order for students to learn more such as believing students are smart and capable, showing students that teachers are on their side, facilitate student’s progress to do better and to show students that they are willing to learn as well. Educators, according to Elbow, must also maintain high standards, view student performance “with a skeptical eye”, not to get attached to students and their views, and to care more about the survival of culture and institution than the individuals. All of this must be done or the constant waxing and waning of the student and subject each yielding to each other end up in a “deformed” unnatural state. In order to better both roles of the educator, there must be professional growth opportunities that help educators understand



the subject more deeply (content) and understand the best practices (pedagogy) available to help the students acquire the knowledge we want them to possess.

As Resnick points out (Resnick, 1998, p. 91), there is a general tendency for teachers to teach students the same ways in which they were taught themselves. There is still a dependence upon Thorndike's "bonds" theory where drills, competitive rewards, and practicing the "good" in and the "bad" out in education today. (Resnick, 1998, p. 93-94). This can be seen particularly in the area of mathematics where math facts are drilled daily and children perform repetitive operations with paper and pencil without real-life applications. There is a comfort in this "associationist classroom" where order and discipline reign supreme and the actual learning taking place is superficial, lacking in the deep thinking promoted by the likes of Perkins. Resnick cites that although the work of Dewey, Piaget, and Bruner were all math and science content-focused, without the professional development for teachers behind the theories, their work only "marginally penetrated" American schools. (Resnick, 1998, p. 99). She also points out that cognitive science confirms that it is essential for learners to construct their own knowledge (Resnick, 1998, p. 100). Knowledge and the thinking process are co-dependent; there must be some new knowledge that must be processed and acquired for there can be no thinking without something to think about. (Resnick, 1998, p. 101). For children to be able to construct new knowledge, there must also be "accountable" talk that is grounded in knowledge (Resnick, 1998, p. 107). As social beings, we cannot underestimate the importance that socialization has in our intellectual functioning. Educators will need a thorough understanding of both content and pedagogy as well as an "effort-oriented

belief system” in order to facilitate children’s learning beyond the elements of the associationism. (Resnick, 1998, 108).

One of the challenges in supporting an environment of knowledge-based constructivism is creating a community of adult learners where educators are continually refining their practice. Resnick explains that learning is the **work** of both students and educators rather than a sign of professional weakness. (Resnick, 1998, p.110). With the creation of learning communities, teachers can begin to relate to one another *through* the study of how their students are learning as well as the educators’ own learning. The sense of community grows stronger as everyone has a single focus, the advancement of teaching and learning within the school.

Resnick advocates for a change in the current supervisory roles that principals play in schools. Currently, it is common for principals to leave decisions about instruction to the teachers while the principals visit classrooms only occasionally in order to carry out the rigid evaluative functions they are expected to complete for the personnel files. Instead, Resnick proposes, principals should be part of study groups, visit other schools and university programs and focus on the work that the teachers are involved in regularly. (Resnick, 1998, p. 113).

### *Professional Learning Communities*

Judith Warren Little has written about ways in which schools can become collaborative learning communities. The main idea, Little found, was that inquiry into student learning must be at the core of any professional development for teachers. (Little, 1999, p. 238).

There are several characteristics that are common among schools who successfully maintain a collaborative culture. First, if a school is truly organized for teachers to learn in order to improve their practice, then the school should support the work of teachers as they investigate the questions and problems that arise as they are teaching. (Little, 1999, p. 236). Secondly, there needs to be a “habit” of sharing student assessments including, but not limited to, standardized tests, portfolios, student performances or exhibitions, open-ended math problems, and writing prompts in order to promote the study of teaching and learning. (Little, 1999, p. 237). Another trait is the sense of shared responsibility for students. As teachers become more invested in working together to help their students learn more successfully, teachers become intrinsically motivated to learn from one another. (Little, 1999, p. 238).

Little identifies some of the obstacles schools must overcome in order to promote a collaborative culture. One obstacle is the relative insularity that the teaching profession espouses. Teachers are often not afforded opportunities to learn about different instructional approaches or are working in environments devoid of any productive criticism. (Little, 1999, P. 242). In fact, teachers are faced with increasing workloads, which result in a smaller chance that teachers in the U.S. can be provided with out-of-class time that schools in many other nations are afforded. (Little, 1999, p. 244). \*

If teachers were afforded more out-of-class time, they would be more likely to delve into more meaningful activities than only being able to discuss the logistical concerns regarding field trips and other day-to-day matters or spending time writing personal lesson plans. Some states have made improvements in this area by promoting

peer review in the teacher induction process. (Little, 1999, p. 252). By using peer review, these states have linked the necessary support and assessments in order to advance the learning of new teachers more quickly. Little explains that teacher learning communities are more successful when the “closed classroom door” and environments of “noninterference” are eliminated. (Little, 1999, p. 255). Schools need to take on more of the responsibility on an ongoing basis for the quality of the teaching staff beyond the initial hiring processes. (Little, 1999, p. 257).

Little (1990) found that there are four kinds of collegial relationships among teachers: *Scanning and storytelling*, *Help and assistance*, *Sharing*, and *Joint work*. When teachers are involved in scanning and storytelling, there are involved in informal conversations about what has happened with their students. Help and assistance conversations, involve one teacher eliciting help from another. The “sharing” takes place when teachers explain how they structured a particular unit or they share the assignments they have given to their students. The desired collaboration, however, is in the “joint work”. The roots of the concept of the “joint work” could include the development of teachers’ content knowledge such as the work involved in the National Writing Project, addressing problems of program implementation or by engaging in the improvement of the craft of teaching itself.

Richard and Rebecca DuFour promote that in order for schools to move forward, the school must harness the power of the “collective intelligence” of the school. (DuFour, DuFour, Eaker & Karhanek, 2004). The “joint work” that Little discusses addresses this need to establish a shared sense of responsibility for *all* students among the

entire school community. Schools need to move away from expecting the individual teachers to respond alone when students are not learning under the guise of “autonomy”. Instead, schools need to establish a system for providing additional time and support to the struggling students (DuFour et al. 2004).

DuFour et al. explain that there are three critical questions that need to be discussed among the educators in a school in order to truly establish a professional learning community. The three questions are:

1. Exactly what is it we want all students to learn?
2. How will we know when each student has acquired the essential knowledge and skills?
3. What happens in our school when a student does not learn? (DuFour et al, 2004, p. 21).

Educators within a school need to work together to identify the “guaranteed and viable” curriculum that *all* students are expected to know and focus the energy and resources on these specific goals, abandoning those strategies and practices which do not further the students growth in the desired direction.

When schools become professional learning communities and work collaboratively, providing additional time and support for struggling students can become easier. With a shared sense of responsibility, regular education teachers and special education teachers can address students with their particular areas of strength to provide necessary challenges and remediation with a seamless services approach where everyone is invested in assisting every student. Teacher assistance teams that use a protocol (such

as the L.A.S.T protocol explained in the next section) have a systematic approach to identifying specific areas of need, establishing a success plan to target these needs and follow up as a team to monitor the implementation of the suggestions. The ongoing diagnostic focus of a collaborative team has become necessary with the external pressures on education such as the NCLB legislation.

### *Collaborative Teaching Model*

Stone explains successful steps a small study group can take to work collaboratively in order to improve teaching and learning. (Stone, 2007, p. 74-75). First, the team needs to set the long-range goals of what the students are going to be expected to know, be able to do, and understand. Once the overarching goal is established, teachers need to select a specific curricular area by examining the available data such as state testing or district-wide periodic assessments. The group plans a lesson making sure to discuss the different ideas and debating how the lesson will be carried out. As one teaching team teaches the lesson, the other group members watch the lesson and take notes targeting the student learning that they observe. After the lesson is complete, the team analyzes what happened and makes suggestions on how to improve the lesson based on the student learning. The next team member then re-teaches the lesson incorporating the suggested changes and the process is then again reviewed by the group. Through this iterative process focused on student learning, teachers can work collaboratively to improve their individual teaching practice as a combined effort of improving teaching and learning as a response to the shared responsibility to the growth of all students in the school.

### *Analyzing Student Work Versus Analyzing Student Thinking*

A great deal of emphasis has been placed on the importance of analyzing student “work”. Essentially, that is what every assessment ought to allow the teacher to do. To truly analyze a student’s work rather than grading it, the teacher needs to delve deeply into the evidence of student “thinking” exhibited within the work. The thinking is visible through not just correct calculations, but in patterns of errors, in misunderstood language, in a misinterpretation of a problem. By determining the root of the error, the teacher can decide which skills and concepts need to be re-taught, reviewed, or reinvented in order to provide an alternative learning opportunity for the students to be able to grasp the essential skills that are needed.

David Perkins and the team at Project Zero in conjunction with Harvard University developed a protocol to assist teachers in Looking At Student Thinking (L.A.S.T.) (Harvard Project Zero, 2001). Through the use of this protocol, teachers are able to freely share examples of student thinking from their classroom with their colleagues in order to identify where the teachers see insights into the students’ thinking based on the work samples or lesson that is observed. It provides an opportunity for the team to have a meaningful dialogue about the practice of teaching and ways in which the work can be extended to future lessons to promote even deeper understanding both of the students’ thinking as well as the teachers’ rationale in employing different strategies.

Chapter Three, which follows, incorporates the areas of research and theory discussed in this chapter and explains the research design and methodology that will be used for this study.

## CHAPTER 3: DESIGN OF THE STUDY

### Introduction

Chapter three will focus on the design of this descriptive case study. The chapter opens with the presentation of the research questions and hypotheses. The research design and methodology are explained and the sample and rationale for the purposive sampling are discussed as well. The final portions of the chapter focus on the data gathering procedures, the methods of data analysis to be used as well as the formats for reporting the data and the discussion of the findings including the significance and limitations of the study.

### Research Questions and Hypotheses

#### *Research Questions*

1. What did teachers learn about math content and pedagogy to help special needs children meet standards-based proficiency in math?
2. What were the most helpful components of the professional development program that promoted teachers' learning?
3. Which of the newly employed strategies did teachers perceive worked the best?
4. What were the challenges of implementing the embedded professional development?

#### *Hypotheses*

1. The challenges of implementing the embedded professional development would include setting the foundation of trust within each study group to allow for freedom of thought among the participants, allowing more time when needed to delve deeply into



student thinking, building teachers' capacity for becoming more reflective in their practice, and consistent staff attendance at all sessions.

2. After participating in the monthly workshops, teachers will have developed a deeper understanding of number sense and the four major operations of addition, subtraction, multiplication, and division as well as developing facility in analyzing student work samples and use that data to guide their future instruction.

3. While the workshops will increase the teachers' knowledge base, the largest impact on student achievement will be brought about through the teachers' collaborative efforts in analyzing student work in study groups and becoming more reflective about the effectiveness of their teaching practices.

4. By using periodic formative assessments from the program, the teachers can use the strategies that match the students' learning preferences to provide various access points to each lesson. In addition, strategies that provide a framework for answering questions in the language arts area can be transferred to math by allowing students to identify the question being asked, using the information in the "story" problem to find the solution, proving their thinking in writing, and reviewing the question to be sure that the answer they arrived at answers the exact question that was asked. Students can explain their thinking in math by using a combination of numbers, pictures, and words.

Essentially, the researcher expects to find that allowing teachers the time to work collaboratively to analyze student work as well as the time to delve more deeply into the subject matter itself, the teachers will be improving their current practice of teaching mathematics to all of their students.

## Research Design

This is a qualitative inquiry study concerned with understanding the intricacies of the teaching and learning process as it pertains to the acquisition of math skills for students with special needs. As Merriam states, “Qualitative researchers *are interested in understanding the meaning people have constructed.*” (Merriam, 1998, p. 6.) As teachers seek to uncover the meaning that their students have constructed, teachers must also seek to uncover the meanings that they have constructed themselves about what their students need to learn in mathematics, the best practices for teaching the essential concepts and skills, and the most effective way for the students to demonstrate their understandings. Since a large component of the project dealt with the teachers’ meta-cognitive practices, it is essential to use a qualitative research design. This allows the researcher as a participant-observer to have an “insider’s perspective” and enables the researcher, as the primary data collection instrument, to interpret the progress as seen through teacher self-reflection, collaborative dialogue, and classroom observations by the researcher.

The value of this qualitative study will inform the educators within the North Edison school district about the effectiveness of the different instructional strategies used. The data collected will document the effectiveness of each of the strategies employed which may be used for other students with similar learning profiles who also struggle with the same mathematical concepts and skills. The participants analyzed their approaches in English Language Arts as well to determine if some of the strategies they have used successfully to teach reading and writing can apply to math instruction as well.

One strategy that had already been identified as a possible link to math success is small group instruction, which teachers currently use more prevalently in English Language Arts.

### Research Methodology

While the sample is not large enough for a quantitative study, this study will lend itself well to the three tenets of qualitative research as explained by Yin (1989): describing, understanding, and explaining. Using a variety of data (observations, study group notes, interviews, surveys) collected from teachers in various roles will enable the researcher to analyze the data in many ways sorting by grade level, areas of expertise, years of experience, as well as looking at the data in the aggregate.

This case study will consist of a small sample (13) of educators in one primary school. Another advantage of conducting a small case study is that the researcher is able to delve deeply into the thought processes and collaborative efforts of the teachers involved with greater facility than if the researcher was merely surveying a large population. Additional cross-case analyses may reveal additional trends when comparing the data among grade level teachers, cross grade groupings, special education teachers and regular education teachers, as well as comparisons among teachers with varying levels of experience.

### *Sample*

The purposive sample for this study will include the entire faculty (23) as well as smaller sample consisting of the 13 volunteers who participated in the study groups. The teachers were all on staff at the Princeton Elementary School which houses grades Pre-K through third grade. The current enrollment is 530 and the breakdown by grade is as follows: Pre-Kindergarten (86), Kindergarten (96), First Grade (118), Second Grade (132), Third Grade (98).

### *Site Description*

Princeton is nestled in a small bedroom community in a middle class suburb in New England. The population is approximately 23,000 and the per capita income is approximately \$30,500. The K-12 school district includes seven schools. There are two primary buildings housing students in Pre-K through grade 3 and one additional primary building which houses students in Kindergarten through grade 3. There are two schools located within a single structure housing the intermediate grades 4-6. Grades 7-9 are housed in the Junior High School and grades 10-12 are housed in the high school. The total student population is currently under 4,000.

The district has been performing increasingly well on the State Comprehensive Assessment System (MCAS). Scores from the Spring 2007 administration revealed that 89% of tenth grade students scored in the Proficient or Advanced category with only two students in the Warning/Failing category. At the third grade level, the only grade tested annually at Princeton, 79% of the students scored in the Proficient or Above Proficient

categories, 20% scored in the Needs Improvement category, and only 1% (1 student) scored in the Warning category. Princeton scored above the district and the state scores.

*Sources*

At the onset of the study, all participants involved in the study groups signed a consent form with the understanding that their participation in the study was voluntary and that they could opt out of the study at any time. The teachers involved in the faculty meetings where the content of the study was also discussed, were obligated to participate in conjunction with the contract for one hour each month.

The sample originally consisted of 14 of the 23 members of the faculty. The participants represent each grade level from K through third grade as well as certified learning specialists who work in multiple grades.

Table 1  
*Number of Teacher Participants in Each Role*

<b>Teacher Category</b>	<b>Number</b>
Kindergarten	2
First Grade	2
Second Grade	3
Third Grade	4
Learning Specialist	3

The teachers were informed about the opportunity to participate in the study groups during the 07-08 school year and will receive a certificate for 30 Professional Development Points (PDPs) at the conclusion of the year for their continued

involvement. The principal asked for volunteers during a faculty meeting to fill the slots available for each grade level as well as the learning specialist role. All 14 teachers who volunteered were included in the sample and were informed that their continued participation is voluntary. They were aware they could have opted out of the project at any time. One first grade teacher opted out of the study due to familial obligations that required more time than originally anticipated. The remaining thirteen, however, continued through the study in its entirety.

It was important to include teachers in different roles. The principal expressed the desire to have a diverse sample within the teaching faculty at Princeton.

Table 2  
*Experience Range for Participating Teachers*

Teacher	1-4 Years	5-10 Years	10+ Years
Kindergarten 1		X	
Kindergarten 2			X
First Grade 1			X
Second Grade 1		X	
Second Grade 2		X	
Second Grade 3			X
Third Grade 1		X	
Third Grade 2			X
Third Grade 3			X
Third Grade 4			X
Learning Specialist 1		X	
Learning Specialist 2			X
Learning Specialist 3			X

This purposive sample will allow each study group to have a broader wealth of knowledge available for their discussions and the groups will also be able to search for commonalities from grade to grade. The range of experience of the participants extends from 7 years to 34 years with 38% of the sample with 5-10 years of experience and 62% of the sample with 10 or more years of experience. All of the teachers have professional status, are certified in the areas they teach, and possess Masters degrees. Nine out of the 13 teachers involved live in town and have a vested interest in improving the state of education in the district.

#### *Pilot Test*

The survey and the interview were subject to a pilot test. They were administered to five colleagues of the researcher. Two colleagues are in similar settings and three served to provide an objective, outside perspective. There were minor changes made to the initial wording of the questions in both instruments so that the purpose of the questions was clear.

#### *Data Gathering Procedures*

The data will be collected using the following instruments

- \*Principal's classroom observations
- \*Interviews before and after the project's implementation
- \*Teachers' reflective journals (study group participants)
- \*Principal's leadership journal
- \*Pre and post implementation survey to all teachers on staff
- \*Principal's (participant-observer) observations during faculty meeting

workshops and study groups.

\*Attendance logs

\*Artifacts from study group sessions and faculty meeting workshops

\*Student work samples and assessments

The principal's classroom observations provided data during discussions regarding the effectiveness of the different strategies used to differentiate the math lessons. The principal noted which students were able to meet the objectives successfully as well as noting the differences in grouping (homogeneous or heterogeneous), the size of instructional group (whole class, small group, individual), the types of materials used (manipulatives, graphic representations, paper and pencil), the type of instruction (direct teaching, experimentation, discovery learning, Socratic questioning technique), and student activity (engaged, distracted, initiating, following).

There are two pre and post instruments. The online survey was administered to all staff before and after the project's implementation to provide an opportunity to evaluate the effectiveness of the faculty meeting workshops. The pre and post interviews were used to evaluate the effectiveness of the study groups and the use of reflection journals. The reflective journals themselves provided documentation of the teachers' learning throughout the process as well as the success of the various strategies with their students.

Artifacts collected included: student work samples, assessments, documentation from study group meetings, attendance logs, and documentation from the faculty meetings. The student work was analyzed for students' rate of success with various



strategies, overall self-concept of math ability, and their successful demonstration of the essential concepts in skills. The artifacts from the faculty meetings and study groups were used to document the teachers' thoughts about the essential concepts that need to be taught, the appropriate pedagogy to teach these skills and concepts and their analyses of the effectiveness of their intervention.

There were four data collection phases in this case study: initial interview, on-going reflective response journals, periodic observations, and an exit interview.

In August, the first phase began. This included a pre-intervention survey given to the entire staff that participated in the faculty meeting workshops each month and an initial interview for the teachers who participated in the study group sessions. This served as a data-gathering step to focus the professional development to best meet the needs of the current staff and student population. The surveys were conducted through the online service called Survey Monkey (<http://www.surveymonkey.com>). Participants were sent an e-mail with the specific temporary URL to access the survey ([http://www.surveymonkey.com/s.aspx?sm=JMqL93pG8tNYNUYm5\\_2bYOvQ\\_3d\\_3d](http://www.surveymonkey.com/s.aspx?sm=JMqL93pG8tNYNUYm5_2bYOvQ_3d_3d)) to maintain participant anonymity. The interviews were videotaped in a one on one session in the researcher's office and were transcribed later by the principal. All of the records were kept in a locked closet in the locked researcher's office.

During the second phase, participants were required to keep a reflective response journal. Through the use of the journal on a regular basis, the teachers were able to track which strategies were effective with which students, which strategies did not work well and why, and what their next steps are in preparing subsequent lessons. Participants also

kept their journals as a record of the events in their class that could be shared and possibly replicated in other classes as the project progressed. Participants were asked to respond in their journals on a weekly basis and responses were to be based upon their experiences and insights related to the faculty meeting workshops, study groups, and classroom events. The faculty meeting workshops targeted specific content and pedagogy related to the mathematics instruction. The study groups focused on analyzing the student work to look for evidence of student learning and the type of misconceptions or missing concepts and skills that need to be addressed by the teachers. The journals were collected by the researcher on the last day of the month from October through May. The journals were also kept in a locked closet within the researcher's locked office with the other records.

The third phase consisted of the researcher's observations. In addition to the informal "walk-through" observations, the researcher will observe the math instruction in each study participant's classroom periodically looking for evidence of differentiated instruction and the ability of all of the students to meet the learning objective(s) of the lesson. During the study group sessions, the observations were discussed with the teachers in order to provide information that would be used to plan future instruction. The researcher also kept a log of what was discussed during the study group sessions in order to provide a focus for classroom observations and to collect data documenting the teachers' thought processes. The log was analyzed to determine specific patterns of thought that may indicate a need for further professional development in content, pedagogy, or both.

There were two components to the final phase in May. One was in the form of an exit interview to learn about each teachers' individual findings throughout this project. The second part entailed the study group participants reporting out to the faculty as a whole during the June faculty meeting. The study group members focused on the overall success of the project and its implications for the following year.

The researcher was serving as a participant observer during the course of the 2007-2008 professional development activities and also kept a reflection journal in the same vein as the teachers involved. The data from the teacher interviews and journals as well as the observations will be triangulated with evidence of student performance.

#### *Methods of Data Analysis*

Once the data were collected, the researcher went through a process of *data reduction, data display, and drawing conclusions* through an iterative process in order to identify what the actual findings of the research were (Miles & Huberman, 1994, p.11).

The data reduction took place throughout the study. The work during each study group was summarized so there is a natural distillation of the most essential actions and thought processes that occurred. In addition, as journals were collected, the researcher summarized the findings from each participant. Another example of the data reduction is the coding processes that occur during the review of transcriptions of the interviews and observations.

The data displays and data reduction phases are interrelated. For example, once the journals were summarized, other questions emerged that needed to be posed to the

participants. Once the questions were answered by the participants, the data reduction phase began again.

The researcher was also drawing conclusions throughout the study. However, final conclusions were made only when the data collection was complete. As the researcher began to draw conclusions, the need for additional data became apparent. This is where the process continues with data reduction and data display. These new displays again informed the researcher in terms of drawing additional conclusions. The charts included in the following chapter, for example, raised some options for further study once the findings were distilled.

Using this inductive process, the researcher was able to draw many comparisons between data sources in order to triangulate the data to ensure that the findings are supported. While there may not be strong correlations that can be drawn from the multiple sources of data, by comparing the data collected in several sources the researcher will be able to show that the data from the different sources do not contradict one another (Miles & Huberman, 1994, p. 266).

There are a number of purposes for analyzing the data in conjunction with this study. The data collected from the surveys and interviews before the project implementation serve as a baseline of what the current beliefs and practices of the staff were at the start of the implementation. The researcher then compared that data to the data collected during the post-implementation survey and exit interview. The differences noted were used to make additional comparisons between sub-groups of the study. These

comparisons served to support the findings of the effectiveness of the various methods used for differentiating math instruction in the various classrooms.

The data was collected through the following vehicles:

***Pre and Post Implementation Surveys***

\*Demographic information will be reported in a table according to the APA format

\*Responses to open-ended questions will be categorized by their commonalities and listed from the most common responses to the least common.

***Pre and Post Implementation Interviews***

\*The video-taped interviews will be transcribed and coded. A table will be created to provide evidence of change in instructional practices by comparing the responses of participants based on different variables: years of experience, grade level, cross grade groupings, special education and regular education.

***Researcher's Observations***

\* The classroom observations and study group observations that are collected throughout the year will be coded and reported in list form and categorized as evidence for the different research questions.

***Participant Reflection Journals***

\*The responses will be coded and reported in list form as evidence for the research questions.

\*A frequency distribution graph will be created to show the use of the different strategies implemented within the classroom according to the teachers' observations.

### ***Student Work Samples***

\*Student work samples were shared during discussions in the study groups as well as the faculty meetings. Anecdotal comments were included in teachers' journals as well. A coordinating list of strategies are included so that additional correlations can be made as to the effectiveness of certain strategies.

### *Formats for Reporting the Data*

The first step was to organize the data and determine which are the important data that correspond to each research question. The pre and post implementation survey data were displayed visually using a variety of tables showing the number of responses in specific categories and the open ended responses were categorized by common responses and listing them in order of the number of responses, the most common being listed first. The interviews were transcribed and coded. The teacher journals and leadership response journals were also coded. The data were then organized according to the evidence they provide for the answers to the research questions. In addition, a narrative summary provides a chronology of the data collection procedures for each instrument used. The findings will be provided in narrative form along with the matrixes to display the data in visual form.

### *Frameworks for Discussing the Findings*

Within this study, there are a variety of sources of data. In order to make sense of the data, the findings will be reported in reference to the four main research questions:

1. What did teachers learn about math content and pedagogy to help special needs children meet standards-based proficiency in math?
2. What were the most helpful components of the professional development program that promoted teachers' learning?
3. Which of the newly employed strategies did teachers perceive worked the best?
4. What were the challenges of implementing the embedded professional development?

Each research question will be restated followed by an answer to the question. The answer will be supported by appropriate evidence. The evidence will be gleaned from the artifacts collected as well as the visual displays of the data noted above. The findings will also be supported by the theoretical framework outlined in the literature review in Chapter 2. After citing the evidence for each research question, a summary will follow that will explain the significance of the study and the future steps to be taken in North Edison in order to make further progress in closing the achievement gap between special education students and general education students in the area of math.

Since high stakes testing is a topic of interest for many in this current political climate, this study will reflect the problem faced by many. While there is a need for each district to analyze what can be done to close the achievement gap between regular education and special education students, this study will provide documentation of the

efforts in North Edison to address this concern. As stated previously, the information will be reported in sections related to each research question to provide a clear, organized summary of the findings.

### *Significance of the Study*

If this project is successful, there are several aspects of this study that have potential benefit to other schools and other districts. First, if teachers are able to differentiate instruction effectively using the Everyday Math materials and students learn the essential skills for that grade level, then additional funds will not need to be allocated for supplemental materials and programs. Second, if the study group format is successful for implementing new procedures or protocols and developing skills, such as building the teachers' repertoire of differentiating strategies, then study groups could be used on a routine basis to implement and develop other district initiatives. The third benefit could be the restructuring of the monthly faculty meetings. Time that was devoted previously to small administrative issues could be used instead as a monthly professional development session. Teachers must recertify every five years to retain their license as a professional educator. Classroom teachers at the elementary level need to have proof of at least ten hours in each subject area. If professional development is carried out by the district in this format, with a different subject area covered each year during the faculty meetings, the districts can save money by providing professional development internally and the teachers will have been provided with professional development that directly benefits their current position and also meets the demands of the recertification process.



Most importantly, if the change in practice of differentiating math instruction using the Everyday Math materials does in fact close the achievement gap between students with special needs and the regular education population, then other districts that have scored similarly on the state assessments may also see an improvement if they use this approach.

If the achievement gap is lessened, there needs to be a plan for sustaining this with a changing staff. Within the next five years, the majority of the staff at Princeton Elementary will have retired. As new teachers are hired, as part of the teacher induction program, teachers will need to be mentored by classroom teachers at their grade level. Some of the mentoring will need to involve observations where the protégé can observe various veteran teachers teach as well as having the mentor observe the protégé's lessons and provide constructive feedback to help the new teacher learn how to use the information from observations as well as performance assessments to drive future instruction.

#### *Limitations of the Study*

Qualitative research studies depend not only on the data collected from the various sources, but also the ability of the researcher to draw out the important information uncovered in the various patterns across the data sources. In order to provide for the greatest objectivity, the bias of the researcher must be mitigated in some way so as not to hinder the credibility of the study. Triangulation of the data as well as having the findings reviewed by a colleague who is not a participant in the study will serve to mitigate bias.

Qualitative research has different demands for validity and reliability than quantitative research. According to Maxwell (1992), for a qualitative research study to be valid, it should be descriptive, interpretive, theoretical, and evaluative. (Miles & Huberman, 1994, p. 278). In this case, the researcher will be describing what occurred during the study, how it will affect the teachers in terms of their ability to differentiate instruction, the relevant theories that support the findings, and drawing conclusions as to the value of this study. In order for this study to be reliable, the questions posed have been subject to a pilot test to ensure they will be clear to the participants. Since data were collected on a regular basis (for example, the journals will be collected monthly and there will be two observations each month) the reliability of the study increases as well. In addition, a colleague who is not part of the study will be involved in reviewing the coding procedures and transcriptions to ensure the study's reliability.

There are several other limitations to the study that need to be mentioned. Since the sample size is small and all participants are faculty members at one site, this study will not be able to be generalized to other schools. Due to the limited amount of time over which this study is carried out (one academic school year) its impact towards closing the achievement gap cannot be fully realized. Finally, although the intent of this study was to provide a purposive sampling, all of the participants are volunteers and may or may not continue on throughout the study. Therefore, sample mortality may have had an effect on the data available throughout the study. However, since the sample includes teachers representing each grade in the school as well as the different roles of classroom

teacher, special education teacher, and learning specialist, the variety of data sources will help to mitigate the limitation of having a small sample.

While the above limitations will have a minimal effect on the results, history may indicate further limitation to this study. While the professional development was implemented through this leadership project, there were several other initiatives in the district as well. First, and most confounding, is the course being taught on differentiated instruction. Three of the teachers involved in this study are also taking the course on differentiated instruction. All three teachers are part of one grade level team so that this factor can be taken into account more easily during the analysis stage.

In addition, there is a district-wide initiative involving Stephanie Harvey's work on Strategies That Work (2007) related to reading comprehension. This should have a positive effect on the involvement in this study since some of the teachers are invested in learning which strategies work for both reading *and* math. Threads of this evidence will be documented in the participant journals and the teachers' and researcher's field notes.

## CHAPTER 4: ANALYSIS OF DATA AND FINDINGS

### Introduction

This chapter reports the findings of the study. The chapter will begin with a description of the site and the teachers who voluntarily participated in the study. The four research questions provide a framework for discussing the findings. Following the presentation of the findings in this chapter, Chapter 5 will include a commentary on the findings, some general conclusions as well as the implications for policy, for practice, and suggestions for further inquiry and for further study at this particular site.

### The Site

North Edison is a small bedroom community with a population of approximately 23,000, a suburb 20 minutes from the nearest metropolis. Within this school district of under 4,000 students sits Princeton Elementary School, a brick edifice constructed in the era when institutional concrete block walls were in vogue. Its stately appearance from the outside is contrasted with the welcoming warmth of the decorated interior complete with the art projects of the tile wall and wall hangings created by past classes in honor of their time in the school. Student work is showcased consistently within each classroom and students recognized as exemplary models of good citizenship are highlighted in the front hall. There is a positive climate of high expectations and high student achievement that pervades through the school in teacher-student interactions as well as teacher-teacher interactions.

During the academic year in which this study took place, Princeton Elementary School consisted of 530 students distributed as follows: Pre-Kindergarten (86), Kindergarten (96), First Grade (118), Second Grade (132), and Third Grade (98).

### The Sample

There were 31 teachers participating in the faculty meetings. The original purposive sample of 14 teachers for this study were drawn from the 23 teachers in grades K-3 on staff at the Princeton Elementary School. By the end of the study, 13 of the original 14 voluntary study participants remained. One first grade teacher decided to leave the study due to personal time constraints. This teacher did still participate in the faculty professional development sessions along with the rest of the staff, but did not continue to participate in the study group or continue with her reflection journal.

For the purpose of anonymity in the study, the names of the participants have been changed. Only one participant was male. Since the researcher did not seek information regarding the differences in male or female respondents, all fictional names are female to protect the identity of all of the participants. Below is the breakdown of the teachers, their level, and years of experience in their current position during the time of the study.

According to Table 3, Fran, Greta, and Jen teach multiple grades. Their roles as reading specialist and special education teachers require that they work in multiple grades. They were assigned to work with students some of whom had teachers participating in the study and some of whose teachers who were not participating in the

study groups. There was some carry over in to the non-participant teachers' classrooms as well which will be discussed further in the latter part of this chapter.

Table 3  
*Characteristics of Study Group Participants*

Teacher	Grade Level				Years in Current Position		
	K	1	2	3	1-3	4-10	10 +
Alice	X					X	
Beth	X						X
Carrie			X			X	
Dori				X			X
Eda		X				X	
Fran	X	X	X			X	
Greta	X		X			X	
Holly				X		X	
Ilene			X				X
Jen			X	X			X
Kelly				X			X
Lori				X			X
Macy			X			X	

### Review of the Problem

The problem, as stated in Chapter One, was the presence of an achievement gap between the regular education and special education students particularly in the area of math as evidenced by the students' performance on the state exam. There was a need to discover what was impeding the progress of students with special needs in the area of math. Overall, students with special needs did not score as low in English Language Arts (ELA) as they did in the area of math. It was necessary to employ an innovative plan to help to close the gap between these two groups.

In North Edison, there is a fairly large percentage of students with identified disabilities compared to the total population. Table 4 below describes the demographics of the student population with regard to identified disabilities. To understand the percentage of students that would possibly benefit from additional measures to improve instruction, Table 4 lists not only the percentage of students identified with disabilities who need specialized instruction and are therefore on an Individualized Education Program (IEP), but also those who only need accommodations to meet their needs and are followed closely on the Section 504 Plan (504). It is helpful to compare the percentages at Princeton Elementary with the other two primary schools in the district and the percentage of students with disabilities in the district overall.

Table 4  
*Percentage of Students with Disabilities*

	Percentage Enrolled in Special Education
<b>Princeton</b>	13.5%
Primary 1	12.5%
Primary 2	14.7%
District	18%
State Average	16.8%

An additional issue to consider is that while the percentage of students enrolled in Special Education in the elementary schools in North Edison is below the state average, the total percentage in the district is *above* the state average. In order to provide appropriate accommodations and modifications to meet the needs of all learners, the teachers in this district need to employ instructional strategies that students can use successfully in the early years of schooling and carry over these strategies from year to year as the skills and concepts become more complex.

## Response to the Problem

The goals of this project possessed the characteristics desired as indicated by the district goals. Table 5 displays the alignment of the two sets of goals.

Table 5  
*Alignment of District Goals and Project Goals*

<b>District Goals</b>	<b>Project Goals</b>
<u>Goal 1 – Student Achievement</u> - All students are held to high expectations and standards through engagement in programs that are designed to maximize student performance.	All students regardless of disability are expected to achieve to grade level standards for all “essential” skills.
<u>Goal 2 – Educator Effectiveness</u> - Educators design and use coordinated curriculum units that integrate technology, the community, the work place, the state’s curriculum frameworks, and an authentic system of assessment; where appropriate, curriculum units incorporate the arts, cooperative learning, and interdisciplinary projects.	Teachers worked collaboratively to design lessons and units integrating the curriculum into relevant, authentic, and meaningful learning opportunities incorporating multiple intelligences and opportunities for students with various learning styles to participate successfully.
<u>Goal 3 – Educator Effectiveness</u> - Educators are afforded optimal time to investigate current trends and approaches, necessary resources to access state-of-the-art teaching practices, and sufficient flexibility to regularly communicate with fellow educators.	All faculty meetings were used to investigate current trends and approaches in math.  Common planning time was afforded twice per month for all study group members to provide feedback to one another and to collaborate.
<u>Goal 4 – School Effectiveness</u> - The community is informed about the successes and challenges of the schools, has opportunities for involvement in school initiatives, and regards itself as a full partner in the collaborative enterprise of education.	This math initiative was part of the Princeton School Improvement Plan. Parents and community members participated in the development of the plan and the goals were communicated before the School Committee and aired on cable.
<u>Goal 5 – School Effectiveness</u> - Financial resources are obtained, and other resources are effectively leveraged, in order to positively support the achievement of established educational goals and objectives.	Princeton Elementary School garnered financial support and was able to provide substitute coverage for the teachers on study group days. Without this financial support, the project would not have been possible.



The project was designed to improve the learning of the struggling math students whether they are receiving special education services or have been brought up to the Instructional Support Team (IST) due to their lack of effective progress in math. The researcher aimed to help teachers step away from parallel and “drop-in” models of inclusion for math instruction and encourage more collaboration in class between the regular education teacher and the special education teachers. In addition, by focusing on the “essential” skills, teachers could focus the reinforcement opportunities with support staff and parent volunteers on skills that were deemed to be “secure” by the end of the year rather than reinforcing extraneous skills that students only needed to be “exposed” to at this level.

### The Study

As stated previously, the leadership project was comprised of a three-tiered professional development opportunity for the teachers. The first component was a new design of the faculty meetings as one-hour professional development sessions focused on math content and pedagogical approaches. The second component was the study group initiative, which entailed teachers being able to meet in grade level groups to identify the essential skills within the curriculum, plan tiered lessons to meet the needs of all learners, and to analyze student work collaboratively. The third component consisted of all of the study group members keeping a reflection journal. The journal was used to record the teachers’ learnings throughout this process with regard to their observations of student performance as well as reflections about their own teaching of mathematics.

### *Faculty Meetings*

According to the teachers' contract, the teachers are expected to attend a one-hour faculty meeting each month. The agenda of the faculty meetings have typically included announcements, discussion of administrative issues, upcoming events, and at times, recognition of staff members. From time to time, faculty meetings have included discussions of a recently published article or working collectively to construct a vision or mission statement. Faculty meetings have not typically been used with the sole purpose of providing professional development at Princeton Elementary School or in the district as a whole. This novelty led to some complications, which will be discussed later in the chapter as well.

Each of the 31 members of the faculty (the original 23 classroom teachers plus the specialists) were provided with a binder labeled "Math Strategies That Work" and included six pre-tabbed sections: Agendas, Summaries, Readings, Case Studies, Vocabulary, Session Notes and Work Samples. According to the contract, the researcher could not expect the faculty to spend time in advance of the meeting to complete readings. However, many did take advantage of the readings provided on their own time, even when they were not given time to read the articles during the meeting. Table 6 identifies the planned agenda for each meeting over the course of one year and the report of what actually occurred during the faculty meetings with the entire PES teaching staff.

Table 6  
*Faculty Meeting Content*

<b>Month</b>	<b>Planned Agenda</b>	<b>Actual</b>
September	<p><b>I. Review of goals</b></p> <p><b>II. Strategies That Work –</b>            Review of survey responses regarding instructional strategies used in reading and math to differentiate effectively</p> <p><b>III. Discussion –</b> Which strategies that are effective in differentiating instruction in ELA can transfer to the teaching of Mathematics?</p> <p><b>IV. Voluntary Assignment –</b>            Read the excerpt from Tomlinson regarding the ways in which to differentiate for content, process, or product. Choose a new strategy to differentiate and report out at the next faculty meeting.</p>	<p><b>I. Review of Goals –</b> District goals, school goals, and initiative goals were discussed</p> <p><b>II. Strategies That Work –</b> The faculty identified similarities and differences between the responses for ELA and Math.</p> <p><b>III. Discussion –</b> The faculty discussed how 14/21 respondents identified small group instruction as an effective ELA strategy and only 7/14 respondents identified small group instruction as an effective strategy for teaching mathematics.</p> <p><b>IV. Voluntary Assignment-</b>            Distributed.</p>
October	<p>Assigned optional readings (<i>Teaching to the Minds of Boys</i> (King and Gurian, 2006) and <i>Orchestrating Multiple Intelligences</i> (Moran, Kornhaber, &amp; Gardner, 2006).</p> <p><b>I. Mental Math Warm-up –</b>            (How are the numbers 8, 20, 1,000, 22, 12, 10 related?)</p> <p><b>II. Assignment Update –</b>Sharing progress in small groups.</p>	<p>Assigned optional readings (<i>Teaching to the Minds of Boys</i> (King and Gurian, 2006) and <i>Orchestrating Multiple Intelligences</i> (Moran, Kornhaber, &amp; Gardner, 2006).</p> <p><b>I. Mental Math Warm-Up.</b> One faculty member discovered that they were all ways to represent the number 8. Discussion ensued over how the binary system works.</p> <p><b>II. Assignment Update -</b> Faculty discussed progress in five cross-grade groups.</p>

<b>Month</b>	<b>Planned Agenda (Cont.)</b>	<b>Actual (Cont.)</b>
October	<p><b>III. Place Value Activity</b> – Faculty participates in “trading” activity, but in base 3, 4, and 6.</p> <p><b>IV. Discussion</b> – What were the difficulties experienced in the “trading” activity?</p> <p><b>V. Voluntary Assignment</b> –  <u>Option 1</u> Using the student inventory, design a lesson catering to the multiple intelligences.  <u>Option 2</u> – Review the case studies. Are any of your students making similar errors to those in the case studies?</p>	<p><b>III. Place Value Activity</b> –Some groups took turns for this activity, some groups chose two to “play” and the others observed. Both were effective.</p> <p><b>IV. Discussion</b> - During the “trading” activity, teachers identified problems that students might be having: face value v. place value, remembering when to trade, decomposing large numbers, the concrete manipulatives were a necessity, more practice was needed.</p> <p><b>V. Voluntary Assignment</b> - Distributed assignment as well as samples of student interest inventories.</p>
November	<p><b>I. Warm-up Activity</b> – Mental Math -3 levels to choose from.</p> <p><b>II. New <u>Everyday Math</u> Features</b> – Math specialist to train teachers on using all of the features of the newest edition of <u>Everyday Math</u>.</p> <p><b>III. Group Activity</b> –Faculty participates in hands-on activity involving money.</p>	<p><b>I. Warm –Up Activity</b> – Faculty chose a level of mental math to complete. The same strategy can be used with students to differentiate based on ability.</p> <p><b>II. New <u>Everyday Math</u> Features</b> – Math Specialist reviews the components. Teachers learn how to use “Part III” to differentiate based on ability (extension or reinforcement) and language needs for ELL students.</p> <p><b>III. Group Activity</b> – Math specialist modeled one lesson to show the faculty each part of the lesson in action.</p>

<b>Month</b>	<b>Planned Agenda (Cont.)</b>	<b>Actual (Cont.)</b>
November	<p><b>IV. Discussion</b> – Math Specialist to provide a Q &amp; A session for staff.</p> <p><b>V. Exit Slip</b> – Modeled the use of an exit slip to reinforce the importance of reflection on what the students are learning.</p>	<p><b>IV. Discussion</b> – Faculty members asked the math specialist questions about the new edition.</p> <p><b>V. Exit Slip</b> – In addition to modeling the use of an exit slip, several samples of different types of exit slips were distributed.</p>
December	<p><b>I. Mental Math</b> – Review of Multiple Intelligences. Faculty members identify their own preferences for problem solving (Canoe Problem)</p> <p><b>II. Assignment Update</b> – Teachers would share their results for the assignments given in October.</p> <p><b>III. Activity</b> – Teachers would be involved in identifying the different strategies that three students used in solving the same addition problem.</p> <p><b>IV. Discussion</b> – Related to the article <i>Using Knowledge About How Students Think About Mathematics</i> (Peterson, Fennema, &amp; Carpenter, 1988).</p>	<p><b>I. Mental Math</b> – Distributes Canoe problem. Faculty solved it using their preferred strategy: small groups or independently. Brief discussion ensued regarding the preferred problem solving approaches with faculty and how the students may have different preferences.</p> <p><b>II. Assignment Update</b> – Two teachers shared a place value lesson incorporating art. In addition to employing multiple intelligences, the lesson could be differentiated by ability by changing the value of the numbers to be represented.</p> <p><b>III. Activity</b> – Teachers looked at the work of the three students and volunteers talked the other faculty members through each step of the students’ procedures. The strategies were labeled as “counting up”, “combining” and “adjusting”.</p> <p><b>IV. Discussion</b> – Teachers reflected upon the following questions individually: What addition strategies could be used to solve the problem? How would the strategies differ with different numbers (15 and 18)? How can we make the strategies accessible for different learning styles?</p>

<b>Month</b>	<b>Planned Agenda (Cont.)</b>	<b>Actual (Cont.)</b>
December	<p><b>V. Voluntary Research Assignment</b> - Identify the different subtraction strategies that your students are using.</p>	<p><b>V. Voluntary Assignment</b> - Distributed.</p>
January	<p><b>I. Warm Up Activity</b> – Write down as many verbs as you can to describe what your students are <b>doing</b> in your class during math.</p> <p><b>II. Activity</b> – Teachers involved in analyzing three (fictional) students’ strategies for subtraction. (Chapin &amp; Johnson, 2006, p.46.)</p> <p><b>III. Discussion</b> – Teachers identify strengths and weaknesses of the various strategies.</p> <p><b>IV. Exit Slips</b> – Teachers finish one of the sentence starters: I learned..., I shared..., or I am wondering about...</p>	<p><b>I. Warm-up Activity</b> – evaluating, listening, disagreeing, adding, estimating, questioning, conversing, acting it out, proving, sequencing, gluing, raising hand, observing, modeling, sharing, moving, planning, clarifying, trading, writing, solving, calculating, helping, building, learning, graphing, measuring, thinking, discussing, analyzing, counting, processing, categorizing, grouping.</p> <p><b>II. Activity</b> – Teacher volunteers led the other faculty members through the different procedures that the three students used to solve the same subtraction problem. (Compensating, adding to both sides, adding on)</p> <p><b>III. Discussion</b> – During the sharing session, one teacher explained that she had learned to subtract like “Louis” did in his example when she was growing up in another country. She explained how it made more sense than the “borrowing” procedure or the traditional algorithm. Several teachers decided to try this strategy with students who were finding the traditional algorithm difficult to use.</p> <p><b>IV. Exit Slips</b> – Exit slips were completed by the teachers. Many teachers listed that they learned new strategies themselves by listening to the discussions and were reflecting on what strategies their students are using and are finding successful.</p>

Month	Planned Agenda (Cont.)	Actual (Cont.)
February	<p><b>I. Mental Math Warm Up</b></p> <p><b>II. Grade Level Updated Action Plan</b></p> <p><b>III. State of Student Progress with Essential Skills (What is working? What is not working? What is needed?)</b></p> <p><b>IV. Upcoming</b></p>	<p><b>I. Mental Math Warm Up</b>– Share the individual journals that students can make easily for math warm up activities each week.</p> <p><b>II. Grade Level Updated Action Plan</b> - The Action Plans were updated and reflected the difficulties students encountered on the recent state test. The updated Action Plans were forwarded to each teacher after they were created on the computer following the meeting.</p> <p><b>III. State of Student Progress with Essential Skills –</b>  <i>What is working:</i>            *Teacher Open Response problems with the rubric and sample answers.            *Small group instruction            *Connecting Minute Math to the students’ lives            *Computer games related to their levels.            *Rotating manipulatives (personalizing)  <i>What is not working?</i> (Nothing)  <i>What is needed?</i>            Kindergarten needed more overhead manipulative kits. Other grades did not request any additional materials.</p>
March	<p><b>I. Math Warm-Up</b></p>	<p><b>I. Math Warm-Up</b> – List a “math” example for the reading comprehension strategies currently being used: Making Connections, Ask Questions, Draw Inferences, Distinguish Important from less important, Synthesize Information, Monitor Understanding.</p>

Month	Planned Agenda (Cont.)	Actual (Cont.)
March	<p><b>II. <i>The Thought-Filled Curriculum</i></b> (Costa, 2008.)</p> <p><b>III. Making Thinking Visible (MYST)</b> (Perkins, 2003.)</p> <p><b>IV. Looking at Student Thinking (LAST)</b> (Perkins, 2003.)</p> <p><b>V. Exit Slip (CSI)</b> (Perkins, 2003.)</p>	<p><b>II. <i>The Thought-Filled Curriculum</i></b> Time was allotted for the reading of <i>The Thought-Filled Curriculum</i>. Groups created a visual for their assigned paragraph to convey the essence of its meaning.</p> <p><b>III. Making Thinking Visible</b> – Due to time constraints, this was saved for the study groups in April.</p> <p><b>IV. Looking At Student Thinking</b> - Saved for April Faculty meeting.</p> <p><b>V. Exit Slip</b> – Faculty use Color-Symbol-Image to share what they learned</p>
April	<p><b>I. Math Warm-Up</b></p> <p><b>II. Review of Math Problem from March</b></p> <p><b>III. Looking At Student Thinking (LAST)</b></p> <p><b>IV. Exit Slip</b></p>	<p><b>I. Math Warm-up</b> – Review of MYST. (Me-how do I make my thinking visible. You-How do I make my students’ thinking visible? Space – how is the space in the classroom organized to help facilitate thinking? Time – how do I give thinking time?)</p> <p><b>II. Review of Math Problem from March</b> from “Fostering Mathematical Thinking”. Open-ended example elicited algebraic representation of the problem from staff.</p> <p><b>III. Looking At Student Thinking</b> – Using the “fishbowl” method, volunteers from the study groups stepped forward to model the use of the LAST protocol using work samples from a few second graders.</p> <p><b>IV. Exit Slip</b> – Staff recorded their reflections on the possible use of the LAST protocol at grade level meetings to provide a structure for analyzing student work.</p>



<b>Month</b>	<b>Planned Agenda (Cont.)</b>	<b>Actual (Cont.)</b>
May *	<p><b>I. Warm up</b></p> <p><b>II. Sharing Session</b> (What strategies have you tried? What strategies were successful?)</p>	<p><b>I. Field Day</b></p> <p><b>II. Placement</b></p> <p><b>III. Flexible Spending Account</b></p>
June	<p><b>I. Assemble Math Strategies Handbook for each grade.</b> Each grade level would create an FAQ formatted collection of suggestions related to trouble areas, specific lessons and units, skills and concepts, and would list the strategies that the “resident experts” had found to be successful.</p>	<p><b>I. Announcements</b></p> <p><b>II. Study Group Presentations</b> Each grade level presented the strategies that they tried, identified what had been successful, and shared samples of tiered lesson plans that worked to aid in planning differentiated lessons. (May’s Agenda)</p> <p><b>III. Surveys</b> The staff completed a grade level survey regarding the implementation of the newest edition of <u>Everyday Math</u> as well as an individual online survey related to the professional development they were involved in as part of this study.</p>

In May, as the information provided in Table 6 indicates, the content of the Faculty Meeting was diverted from the math focus. Instead, it was devoted to issues relating to the upcoming Field Day that needed to be addressed with the entire staff. Due to contractual restraints, the agenda related to the project had to be postponed. It was intended that the staff would be provided with time at the May Faculty Meeting to report out to the whole faculty about the strategies that their group had found to be successful in order to meet the needs of every student. The May agenda items were addressed at the

June Faculty Meeting in order to provide closure for the year and to honor everyone's efforts throughout the project.

For each month that the faculty member attended the faculty meeting they received 1 Professional Development Point (PDP). The idea being that if the teacher attended all ten meetings, the teacher would receive 10 PDPs in the area of mathematics, which would count towards their recertification. Forty-two percent (42%) of the faculty members received a certificate for 10 PDPs for their participation in the faculty meeting professional development sessions which can count towards their re-certification. Ninety-four percent (94%) of the faculty received 8 or more PDPs. There were two faculty members that were out on extended leave and were not able to attend all of the sessions. Study Group Participants were eligible to receive up to 30 PDPs for their work in the embedded professional development portion of the project. Every study group participant participated in a total of at least 38 of the possible 40 contact hours for the faculty meeting sessions and the study group sessions. While not every faculty member was present for every faculty meeting, all of the study group members were present for all of the study group sessions. Their commitment to attend the study groups and to their colleagues suggests that the embedded professional development portion was a valuable experience. This will be explored further by analyzing their responses in their reflection journals.

### *Study Groups*

The second component of the professional development was the opportunity for grade levels to meet in study groups. Out of the 31 teachers on staff, 26 teachers had

already reached “professional status”. Thirteen out of the 26 teachers elected to participate in the study group sessions. The study groups were embedded within the school day, which consisted of six hours and 20 minutes. There were four study groups per day, one for each grade level Kindergarten, First Grade, Second Grade, and Third Grade. Each study group met for 90 minutes at each session. The format of the study groups varied. At times, the study groups were assigned a task or led through a procedure, such as the Looking At Student Thinking (LAST) protocol, and at other times, the group worked together to break down specific units and lessons in order to infuse additional strategies within the lesson to target the needs of all of the students in the classroom. While not every lesson needed to be planned using a tiered lesson, the teachers were charged with identifying the essential skills for their grade and differentiating lessons that targeted those essential skills to ensure that every student in their class had appropriate and sufficient opportunities to learn the essential skills by the end of the year. The researcher took notes of the conversations that occurred as well as questions that were asked during the meetings. At times, the study groups met without the researcher. During these times, one of the participants took notes during the session and provided the researcher with a summary of what was accomplished and potential goals for the next meeting.

### *Reflection Journals*

Study group participants documented their reflections through the year by recording their thoughts in a journal. The purpose of the reflection journal was to raise

the awareness level of the participants regarding the ways in which they successfully differentiate mathematics instruction to meet the needs of all of their students. The journals included reflections about strategies that were shared during the faculty meetings, reflections regarding the collaborative planning and analysis of student work, and finally the reflections of their own growth as a teacher of mathematics.

The remainder of Chapter 4 will be devoted to reporting the findings within each data collection method as they relate to each of the four research questions:

1. What did teachers learn about math content and pedagogy to help special needs children meet standards-based proficiency in math?
2. What were the most helpful components of the professional development program that promoted teachers' learning?
3. Which of the newly employed strategies did teachers perceive worked the best?
4. What were the challenges of implementing the embedded professional development?

The leadership project was conducted as a two-tiered study. One part involved the entire faculty who participated in redesigned faculty meetings. The other part consisted of a volunteer sample of thirteen teachers who, in addition to participating in the faculty meetings, participated in study groups twice a month where they followed through with applications of ideas and strategies presented at the faculty meetings and who kept a journal of their learnings throughout the year. The findings were derived from the data related to the whole faculty and data related to the volunteer sample.

The findings collected will be reported in the following order:

- \* Pre and post implementation survey (whole faculty)
- \*Interviews before and after the project’s implementation (study group participants)
- \*Teachers’ reflective journals (study group participants)
- \*Researcher’s observations during faculty meetings and study groups
- \*Artifacts from study group sessions and faculty meeting workshops
- \*Researcher’s Field Notes

## Findings

### *Pre-implementation and Post-implementation Surveys*

The pre-implementation and post-implementation surveys were distributed to the 31 teachers who comprise the teaching faculty at Princeton Elementary School. Table 7 provides information regarding the sub-sample of the faculty that participated.

Table 7  
*Pre and Post Implementation Survey Demographics*

	Pre-Implementation Survey	Post-Implementation Survey
Kindergarten	9.5%	12.5%
First Grade	19.0%	18.8%
Second Grade	23.8%	25.0%
Third Grade	19.0%	18.8%
Multiple Grades	28.6%	25.0%
	Pre-Implementation Survey	Post-Implementation Survey
Less than a year of experience	0.0%	6.3%
1-3 years of experience	14.3%	6.3%
4-10 years of experience	23.8%	37.5%
10 + years experience	61.9%	50.0%

The percentages indicate the percentage of staff represented for each grade level out of the total number of respondents. The survey was administered through an online service called *Survey Monkey* (<http://www.surveymonkey.com/>) and included fourteen questions. Twenty out of the possible 31 respondents completed the pre-implementation survey (65% return rate). Sixteen of the possible 31 respondents completed the post-implementation survey (52% return rate). Although the surveys were completed anonymously, some demographic information was collected and can help to describe the sub-sample of the faculty that participated in the survey.

While the sample did not exist of exactly the same people before and after the implementation, the percentage of the different grade level teams was fairly consistent, with a difference of a small range of only 0.2% to 3.6%. The majority of respondents had achieved professional status in both samples with 85.7% in the pre-implementation sample and 87.5% in the post-implementation sample. With representation from each grade level and with the majority of the respondents falling into the “veteran” category, the responses on the surveys provide information regarding the trends in the instruction at Princeton Elementary as well as evidence of the impact of the implementation of a new professional development opportunity.

A considerable amount of data was collected through the pre and post implementation surveys. The findings based on the responses to the fourteen questions asked (See Appendix A) are reported following each research question.

*Research Question 1: What did teachers learn about math content and pedagogy to help special needs children meet standards-based proficiency in math?*

While the survey directly asked the teachers which professional development components they perceived had the greatest positive impact on student success in math, by analyzing a few of the responses to the other survey questions, other positive changes could be gleaned as well. The other survey questions regarding content and pedagogy knowledge that could ensure that students with special needs would gain the essential skills, included one regarding the types of differentiation teachers employ in reading and math as well as the types of assessments teachers use and the extent to which they use the information gleaned from the assessments to inform future instruction. While 71.4% of the teachers reported that they perceived a benefit from the math topics discussed at the faculty meetings, evidence of the impact is seen by comparing the responses from the pre-implementation survey and the post implementation survey and looking for the changes in the instruction. The researcher was also looking for examples of successful instructional practices that teachers employ for the teaching of language arts that could be transferred to the teaching of mathematics. Since there was a simultaneous focus in the district of employing strategies that work for reading, there were changes to both reading and math instruction over the course of this year. Table 8 displays the common responses regarding the strategies used for reading and math and compares the pre-implementation survey data to the post-implementation survey data. The number of responses for each strategy is listed as well as the percentage of the responses for these common strategies. When there was only one response from both surveys, the difference was not calculated.

The percentage calculation of one response out of 16 and one response out of 21 will automatically be different. With such a small sample, it would not be statistically significant to look at the percentages as true indications of increases or decreases in the use of the strategies when the number of responses (one) is constant. However, the data can provide information regarding a general trend of usage.

Table 8

*Common Differentiated Instruction Strategies for Reading and Mathematics*

	Reading Instruction Strategies				Math Instruction Strategies			
	Pre	%	Post	%	Pre	%	Post	%
<b>Differentiate topics by interest</b>	2	9.5%	6	37.5%	0	0.0%	6	37.5%
<b>Small groups (by ability-homogeneous)</b>	14	66.7%	8	50.0%	8	38.1%	10	62.5%
<b>Mixed ability grouping (heterogeneous)</b>	1	4.8%	3	18.8%	1	4.8%	0	0.0%
<b>Differentiate end products</b>	4	19.0%	1	6.3%	7	33.3%	6	37.5%
<b>Questioning at various levels</b>	1	4.8%	1	6.3%	1	4.8%	1	6.3%
<b>Differentiate to learning style strengths</b>	1	4.8%	1	6.3%	3	14.3%	6	37.5%

Over the course of the year, teachers learned about other ways to differentiate their instruction and they were able to identify some strategies that they had found to be successful in reading, such as instructing students in small groups, that could be transferred into math instruction in order to meet the needs of all learners. In reading, there was an increase in the teachers' use of mixed ability groups and leading small groups based on the students' interests.



Over the course of the year, there were several changes in the strategies teachers were using to differentiate instruction in math. According to the pre-implementation survey, teachers were not differentiating by allowing students to engage in topics of their interest. By the end of the year, six of the sixteen teachers reporting (37.5%) noted that they found that differentiating by interest was indeed a successful strategy. There was also an increase in the number of teachers who were employing “guided math” groups where they provided small group instruction based on students ability. Although some teachers were already using some small group instruction for math, by the end of the year, more teachers were finding it to be a successful strategy as well. Teachers were also experimenting by using a variety of presentation styles as evidenced by their increase in the category of differentiating by learning style.

*Research Question 2: What were the most helpful components of the professional development program that promoted teachers’ learning?*

The faculty meetings were designed to provide additional background in math content and pedagogy. In order to assess the learning of the teachers from the professional development opportunities, the initial survey collected teachers’ ratings of the other professional development experiences they had had for the *Everyday Math* program thus far. On the exit survey, the teachers rated the professional development experiences they had had over the course of the year of the study. Their ratings were based on a four-point scale where a rating of “1” was the strongest positive impact and “4” was the weakest positive impact.

Table 9a

*Teachers' Perceptions of the Benefit of Previous Math Professional Development*

	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
<b>Overview with the consultant in the beginning</b>	10.5%	42.1%	42.1%	5.3%
<b>Embedded PD with the consultant during the year</b>	15.8%	21.1%	52.6%	10.5%
<b>“Everyday Math for Everybody”</b>	7.1%	64.3%	28.6%	0.0%
<b>Assessment Assistant Software</b>	6.3%	56.3%	8.8%	18.8%

The “overview” and the “embedded professional development with the consultant” were sessions where the consultant explained the components of the program. She explained that there were three parts to the lesson and made suggestions for how to manage the pacing of the program. In addition, she allowed the teachers time to explore the games that they would be using with the students to help them understand what the expectations would be for the students in the classroom. Rather than being considered professional development in the area of math, it was training on how to use the program itself and to make the most out of the planning suggestions in the manual. Looking at the positive ends of the rating scale (ratings of 1 or 2), 52.6% of the teachers surveyed perceived a positive impact for the overview while only 36.9% of the teachers perceived a positive impact from the embedded opportunities to meet with the consultant by grade level.

The other two previous professional development offerings, the Assessment Assistant software training, and “Everyday Math for Everybody” provided options for differentiating the math program to meet the needs of all students. According to the

survey, 62.6% of the teachers perceived a positive impact (rating of 1 or 2) for the training on the Assessment Assistant software. While this was a technical training and not training to enhance content or pedagogical knowledge, this training allowed the teachers to adapt assignments and assessments with greater facility by creating modified work on the computer. Teachers could change the numbers of a problem, change the quantity of the problems, and adjust the layout to match different learning needs.

The largest positive impact from previous professional development offerings was clearly from the experience with “Everyday Math for Everybody”. One of the special education teachers in the district had attended an off-site conference created to help educators differentiate instruction using a variety of manipulatives and organizational tools specifically designed to improve the access to the curriculum for students with special needs. This teacher then presented the information she had learned and demonstrated the use of the new tools to the regular education and special education teachers in North Edison during an early release professional development day. Out of the teachers surveyed, 71.6% of the teachers perceived a positive impact on the students’ success with the math concepts and skills. The teacher who facilitated that session abstained from rating on the survey. Otherwise, the percentage of perceived positive impact would have been even greater than the 71.6% reported. This session broke down individual skills and introduced alternate pedagogy for introducing the concepts and skills and provided an introduction to the teachers on alternate manipulatives, games, and visual supports that would meet the needs of various learning styles.

Teachers responded most positively to this session run by one of their colleagues. In summary, the teachers perceived the largest positive impact when they were shown practical strategies that could be used in the classroom with their students right away. They were also given time at these sessions to use the materials and gain comfort with them before being asked to use them in their classroom or spend time beyond the construct of the “work day”.

Table 9b displays the teachers’ perceptions of the positive impact of the various professional development components provided during the course of the year long study.

Table 9b

*Teachers’ Perceptions of the Benefit of the Professional Development Initiative*

	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>N/A</b>
<b>1. Exploration of math topics at Faculty Meetings</b>	0.0%	71.4%	21.4%	0.0%	
<b>2. Opportunities to share examples of differentiation with colleagues</b>	40.0%	33.3%	20.0%	0.0%	6.7%
<b>3. Readings</b>	0.0%	42.9%	50.0%	7.1%	0.0%
<b>4. Handouts</b>	0.0%	46.2%	46.2%	7.7%	0.0%
<b>5. Grade Level Study Groups</b>	46.7%	13.3%	0.0%	0.0%	40.0%

Teachers reported a similar positive impact rating (rating of 1 or 2) of the exploration of math topics at the faculty meetings (71.4%) and for the opportunities to share examples of differentiation with their colleagues (73.3%). However, 40% of the teachers surveyed perceived the opportunity to share “what is working” in terms of differentiating as having the strongest impact. The teachers who reported in the “N/A” category were not

participating in the study groups this year. What is even more striking then is the positive impact of the Grade Level Study Groups that were embedded within the school day twice per month. Table 9b shows that 60% of the teachers reporting on the survey perceived a positive impact on their students' success. The other 40% of the staff who were not involved in the study groups responded in the "N/A" category. Therefore, 100% of the 13 teachers who participated in the embedded study groups perceived a positive impact on their work with students. The implications of these findings will be further discussed in Chapter 5.

*Research Question 3: Which of the newly employed strategies did teachers perceive worked the best?*

The previous two sections collectively answer this research question. There were new strategies employed promoting teachers to reflect on their practice of mathematics instruction and there were also new strategies that they employed in their classroom as a result of that reflection. By reviewing the data from Table 8, teachers perceived that small group instruction promotes students' understanding of mathematics skills and concepts. Depending on what concept or skill was the current focus, teachers grouped by ability, interest, or learning preferences and found that guided math groups, just like guided reading groups, provide a structure that enable teachers to cater to the individual needs of the children in their classroom therefore promoting success for their class in gaining the grade-level essential skills. More information regarding lesson-specific

strategies were recorded in the teachers' reflection journals which will be discussed later in this chapter.

The previous section regarding the different professional development components highlighted the teachers' positive perception of the experience in the faculty meetings, sharing opportunities, and the study groups. These were structures for which time was provided during contractual hours. The additional readings and handouts, which required teachers to invest time outside of the contractual hours, received mixed responses with less than 50% teachers reporting a perceived benefit to the readings (42.9%) and the handouts (46.2%).

*Research Question 4: What were the challenges of implementing the embedded professional development?*

One large unanticipated challenge was the disapproval of the Teachers' Union in changing the format of the faculty meeting from a general meeting to a professional development session. The researcher had surveyed the staff during a faculty meeting the previous year to ask for their support. None of the teachers at that time came forward to voice their disapproval, so the union involvement came as a surprise.

After surveying the staff before the October faculty meeting, the researcher garnered the support of the staff and the Union to proceed with this format for the year of the study only. The teachers agreed in order to support the researcher's own educational pursuits. This will be addressed in detail in the section regarding the findings from the

faculty meeting sessions themselves, but the last question on the exit survey addressed this issue directly.

The question was:

Imagine that there is a school that holds 10 faculty meetings a year.

That same school uses those faculty meetings to focus on the study of a different curriculum area each year. As a result, the teachers who participate in the faculty meetings receive 10 PDPs for each of the five curriculum areas they teach. If this type of opportunity were available to you AND it was supported by the other policy-making structures in your district, would you want to take advantage of this type of free professional development opportunity.

In response to this question, twelve of the sixteen respondents for the exit survey said that they would take advantage of this type of professional development and listed the following as strengths:

- \* “The good thing about doing it, is that everyone will be recertified”
- \* “It seems like an easy way to learn over time, integrate ideas into the classroom AND get PDPs easily.”
- \* “It provides the opportunity to look at curriculum and children's work in other classrooms it also provides time to talk solely on a particular aspect of the curriculum with colleagues”

\* “The knowledge we got out of the meetings this year was very useful in helping to drive instruction for all of our students.”

\* “It makes getting PDP's so much easier. Often times, it is hard to find worthwhile workshops and classes to take that will provide you with skills and ideas to use in the classroom. At least this way, what is being discussed/learned is part of the NEPS curriculum so we know it is relevant.”

There were four teachers out of the sixteen who said that they preferred the format where there were general announcements about upcoming events and issues were brought up and discussed as a whole school. The researcher did provide a time each Friday morning to meet with a representative of every team to discuss any issues that arose, but this did not fill the void for those who wanted every issue to be addressed by everyone at the faculty meeting.

Even among those who agreed that they would take advantage of a future professional development offering during faculty meetings, there were drawbacks cited:

- “The congeniality of the staff is lost”
- “I feel like without regular staff meetings we kind of lose contact with each other and with what is going on in our school.”
- “I did learn this year but it was not a personal choice. I would rather take a course on my time.”

In Chapter 5, the implications of the strengths and weaknesses of providing professional development sessions during faculty meetings will be discussed further.



*Participant Interviews*

Each of the thirteen teachers who participated in the study, were interviewed before the project began and after it was completed (Appendix B). Each interview was videotaped and transcribed. The benefit of conducting an individual interview in addition to the online survey was that participants provided answers that were considerably more in-depth than what the typical respondent would comment on for a survey. The subjects provided the researcher with additional data in response to the four research questions.

*Research Question 1: What did teachers learn about math content and pedagogy to help special needs children meet standards-based proficiency in math?*

Table 10 displays the changes in the teacher responses by comparing the pre-implementation interview remarks with those provided during the exit interview regarding the strategies used during math lessons. The new strategies employed are highlighted in bold print.

Table 10  
*Teacher Interview Responses Before and After Implementation*

	<b>Initial Interview</b>	<b>Exit Interview</b>
Alice	*Large group instruction *Hands on practice *Questioning to bring learning further	*Large Group * <b>Differentiated activities for low, middle, and high students.</b> * <b>Pairing visuals with the auditory</b>
Beth	*Whole group *Small groups of 3 or 4 *Whole group for summary/discussion	*Whole group *Small group ( <b>practice with parent volunteers or staff</b> ) * <b>Groupings with same-ability peers</b> *Whole group sharing ( <b>pairing up to share strategies with partners of mixed-ability</b> )

	<b>Initial Interview</b>	<b>Exit Interview</b>
Carrie*	<ul style="list-style-type: none"> <li>*Three small groups led by adults</li> <li>*Manipulatives available as needed</li> <li>*Follow up activity or homework</li> </ul>	<ul style="list-style-type: none"> <li>*<b>Whole group</b></li> <li>*Adult-led groups (<b>grouped by interest or ability</b>)</li> <li>*<b>Whole group sharing</b></li> </ul>
Dori	<ul style="list-style-type: none"> <li>*Whole group presentation</li> <li>*Students demonstrate knowledge with preferred style (paper &amp; pencil, demonstrating with manipulatives)</li> <li>*Whole group sharing</li> </ul>	<ul style="list-style-type: none"> <li>*Whole group presentation</li> <li>*<b>Small groups (grouped by interest or ability)</b></li> <li>*Whole group sharing</li> </ul>
Eda	<ul style="list-style-type: none"> <li>*Warm up/Mental Math/Whiteboard</li> <li>*Whole group introduction to objective and vocabulary</li> <li>*Students practice skills in journals</li> <li>*Teacher corrects journals and distributes homework</li> </ul>	<ul style="list-style-type: none"> <li>*Warm up/Mental Math/Whiteboard</li> <li>*Whole group</li> <li>*<b>Game/Activity introduced (using modeling and guided practice—usually in pairs or small groups)</b></li> <li>*Students practice on paper or in book</li> <li>*<b>Group sharing</b></li> <li>*<b>End with Math Boxes</b></li> </ul>
Fran	<ul style="list-style-type: none"> <li>*Review/Warm up/Whiteboards</li> <li>*Whole class instruction</li> <li>*Follow up activity (modify as necessary)</li> <li>*Homework to provide practice and communication to parents</li> </ul>	<ul style="list-style-type: none"> <li>*Whole group</li> <li>*<b>Small group instruction</b></li> <li style="padding-left: 20px;">-using different modalities</li> <li style="padding-left: 20px;">-changing numbers as needed</li> </ul>
Greta*	<ul style="list-style-type: none"> <li>*Whole group</li> <li>*Small groups (flexible groups—student members may change depending on the topic)</li> <li>*Whole group</li> </ul>	<ul style="list-style-type: none"> <li>*Whole group</li> <li>*Small groups (<b>by ability with manipulatives, visuals, and varied presentations</b>)</li> </ul>
Holly*	<ul style="list-style-type: none"> <li>*Whole group (introduce objective and vocabulary)</li> <li>*Small groups by ability</li> <li>*Whole class review of the lesson</li> </ul>	<ul style="list-style-type: none"> <li>*<b>Centers</b></li> <li>*<b>Flexible groups at each center.</b></li> <li>*<b>All students rotate to all centers (activities for each center/skill vary depending on the students' needs.)</b></li> </ul>
Ilene	<ul style="list-style-type: none"> <li>*Whole group introduction with open-ended question</li> <li>*Student exploration of the skill/concept</li> <li>*Whole group sharing</li> </ul>	<ul style="list-style-type: none"> <li>*<b>Adapt whole lessons to account for differences in ability and learning style.</b></li> <li>*<b>Small group instruction with adult support (Akin to Lang. Arts model)</b></li> </ul>

	<b>Initial Interview</b>	<b>Exit Interview</b>
Jen*	<ul style="list-style-type: none"> <li>*Whole group – introduce objective</li> <li>*Review previously taught skills in preparation for the day’s lesson</li> <li>*Teacher-directed activity or student exploration</li> <li>*Small group practice with manipulatives as needed</li> </ul>	<ul style="list-style-type: none"> <li>*Whole group introduction</li> <li>*Small groups (<b>grouped by ability, interest, or content/material</b>)</li> <li>*Review of skill/reinforcement</li> <li>*<b>Informal assessment of how students performed.</b></li> </ul>
Kelly	<ul style="list-style-type: none"> <li>*Whole group (assess prior knowledge and introduce objective and vocabulary)</li> <li>*Hands-on practice in homogeneous or heterogeneous groupings (using manipulatives and visuals)</li> <li>*Assess understanding by asking questions</li> </ul>	<ul style="list-style-type: none"> <li>*Whole group (introduce objective)</li> <li>*Small group reinforcement</li> <li>*<b>Whole group sharing</b></li> </ul>
Lori	<ul style="list-style-type: none"> <li>*Whole group introduction</li> <li>*Practice on board or in journals</li> <li>*Students work towards independence</li> </ul>	<ul style="list-style-type: none"> <li>*<b>One lesson in two parts or over two days</b></li> <li>*Whole group introduction and practice</li> <li>*<b>Small group practice (grouped by ability)</b></li> </ul>
Macy*	<ul style="list-style-type: none"> <li>*Whole group demonstration, introduction of objective</li> <li>*Three small groups by ability</li> <li>*Whole group sharing</li> </ul>	<ul style="list-style-type: none"> <li>*Whole group introduction of objective</li> <li>*Small groups (<b>grouped by interest or ability</b>)</li> <li>*Whole group sharing/wrap up</li> </ul>

Based on the responses to the interview questions, the teachers responded more often with regards to pedagogy and using differentiated instruction practices in particular. Although several teachers made comments on the survey that the faculty meeting sessions were helpful and they “learned a lot”, the content of the meetings other than differentiated instruction and multiple intelligences was not mentioned.

According to the teacher responses during the exit interview, each teacher who participated in the study groups, believed that small groups were essential to an “ideal” math lesson. It is interesting to note that Carrie, Greta, Holly, Jen, and Macy listed small group work as an essential part of the lesson before the implementation as well. All five teachers are involved in “inclusion” classes. Inclusion classes at Princeton Elementary denotes a classroom where there are 6-8 students with Individualized Education Programs. Typically, during Language Arts and Mathematics blocks, the classroom teacher and special educator or their assistant will work together in the classroom. By having more than one person in the room, small groups are managed more easily. Not every classroom has the benefit of additional support in the room during mathematics. Regardless of whether the room had “official” support in the room or not, teachers saw the benefit of working in small groups. In chapter 5, there will be a discussion of how to make guided math groups possible in all classrooms as opposed to a select few.

Four of the teachers also mentioned grouping students into small groups based on interest in addition to ability. While grouping by ability was more prevalent, teachers saw the value in grouping students based on interest. By activating their natural curiosity and eagerness to explore a topic of interest further, students were more engaged and benefited from the experience. Lori noted:

“One thing that was new to me, differentiating by interest level which was not something I...I didn’t typically think of differentiating that way. Pretty much what I had thought of in the past was differentiating by ability level only. And I do think that’s a good portion of it. But like using the explorations and things this year, I’ve noticed differentiating by interest level actually is very good. And by just giving them a choice, it makes it a little more fun for them. They’re choosing what they get to do for math.”

Several teachers (Alice, Greta, and Ilene) noted in the exit interview that they were taking into account the preferred learning style of the students. Either pairing visuals with the auditory or providing additional materials or manipulatives, these teachers were changing their presentation methods based on the strengths of the students. Ilene also notes, however, that sometimes she deliberately presented in ways that did not cater to the students' strengths:

“Look at each child to see where they're coming from and take them where they need to go and through the learning style that best suits them most of the time. But not all of the time, because sometimes, it's better for us to receive instruction through our non-comfort zone to make us more flexible.”

Ilene is taking into account what her students need from her in order to grow, not necessarily to “get through” a math lesson in the easiest way that they can. What has changed overall when comparing the initial interview responses and the exit interview responses is a shift from teaching the program and following through with a pre-designated lesson plan to teaching the students. Teachers are more focused on which essential skills the students need to master and they are exploring new and creative ways to help their students achieve.

During the interviews, the researcher asked the teachers to choose whether it was most important for students to understand the concept or whether it was more important for students to grasp a procedure or process for carrying out a task. Table 11 displays the data regarding their responses. The data was recorded by marking the teacher's role in the appropriate box where K, 1, 2, and 3 denote the grade level the classroom teacher was teaching and M denotes the role of teachers working in multiple grades.

Table 11

*Teacher Responses Regarding the Import of Concept v. Procedure*

	<b>Initial Interview</b>	<b>Exit Interview</b>
<b>Concept</b>	M, 2, 3, 3, 3	M, M, M, K, 1, 2, 2, 2, 3, 3
<b>Process/Procedure</b>	M, K, K, 2	
<b>Both</b>	M, 1, 2, 3	K, 3, 3

The Kindergarten teacher remarked that both are important in the exit interview. She cited that they need to understand the concept, but they need to be able to apply the process or procedure such as identifying and using patterns in math and in reading. She felt that in order for there to be carry over from one area to the other, both concept and process/procedure were important. The two Grade 3 teachers both agreed that the concept was important but mentioned two reasons for maintaining that the process or procedures were just as important. Holly explained that the students should be able to understand the concept for skills that should be secure, but they may only be able to grasp the procedure or “how” to attack the problem, if it is a newer skill that they will revisit in fourth or fifth grade. Lori explained that it depends on the concept, “ ‘Cause sometimes I think they really have to have a strong understanding. Like place value...other times, it’s more computation...lattice, or the partial sums, the partial products, as long as you can get to the answer, I’m happy.”

There was quite a large shift for the remaining teachers. The distribution of responses choosing the concept or the procedures were fairly even (5:4) during the initial

interview. There is even a mix of grades and roles in each category. During the exit interview, however, with the exception of the three teachers who claimed that both are equally important, the teachers agreed that the concept was most important for students to understand.

Following this question, the teachers were asked if the import changed as the time of the state test drew near. During the initial interview, all five teachers involved in the state testing (one special educator and four classroom teachers) responded that although they wished that it didn't change, there was more focus on making sure they can perform the tasks, even if they didn't understand it completely. Lori commented, "You do things differently, because they have to do certain things. However you can get them to do it, you do it." Kelly explained, "We're put under pressure to make sure they are exposed to everything before the test. We rush the kids and then they don't understand." Holly noted initially, "Maybe not for the kids, but for me. I try not to let it change, but when we review and I thought they knew something, and they don't," there's a sense of urgency to teach "how" to do it.

There was a shift in the thinking during the exit interview. Holly explained, "I would hope (that the focus doesn't change), but maybe for some it does. (Researcher: For you it doesn't change?) No, especially when I see their thinking. They could get the bottom one wrong, but get a, b, and c right." Kelly also expressed a change in thinking, "For the most part, what is asked (on the state test) is reasonable and they are capable of it in May with the exception of some of the SPED kids who need more time to conceptualize everything." There are some children for whom under standard test taking

practices, the state test would be too difficult. However, with accommodations such as a reference sheet or paraphrasing the question, they, too, can demonstrate success. Dori noted that the import of the concept versus the procedure did not change, “We provide practice throughout (the year) and *Everyday Math* is constantly reviewing previously taught skills. No need to stop and review how to do something.” There was less of a sense of “panic” regarding the state testing during the exit interview. Teachers seemed more comfortable in having prepared the students well in general, without specifically preparing them for one test.

While the teachers were all dedicated to making sure that they were meeting the needs of all of the learners in their classes, they mentioned some obstacles. Some of the challenges are directly related to the pedagogical approaches that they have been successful with such as providing small groups and repeated exposure to increase the opportunities to learn for all of their students. Table 12 displays the challenges teachers experienced in teaching students with special needs.

Table 12

*Challenges Teaching Students with Special Needs*

	<b>Time</b>	<b>Personnel</b>	<b>Materials</b>	<b>Language</b>	<b>Lack of confidence/ student frustration</b>	<b>Getting students to like math</b>
<b>Initial Interview</b>	6	1	2	2	4	1
<b>Exit Interview</b>	6	7	0	1	7	0



The three most common challenges that teachers experienced were the need for more time, more personnel, and reducing students' frustration and building confidence. Time was an issue. Kindergarten teachers were commenting that to do everything they would want to do in math would require a full-day program as opposed to 2 ½ hours per session. Other teachers commented that some students just need additional time to work with the concepts or skills in order to grasp them.

Appropriate classroom personnel arose as an issue since instructing in small groups effectively requires more than one adult to be present. The inclusion classes do have more support in the form of a special education teacher or an aide, but at times the service delivery schedule and the length of the math block may not be equivalent. For example, one first grade teacher's math block is an hour long, but the special education teacher is only in the classroom servicing the students for 30 minutes. While on paper, that is all that is required, it does not provide for the optimal flow of a lesson. Consistent additional support was cited as being a benefit since the support personnel would have an opportunity to get to know the children and how they function as opposed to coming in for an isolated half hour a few days per week. While a few teachers mentioned that they have parent volunteer, they were not as consistent in following through with their schedule and as a result, teachers would need to forego a lesson where there was more small group work, because they did not have the support they planned on.

The students' frustration or lack of confidence also presented a challenge for the teachers to contend with as they strove to help children with special needs reach standards-based proficiency. Teachers want to be able to help their students and as Fran

noted, it is difficult to understand what the students are thinking, “If I knew, it would be easier to modify and adapt. Sometimes, it’s hard to figure that out.” Jen put this challenge in another way, “Getting the child to feel successful when he sees others get it quickly.” There’s also a sense that they have not fulfilled their obligation to the students when the students do not understand something as Lori said, “You want them to be successful and to learn. So that’s what gets me sometimes.”

Overall, the teachers demonstrated more facility in employing a variety of strategies to differentiate the math instruction over the course of the year. In order to make these practices successful, however, changes need to be made to allow for more time to master concepts and skills and additional personnel to enable small group instruction to occur on a regular basis just as it is done in the Language Arts block.

*Research Question 2: What were the most helpful components of the professional development program that promoted teachers’ learning?*

Comments regarding the benefit of the professional development program were reported by the teachers at the end of the exit interview regarding their experience in the study group as well as the open-ended prompt when they were asked to share anything else they wanted to share about the year’s experiences. Benefits of the study group included using the LAST protocol to analyze student work and the students’ thinking behind their work, spending time together to talk about the curriculum, using the information from the study group and the discussions with peers to inform instruction.

*Using the LAST protocol.*

**Alice:** Exemplars...(we) used LAST and were able to get the other three teachers' perspectives on the thinking processes of my students as well. Also, when the lesson didn't go well, it wasn't just me—teachers planned together about finding a new way.

**Beth:** Exemplars—nice to see that my kids were doing similar things to kids in other classes. Good to talk about modifications and ways to present things and reflecting on how the students did.

**Carrie:** Reflecting on one class's work was helpful for all teachers—saw parallels with own students.

**Dori:** We were able to go over the work, especially the open responses, together. We saw where they were coming from and how to take them to the next step.

**Ilene:** LAST – Nice to get the input from other teachers of what they saw of my students.

**Jen:** Using the LAST to look at student work—even though I talked with the classroom teacher regularly the other teachers still saw things in our students' work that we hadn't seen.

**Lori:** With the open response which is new this year, we planned out how to administer it (with manipulatives, follow up problems) and then looked at the work. Holly saw something I didn't. Good to have another pair of eyes—can provide another perspective.

*Spending time with colleagues to discuss the curriculum.*

**Eda:** We looked at the results of the whole grade on the midterm. Time and money was an issue across the board. Also allowed us to look ahead and break things down in advance.

**Fran:** We noted where the difficulties were across the grade and brought it to the whole team.

**Greta:** Pooling ideas together...problem solving discussions in Kindergarten, rewriting the problem to make it meaningful for the students (knitting mittens became buying Webkins.)

**Holly:** Sharing different centers and things that worked...time devoted just to talking about math.

*Using study group discussions to inform instruction.*

**Kelly:** Good to be able to talk to your peers. When the samples were brought in it stimulated us to go back and try things and to see what other classes could do.

**Macy:** Put our heads together—what are the pitfalls? How should we start it? I have this game, let's all use it. All the sharing and pooling of ideas. Ilene brought her samples and it helped me to think more about how my students did, too.

The last open-ended question also elicited positive feedback regarding the experiences this year. Beth reported that she enjoyed working in the study groups. Carrie commented that looking ahead and planning tiered lessons together was helpful and that the LAST protocol was helpful as well. Ilene noted that , “It was helpful to have the time to differentiate the lessons. If it doesn't continue, I'm not sure of how much we've done this year will continue.” Jen also mentioned, “I hope we get to continue further with this.” Macy remarked, “I liked meeting regularly even though it was hectic and crazy to make it happen, I did find it helpful.” This challenge will be explored further under Research Question 4 in this section. The teachers benefited from the experience and their enthusiasm to continue this practice of reflecting on practices as well as student performance with their peers needed to be capitalized. As a result, Princeton Elementary continued this practice over the summer and throughout the next year, although with a different curricular focus. The follow up activities related to the study groups will be discussed in greater depth in Chapter 5.

*Research Question 3: Which of the newly employed strategies did teachers perceive work the best?*

The teachers began to reflect on the types of differentiation they habitually employ in their teaching. During the exit interview, they provided information regarding the ways in which they would differentiate by the content, process, or the product. The responses are categorized by grade level in Table 13.

Table 13

*Effective Strategies for Differentiating Instruction in Math*

	<b>Differentiated Instruction Strategies</b>		
	<b>Content</b>	<b>Process</b>	<b>Product</b>
<b>Kindergarten</b>	*changing the numbers or levels (2) *Accommodating language deficits	*more visuals *Mix of VAKT	*Product the same as designed in EDM
<b>First Grade</b>	*Same expectations of learning the skill, but use different numbers	*Multi-modal presentations	*Same product/skill (how they get there is different)
<b>Second Grade</b>	*Vary the content for individuals at different levels (Ex: change numbers) (2) *Vary content based on interest (1)	*Accommodate preferred learning style *Allow additional time to grasp concepts	*Accommodate preferred mode of output
<b>Third Grade</b>	*Alter content based on interest or ability (3) *Pre-assess to determine appropriate level	*Allow students to use different methods (2) *Vary the level of adult support given *Allow students extra time	*Products can vary depending on students' needs (2)
<b>Multiple Grades</b>	*Alter content based on ability (3)	*Allow students to use different methods (2) *Vary presentation styles. (3)	

Teachers reportedly differentiated instruction in all three ways, but there were several common recommendations. Teachers of all grades encouraged flexibility in allowing students to utilize methods and processes that are understandable and efficient for them. In addition to differentiating the processes that students use in completing a task, the teachers also advocated for flexibility in deciding how to present the material. Several teachers mention using multi-modal approaches or accommodating the students' learning style.

All of the teachers in the study recommended altering the content as needed in order to meet students' differing needs. Second and third grade teachers also recommended differentiating by interest in addition to ability. Kindergarten and First Grade teachers suggested grouping students and addressing their needs at varying ability levels. This could be because during these first two years, the teachers are focusing on students learning basic building blocks that they all need whereas in the upper grades, there may be more room for choices of the activities based on interest for further exploration. The same was true of the teachers of multiple grades. Special educators and reading specialists typically work with students who are struggling. They have limited time in the classroom to address the students' specific needs so this could explain the focus on grouping by ability as opposed to considering grouping by interest level as well.

Kindergarten and First Grade teachers also made comments regarding the need to keep students connected and motivated. While they did not mention grouping students based on their interests, they agreed that it was important for students to be interested in

what they were learning. One of the Kindergarten teachers explained that relating the “teen” number unit to the students’ lives made a difference. She and a colleague worked together to plan assignments and activities that would relate teen numbers to the world around them. They went on a teen number hunt, they worked on several estimating assignments with their families as well as other activities connected to their real lives. Alice explained, “At least three-fourths of the students by November had those teen numbers and they understood the concept moreso than just plain number cards.”

Another teacher, Eda, explained that it is the teacher’s enthusiasm that keeps kids interested in math. She explains, “When I do present something, I’m usually nauseatingly gushing like, ‘This is so awesome! This is one of my favorite things—frames and arrows! I love that kind of stuff! The function machine—I think it’s the coolest thing they ever invented!’ So it’s that oozing of excitement.” Whether it is through connections bridging school and the students’ lives, the teacher’s contagious excitement for the subject or the enticing nature of choice, all of the teachers agree that it is important for the students to be personally engaged in the activity.

*Research Question 4: What were the challenges of implementing the embedded professional development.*

Through the interviews, there were two teachers who made reference to the challenges encountered with the implementation of the embedded professional development. The first was Macy’s mention that, “I liked meeting regularly even though it was hectic and crazy to make it happen.” North Edison provides the teachers with five

half-days of professional development. At the elementary level, these days are reserved for district-wide initiatives and by having only five per year, this structure does not provide the consistent follow up that would be needed to allow the study groups to build momentum by working with each other frequently. Some districts have a half-day reserved once every two weeks. In such districts, a format such as this would be more easily implemented. Without having half-day professional days on a consistent basis, the routine at Princeton Elementary was indeed hectic. Substitutes arrived in the morning and were assigned to four different classrooms, which relieved the teachers from their classroom so they could meet with each other. Leaving the class in the middle of the day, planning for a substitute, you may or may not be familiar with and ensuring that the substitute can manage the behaviors, maintain expectations, etc, results in a “crazy” and hectic day. Some suggestions for how this might be resolved in the future will be included in Chapter 5.

The other challenge that was mentioned was for Eda who explained, “Well, it was basically Fran and I for the whole year until we said, maybe we should just join (another grade).” In the beginning of the year, Eda’s study group had four people, but two left the study group for different reasons, which left only two members of a team together. If this job-embedded study group had been open to *all* staff as opposed to only the professional status staff, this situation may not have occurred.

#### *Teachers’ Reflection Journals*

Each teacher participating in the study groups was given a spiral notebook in which they were instructed to record their reflections throughout the year. In order to



provide a structure where they would write in their journals regularly, the researcher collected the journals each month. Periodically, the researcher asked additional questions for the teachers to answer based on what they had recorded at that particular moment in time. The purpose of the questions was to probe their thinking further or to redirect the teachers towards the goals of differentiating their instruction in the area of math. This section will provide evidence related to each research question based on the reflections the teachers recorded.

*Research Question 1: What did teachers learn about math content and pedagogy to help special needs children meet standards-based proficiency in math?*

The responses to this question included information primarily referring to specific teacher actions during the lessons and various references to multi-modal presentations. Table 14 shows the distribution of the different types of teacher “actions” that the teachers found helpful in assisting the students in their learning of mathematics concepts and skills. The responses did not indicate that there was new information that they learned about math content and pedagogy, but instead, the responses indicated which teacher actions they found to be successful when teaching mathematics. The teachers reflected upon what they learned worked for them and their teaching style. (Answers to Research Question 3 address which strategies worked for the *students*.)

Table 14

*Distribution of Teacher Actions During Mathematics Instruction*

	<b>Number of Actions Recorded in Journals</b>
<b>Modeling</b>	11
<b>Circulating/Monitoring/1:1 on the spot</b>	7
<b>Teacher-Created Materials</b>	7
<b>Opportunities for Student Self-Assessment</b>	6
<b>Connect to Prior Learning</b>	5
<b>Review</b>	5
<b>Opportunities for Student Sharing</b>	4
<b>Extended Time to Complete Activities</b>	3
<b>Preview</b>	3
<b>Use Consistent Language Cues</b>	3
<b>Games in Ongoing Centers</b>	2
<b>Modify Games</b>	2
<b>Supplement EDM</b>	2
<b>Wait Time</b>	2
<b>Hand Motions</b>	1
<b>Re-Explain / Paraphrase</b>	1
<b>Scaffold Questions</b>	1
<b>Target Instruction to Higher Level</b>	1

Based on the teachers' reflection journals, modeling is the most-often strategy used by teachers during mathematics instruction. In addition to modeling the steps to complete an activity or solve a problem, Beth noted that, "Modeling thinking, as Stephanie Harvey (Harvey & Goudvis, 2007) has shown, gives the boys and girls the tools to help them express their thoughts more easily."

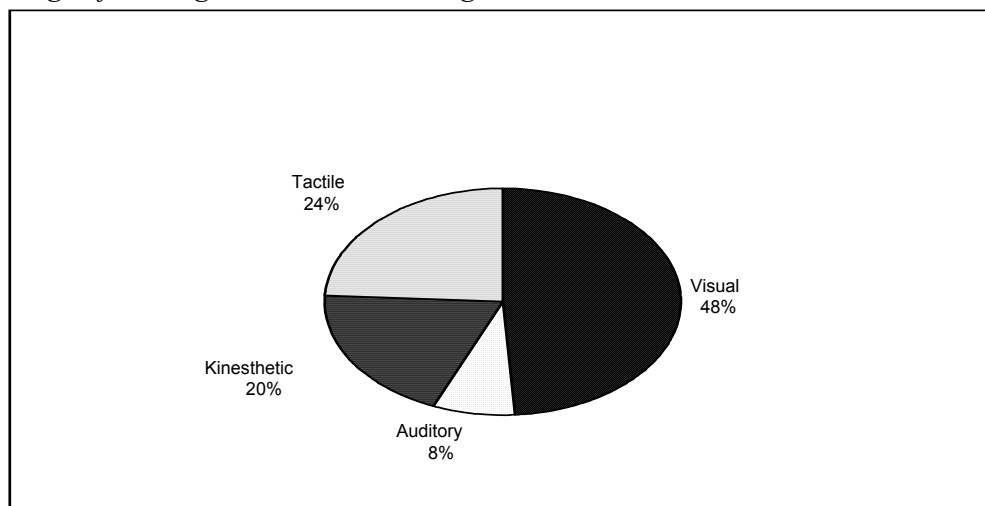
Both "circulating" and providing "teacher-created" materials were commonly listed in the reflection journals. These two areas go hand in hand. As teachers monitor students' progress, there are times when they can provide 1:1 assistance or clarification. There are also times when the teachers realized that a specific type of visual, such as a

recording sheet to use with a game, would assist the children in which case, they would create a special reference to aid the students with the activity.

There were four areas where the teacher “action” could be interpreted as a relinquishing of their actions to allow the student actions to take over. These areas include: opportunities for student self-assessment, extended time to complete activities, opportunities for student sharing, and wait time. Two third grade teachers, in particular, mentioned allowing students opportunities to assess their own level of learning frequently throughout the year. Kelly noted, “Reviewing the rubric for math writing with the students gives clear expectations for them to perform to.” Holly also remarked that she used the students’ self-assessments to guide her planning of upcoming lessons based upon their interest level and their need to revisit topics. Several teachers extended the time allotted to complete an activity so the student learning would continue rather than being sacrificed for the sake of preserving the week’s plan. By being flexible, the teachers allowed the students’ learning pace to guide their teaching pace. Several teachers cited the benefit of allowing the students to share their own strategies. In addition to building their confidence level in mathematics, Greta noted, “Students are invited up to the board. (It) helps students who are weak with a concept to hear the explanation in a different and maybe less threatening way.” Finally, two teachers remarked on the importance of wait time to allow the students to explore their own thinking. Ilene stated one notable change in her teaching, “I am much more careful about allowing students ‘thinking’ time and we almost always share our strategies and thought processes.”

Teachers reflected often on the types of presentations that targeted their students' learning style. Teachers reported various opportunities for multi-modal presentations as well. Figure 1 displays the percentage of strategies for each of the four modes: visual, auditory, tactile, and kinesthetic. Visual strategies comprised almost 50% of the strategies teachers cited in their reflection journals. Although visual strategies were listed prominently in journals of all of the teachers, tactile and kinesthetic strategies were most often listed by Kindergarten, First Grade, and Special Education (Multi-Grade) teachers.

Figure 1  
*Percentage of Strategies in Four Learning Modes*



It appears that although visuals are helpful for all of the learners, those who are struggling to master basic math concepts need additional presentations in other modes. As Kelly commented, “How could you not include these various ways of approaching teaching, especially in an inclusion classroom?”

Table 15 lists the specific strategies within each mode presented. Under the visual category, “observing the teacher” was one of the two most common responses.

This corresponds with the frequency with which teacher modeling occurred in terms of the types of teacher “actions” taken during math instruction. The number grid (100 chart) is used in every grade and may explain the high frequency of use as reported in the journals.

Table 15

*Strategies Referenced for Various Learning Modes*

	<b>Strategy</b>	<b>Number of References</b>
<b>VISUAL</b>	Observing Teacher	10
	Number Grid	10
	Teacher-Created Materials	9
	Numberline	5
	Calendar	4
	Clocks	4
	Dotted Numbers/Symbols	3
	Overhead Transparency	3
	Pictures	3
	Whiteboards	3
	Charts	2
	Color Coding	2
	Mats	2
	Compass Rose	1
	Domino (subitizing)	1
	Estimating Reference Jar -10	1
	Paper Clip Chains	1
Thermometer	1	
<b>AUDITORY</b>	Choral Counting	6
	Consistent Language Cues	2
	Aural Math Problems	1
	Listen to Story/Literature	1
<b>KINESTHETIC</b>	Moving (Gross Motor)	10
	Speaking	7
	Writing	4
	Pointing (and Counting)	3
	Clapping	1
	Painting	1

	<b>Strategy</b>	<b>Number of References</b>
<b>TACTILE</b>	Coins	7
	Base Ten Blocks	5
	Touching Chart	3
	Craft Sticks	2
	Cutting Activity to Demonstrate Concept	2
	Meterstick	2
	Pattern Blocks	2
	Rulers	2
	Counting into Hand	1
	Feel Edges and Points of Shapes	1
	Geoboard	1
	Measuring Tapes	1
	Seeds	1
	Show Time on a Clock	1
Snowman manipulatives	1	

It is important to note that many of the strategies listed in each of the four categories are present in the games that are played throughout the *Everyday Math* program. The games provide additional practice of the newly learned skills and allow the students additional opportunities to use the mathematics tools such as the number grid as the students work in partners or small groups.

Two teachers also commented that the more open-ended approaches were successful. Lori mentioned that, “The Open Response (was) written for all learners; (they can) use concrete items, draw a picture or array, or use just numbers. Macy commented on the value of the open-ended prompt, “Ways to Make \_\_\_\_” where students list many ways to get to a certain number, “It’s a great open-ended activity and a good way for me to informally observe how students can creatively manipulate numbers.”

*Research Question 2: What were the most helpful components of the professional development program that promoted teachers' learning?*

Teachers commented most about their experiences in the study groups in their reflection journals. However, several teachers also noted benefits from the faculty meetings as well as the practice of keeping a reflection journal.

#### *Faculty Meetings*

Several teachers commented on positive aspects of the faculty meetings. One indicated that the sharing session in June where each grade reported out to the staff on how they used the time at each grade level, Macy said, "Each grade had a different concentration and a totally different approach to working through the issues they found essential. Talk about differentiation!" Another teacher, Jen, indicated that the article about Universal Design got her to think about mathematics instruction in a different way where it is not the student with the disability, but rather the curriculum has a disability and needs to be adapted. A third teacher, Beth, commented that the experience as a learner during the faculty meetings was helpful, because, "It got me thinking about how we ask children to share their answers, but many times (right or wrong) we miss learning opportunities by not asking the children to share their thinking."

#### *Reflection Journals*

Three teachers included reflections about keeping a reflection journal. Two cited that the running record of how the teaching and learning was progressing was helpful. Macy remarked, "I find myself differentiating most by ability...I do not feel I am

differentiating enough by interest or different intelligences, or by product.” Three other comments centered around the usefulness of the journal in tracking ideas for the following year including teaching it whole class, because it was too difficult without the teacher leading the activity and assigning groups. When it was left up to the students’ choice, they did not always choose to challenge themselves and instead chose a less challenging problem that was not commensurate with their abilities.

### *Study Groups*

According to the teachers’ reflection journals, participating in the study groups was a positive experience for all. Teachers reported benefits in four different areas: analysis of student work, group discussions, planning opportunities, and teaching tools. Table 16 shows the percentage of teachers’ remarks for each identified benefit category. While the benefits of the study groups were not identified in advance of the study, these categories emerged as the researcher read the reflection journals. Sample statements regarding each benefit are listed as well to capture the teachers’ perception of the benefits ascribed to the study group experience.



Table 16

*Comment Percentages for Study Group Benefits*

Analysis of Student Work	Discussion	Planning	Teaching Tools
16.7%	29.1%	39.6%	14.6%
<p>“We would share how one lesson went and it was amazing how the children responded in the same manner in other classes.” Holly (Gr.3)</p>	<p>“I feel that having Fran (Multi-grade teacher) in the group, not just classroom teachers, had a huge impact on my teaching in the classroom. She would give us the viewpoint from other grade levels which would guide my lessons.” Alice (K)</p>	<p>“I feel better about teaching math as I move through each lesson knowing that I have looked it over beforehand with colleagues and can offer more choices to students.” – Macy (Gr.2)</p>	<p>“(It was helpful) using the tiered lesson template.” Macy (Gr.2)</p>
<p>“Another positive aspect of the study group was having time to analyze students’ work not just in one class, but across grade level.” Fran (Multi-Grade)</p>	<p>“It (the study group) placed teachers in a setting where it was okay/expected to discuss what did not work for their community of learners with the purpose of altering the plan to reach more students.” Greta (Multi-Grade)</p>	<p>“When we focused our study group time on reviewing each unit and differentiating lessons, I was much more successful at differentiating the math lessons in the classroom. I actually did differentiate several math lessons, not only by ability, but also interest and (learning) style.” Ilene (Gr.2)</p>	<p>“The other positive was the LAST method as a model to look at children’s thinking and work.” Carrie (Gr.2)</p>

Each teacher meets with their grade level each week, but with the demands of the curriculum increasing and with minimal time to meet as a team during the day, common planning time is at a premium. Many times, the grade level meetings are consumed by discussing upcoming events, delegating various tasks that need to be completed for the administration, and following up on student behaviors during unstructured times such as lunch and recess. As a result, teachers appreciated the time they were given to delve deeply into the curriculum and to study and refine their own practice.

*Research Question 3: Which of the newly employed strategies did the teachers perceive worked the best?*

Teachers noted many strategies that they found to be successful for their students during the course of the year. Whereas Question 1 addressed the strategies for the teachers to employ in the teaching of mathematics, Question 3 was aimed at uncovering the strategies that teachers found successful for their students to employ during mathematics activities in order for them to achieve proficiency with mathematics skills and concepts.

One strategy that was cited often was the use of small groups. While also a teacher “action” since the teacher plans to divide the class into small groups, it was cited often as a setting in which students were able to grasp concepts and skills more readily.

Small groups were utilized in a variety of ways. The most common way teachers reported using small groups was assigning students by ability. Eda explained the benefit of using two groups in her first grade class, “Without having help in my room this year

for an entire hour, I am not sure that these kids would even be as far along as they are now. I was able to give the kids who need more help the benefit of a 9:1 (student : teacher) ratio with another adult in the room. I believe that it did make a difference!”

Greta explained that, “Small group activities are a great method for teaching for all students. Guided Math groups address students that need preview and review. It would also facilitate higher level learning for stronger students.” In previous years at Princeton, small group instruction had been saved for students on IEPs in a “pull-aside” service delivery model in the classroom. Here Greta is speaking of breaking the whole class into smaller groups much like the teachers do for the Guided Reading portion of the day ensuring that students are met at their “instructional” level.

Jen gave two examples of how using three ability groups helped her to be able to differentiate with three different activities all addressing the same content. Her first example was one of her lessons on place value where she designed three levels of activities. Based on the students’ current level of instruction, Jen explained the three foci using Base Ten Blocks, “To create numbers, work on writing numbers from the Base Ten Blocks, (and) identifying the value of the digits (of the number).” The second example she gave highlighted a geometry lesson where students were, “Identifying shapes, identifying properties of shapes, or (learning) vocabulary.” Jen also explained that it was important to, “Modify the amounts so my students can gain a better understanding of the concept before moving into the larger numbers.” In all examples, Jen focused on providing a setting where each student could be successful at his or her own level.

Another type of small group opportunity involved stations. When students participated in stations or centers, unlike the small groups based on ability level, the stations required each student to visit each station. Eda explained that in her first grade classroom there were, “Three high-interest station rotations. 1. Write on-wipe off clocks, 2. Making a giant floor clock with students as the hands, 3. Memory game – matching time cards to word cards.” While all three stations gave the students practice with time concepts (showing the time on the clock, understanding the difference between the minute hand and hour hand, and learning the language to reference time,), each station provided the students with a high-interest activity to keep them all engaged.

Holly also utilized this type of small group by providing three stations to review graphing concepts. There were three stations each providing a different type of graphing activity: a pictograph, line graph, and bar graph. As each student visited the stations, the adult monitoring the station could further differentiate for ability if necessary.

Lori presented her explorations in a different type of station set up. In Lori’s classroom, she “Present(ed) three explorations and allow(ed) them to start with which ever one appeal(ed) to them. Some kids wind up only doing one (station) while others will do all three. (It) allows for ability and interest.” This set up also provides the flexibility for the teacher to be able to circulate and monitor the students’ progress more easily since all of the students are actively engaged in the activities.

Dori had tried another approach to accommodate students’ ability by providing multiple levels of difficulty for a single lesson. In her classroom, she presented examples of how the students could challenge themselves as they completed the activities if they so

chose. Unfortunately, “I offered 8, 12, and 20-sided dice, but only 3 took me up on the offer.” In this case, her more capable students may have needed to be assigned to a group in order to rise to the challenge as they were not ready to self-initiate a more challenging variation to the activity.

In addition to the examples teachers gave of differentiating by ability and by interest, they also reported ways in which they differentiated instruction to meet the needs of students with different learning styles (Table 15). Table 17 shows the trends of differentiating by ability, interest, or learning style over the course of the year based upon the teachers remarks in their reflection journals.

Table 17

*Number of Reflections Recording Differentiated Instruction Strategies*

Grade Level (Number of Participants)	Ability (% reported)	Interest (% reported)	Learning Style (% reported)
K (2)	15 (78.9%)	2 (10.5%)	2 (10.5%)
1 (2)	23 (88.0%)	3 (11.5%)	0 (0.0%)
2 (3)	35 (77.8%)	1 (2.2%)	9 (20.0%)
3 (4)	49 (69.0%)	5 (7.0%)	17 (23.9%)
Multi-Grade	13 (65.0%)	2 (10.0%)	5 (25.0%)

An overwhelming majority of the reflections, a total of 74.5% of the differentiated instruction strategies focused on meeting differentiating instruction based on the students’ ability. Most of the reflections regarding meeting the needs of varying ability levels also included the use of small group instruction. Teachers reflected upon their experiences working with 2-4 groups within the large group setting. For the most part, teachers utilized support personnel including the special education teacher and the

paraprofessional in order to lead more than one group at a time. This was the typical format used which is similar to how Guided Reading groups are conducted. Teachers meet with students who are working at a similar ability level and facilitate their learning by using activities that not only address their needs, but are appropriate to their learning style.

It is interesting to note that very few teachers mentioned how they address the learning styles of their students. Contrary to the information on the chart where teachers reported differentiating by the students' learning style in only 18.2% of the total reflections, teachers at the early elementary grades are constantly using multi-modal strategies to tap into the strengths of their students. They provide repetition and rephrasing of the directions, they provide many opportunities to use manipulatives in order to see the concept at a concrete level and they very often use poems or songs to solidify new concepts along with many more strategies. The "teacher actions" listed previously in this section under Question 1, displays the many ways the teachers at Princeton Elementary meet the needs of the learning styles of their students. In addition to the fact that teachers at this level are accustomed to making accommodations to meet the learning styles of the different students in their class, there also seemed to an increased awareness throughout the reflection journals that by using small group instruction on a regular basis, **all** students are able to grasp the concepts more readily. As Fran mentioned, "Small groups that focus on specific skills give students a chance to ask questions they might not ask in a large group and get extra help and practice on skills.

Students do like working in small groups. We're able to do activities that may be more hands on; they participate more, so the kids are enthusiastic."

Out of the reflections focusing on small ability groups, only 5.9% of the reflections mentioned "mixed-ability" or heterogeneous groupings. Those that did commented that it was helpful to encourage students with relative weaknesses in math to rise to the occasion. Beth for example explained that when she was setting up opportunities to practice number concepts by using games, "I partnered them (struggling students) up with children who were more familiar with the numbers 0-9." Kelly also mentioned the benefits of heterogeneous grouping, "(I) set the learning at a higher level and I have seen students that struggle working alone, (are) working better and harder."

Several teachers wrote about the difficulties that arise in trying to implement the use of small group instruction in mathematics. Jen noted, "We continue to talk about the need for small group support of skills the way it is done in reading and all of us continue to search for the answer to where and when it can happen. When possible, the teacher and I have worked it out so 1 or 2 times a week during calendar, Math boxes, or another activity, some additional support is provided." Carrie also noted that it is difficult to implement without consistent additional support as it means additional planning on the part of the teacher, "The small group at first helped, but it's easy not to do it." In order to have the students working in small groups without additional support in the classroom, teachers need to spend additional time creating activities that students will be able to be engaged in authentic learning opportunities while the teacher is meeting with one of the groups. The teachers have been used to doing this with Guided Reading, but Guided

Math groups are not automatic at this point and it is difficult to do without having another teacher and aide to help facilitate the learning at each group or station.

Teachers noted that small group instruction was useful in order to differentiate instruction appropriately to meet the needs of all learners. Within the small groups as well as during times of independent practice, teachers found that students made gains by using specific strategies. Five different teachers reported that the cross-curricular connections whether it was through reading a book, learning a poem or song, or relating the math concept to the world around them at home or through sports, students were able to grasp onto the new concepts and skills with greater facility. As Beth pointed out, “Typically, the children who have established identifying numbers 0-20 is 50-60% (in Kindergarten). At this point, (after the interdisciplinary unit on teen numbers), approximately 80% of the children have this skill established.”

Teachers also cited specific arithmetic strategies that students found to be successful. For addition, four teachers reported that the 9+ strategy and the “double + 2” strategy were helpful. When given a problem such as  $9+7$ , the “9+” strategy requires the student to take one away from the “other” number and make the 9 a 10. Then, the student has an easier time finding the answer.

The steps are done mentally as follows:

Problem:  $9 + 7 = \underline{\quad}$

Step 1:  $9 (+1) + 7(-1) = \underline{\quad}$

Step 2:  $10 + 6 = 16$



The “double + 2” strategy requires the students to choose the number in the middle and “double it” to get the answer following the steps that follow as a mental math strategy:

Problem:  $6 + 8 = \underline{\quad}$

Step 1:  $6, (7), 8$

Step 2: Double “7”  $(7+7) = 14$

Students are used to breaking apart numbers and putting them back together so these strategies help them visualize a quick way to calculate answers to facts that students are often apt to miscalculate.

Three teachers mentioned “counting up” as a successful strategy. For some, counting up can simply mean that the student is holding the first number in his head and then counting out the amount of the second number. For example:

Problem:  $7 + 8 = \underline{\quad}$

Step 1: “Put 7 in your head”

Step 2:  $(7) 8 \dots 9 \dots 10 \dots 11 \dots 12 \dots 13 \dots 14 \dots 15.$

When the student is counting on, he puts out one finger for each new number he says. Since 8 is the second number, the student stops counting when he has his eighth finger up. This strategy helps the students keep track of their counting and by using their fingers, they have a visual prompt to tell them when to stop counting on.

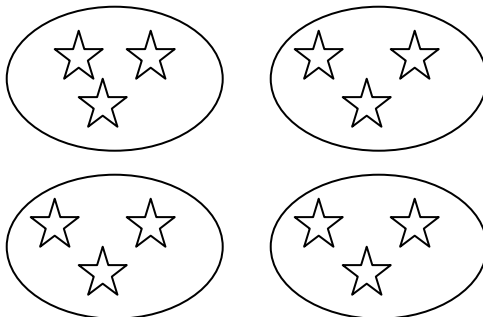
“Counting up” also refers to the skill requiring students to calculate the change they should receive when they are calculating answers to problems concerning money. By using the 100s chart, students find the amount of money and then count up on the 100s chart to figure out the difference between the amount they are paying and the whole

dollar or 100. By utilizing the visual patterns on the hundreds charts (5s, 10s, and 25s are color coded), students are better able to calculate which coins to use and the actual amount they need to receive as change.

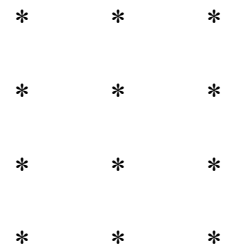
Several teachers mentioned successful computational strategies for multiplication as well. Four teachers mentioned that students used repeated addition. Three teachers mentioned using skip counting and one of the three mentioned using the color coded 100s chart as a visual aid as well while the students are skip counting. Two teachers included that students found it helpful to draw a picture of what was occurring in the multiplication problem and two teachers also reported that drawing an array was helpful for the students to be able to calculate the answer to a multiplication problem. These strategies all preserve the concept of multiplication. If students are using repeated addition or skip counting, they are counting in sets of a number. For example, to skip count  $4 \times 3$ , students would count “four groups of 3” or “3...6...9...12”. By drawing a picture, students are able to “see” the sets in front of them and the same is true of arrays. Examples using the same problem mentioned above ( $4 \times 3$ ) are listed below:

Problem:  $4 \times 3 =$

*Drawing a Picture*



*Drawing an Array*



Based on the teachers' responses regarding the success students experienced using these strategies, it is clear that it is important for the strategies to make the concept of the arithmetic operation clear to the students. Each of these strategies retains the integrity of the original multiplication problem so that it is not a rote task where students can solve it simply by memorizing a table, poem, or a "trick" to remember the facts without ever truly understanding the concept.

*Research Question 4: What were the challenges of implementing the embedded professional development?*

Teachers who participated in the study for the entire year did not include challenges of implementing the embedded professional development in their reflection journals. In the next section, this question will be addressed through findings from the researcher's field notes.

#### *Researcher's Field Notes*

This section will include findings based on the researcher's field notes collected during Faculty Meetings and Study Group sessions over the course of the year related to the study. Artifacts that were created during the faculty meeting sessions or as a part of the study group sessions will be included, when appropriate. The findings will again be reported within the framework of the four research questions.

*Research Question 1: What did teachers learn about math content and pedagogy to help special needs children meet standards-based proficiency in math?*

The initial intent behind changing the format of the typical monthly faculty meetings was to provide an hour-long session devoted to math. Since elementary teachers are responsible for teaching every subject area, using the faculty meetings as a way in which to deliver ongoing professional development would provide an opportunity for staff to delve more deeply into the math content area. The faculty meetings provided a mix of content related skills and concepts and the discussion of strategies in which to teach mathematics. Periodically, the teachers were asked to fill out exit slips to provide feedback regarding the content of the faculty meetings.

At the end of the December Faculty Meeting, the teachers were asked to fill out a brief Exit Slip. They were asked to list something that they learned during the session. During that meeting, teachers analyzed three (anonymous) students' work as they solved the same addition problem in different ways. Once they analyzed the students' work, they were given a different problem to solve using that child's strategy. By completing this exercise, teachers were able to see that all of the strategies worked, but some were more efficient than others. According to the Exit Slips, 9 of the 26 (34.6%) teachers present at the meeting learned three new strategies for solving addition problems. An additional group of eight teachers (30.7%) learned new vocabulary for the strategies and the remaining nine teachers (34.6%) listed that one of the strategies was new to them. While the teachers were not new to addition, they had not previously had the opportunity

to explore the strategies that are common for students to use in order to either encourage the use of the strategies or to teach them additional strategies that may prove to be efficient and effective for them.

During the January Faculty Meeting, the teachers again analyzed three (fictional) students' work, but the focus was on subtraction strategies. Two of the methods Chapin and Johnson presented (2006, p. 46.) in the examples were familiar to the teachers, but the method one student used sparked the most discussion. "Louis" used the concept of "compensation" and increased the number in the tens column of the subtrahend and added that same ten in the form of ten ones to the ones column in the minuend as in the following example:

$$\begin{array}{r} \text{Problem:} \quad 152 \\ \quad \quad \quad -39 \\ \hline \end{array}$$

$$\begin{array}{r} \text{Step 1:} \quad 15\boxed{12} \\ \quad \quad \quad -\boxed{4}9 \\ \hline \end{array}$$

$$\begin{array}{r} \text{Step 2:} \quad 15\boxed{12} \\ \quad \quad \quad -\boxed{4}9 \\ \hline 113 \end{array}$$

This strategy works, because both expressions have the same difference:

$$152 - 39 = 113$$

$$(152+10) - (39+10) = 113$$

The reason why this strategy appealed to the teachers was clear once we explored the traditional algorithm and the "Louis" strategy to solve  $10,000 - 7,432$ . It is difficult for second graders to accurately "subtract across zero" using the traditional algorithm.

“Louis” presented an alternative:

$$\begin{array}{r} \text{Problem:} \quad 10,000 \\ \quad \quad \quad - 7,432 \\ \hline \\ \text{Step 1:} \quad 10, \boxed{10} \boxed{10} \boxed{10} \\ \quad \quad \quad - \boxed{8} \boxed{5} \boxed{4} \boxed{2} \\ \hline \\ \text{Step 2:} \quad 10, \boxed{10} \boxed{10} \boxed{10} \\ \quad \quad \quad - \boxed{8} \boxed{5} \boxed{4} \boxed{2} \\ \quad \quad \quad \quad \quad 2, \quad 5 \quad 6 \quad 8 \end{array}$$

Students have a lot of practice with compliments of 10, so this can be a much easier strategy for students to use successfully without excessive errors. The Exit Slip completed at the end of the meeting reported that this strategy was new to 14 of the 23 respondents. Several teachers eagerly took this strategy to their classrooms to see if it would help their students, others remained skeptical that it would help and questioned if students who had organizational difficulties would have trouble with this strategy as well. Even though teachers are familiar with several strategies that students can use, it is helpful to continue to learn new strategies as it may be a perfect match for another student’s thinking patterns.

In February, the teachers participated in a discussion regarding which strategies were proving to be successful in facilitating students’ progress towards proficiency with the essential skills. All of the teachers had an opportunity to share what was working for them and the following five strategies were listed as they were mentioned in the discussion:

1. Teaching Open-Response problems with the rubric and sample answers.

(Teachers found that students performed better on the Open Response problems when

they had sufficient experience rating others' responses. Once they had a clear understanding of the expectations, students performed well.)

2. Small group instruction.

3. Connecting Minute Math to the students' own lives. (This included rewriting problems to include objects such as Webkinz that students were familiar with.)

4. Computer games at their level. (*Everyday Math* computer games were installed on a computer in every classroom to allow for additional reinforcement for specific skills.)

5. Rotating manipulatives and personalizing problems. (Kindergarten teachers had to share manipulatives, but when they did rotate, all were able to benefit. After the teachers reported that they did not have all of the manipulatives available for use in each of their classrooms, the researcher secured additional kits.) All five of these strategies were mentioned in at least one of the study group participants' reflection journals as well, but the most common strategy mentioned in the journals, was the use of small group instruction.

During the study group sessions, another strategy was shared which focused on errorless learning strategies. The time-delay strategy mentioned in the research of Touchette (1971) and Shuster (1990) can be easily applied to student pairs where additional practice is needed (Bender, 2005). At the beginning of the year of the study, high school honor society students were trained in the time delay technique to help students learn multiplication facts. In October, second grade teachers suggested having the high school tutors work with addition and subtraction facts and Kindergarten

suggested the use of the time-delay errorless learning procedure in order to improve number recognition skills. Some student progress was noted, but unfortunately, most of the tutors were not able to continue on a consistent basis due to changes in their schedules.

Another advantage of the study group included the opportunity for teachers to have the time needed to review student assessment data. When the first grade teachers took the time to analyze the performance of the entire first grade on the mid-year assessment, there were three areas they noted that required additional instruction: money (especially notation of amounts), time, and problem solving. By having the time to review the data, the teachers realized that they needed to provide additional, and possibly different, learning opportunities in these areas. Second grade teachers mentioned that providing pre-assessment opportunities through “morning problems” on the board, they could quickly assess which activities in the small groups would be appropriate for each student.

While the first and second grade teachers used the data to inform their future lessons with their current students, third grade teachers had a different understanding of how the data should be used. Lori explained, “Looking at student work can help improve student learning for the following school year. However, it does not improve instruction for the current class, as we typically don’t/can’t share student work until after the unit is done and topics are not revisited in the same school year. Using data to guide instruction would be helpful if we were allowed to use alternate methods/materials/lessons to remediate and reteach as necessary.” While two of the third grade teachers mentioned



other resources like problem solving binders and activities they have used in the past as appropriate additional resources, Lori and Dori both felt stifled by the *Everyday Math* program and did not feel they had the professional freedom to use other materials. While the district did ask teachers to use only the *Everyday Math* program during its first year of implementation, teachers were given the latitude to use their professional judgment and to provide the learning opportunities that would benefit their students by supplementing the program, being careful not to supplant the program entirely.

By sharing their successful strategies with one another during the study groups, teachers also learned a few strategies that helped them to make the most of the learning opportunities using the games. First grade teachers explained, “Previewing and modeling games throughout the week before game day on Friday,” helped to ensure student success with the games. Once the students were able to engage in the games more independently, teachers tried to make use of the time to pull additional instructional groups if necessary. First grade teachers also found it helpful to set up different games at centers, which minimized the amount of teacher interaction needed to help the students begin the games.

*Research Question 2: What were the most helpful components of the professional development program that promoted teachers’ learning?*

Before the first faculty meeting, the researcher had surveyed the staff regarding the strategies the teachers were currently using to differentiate instruction in reading and math. A meaningful discussion ensued during the September faculty meeting where the teachers noticed that 14 teachers reported that they use small group instruction in reading,

but only eight used small group instruction in math. This discussion served to celebrate teachers who had already been using small group instruction in math and it also served to motivate others to use their strengths in teaching reading to teach math. This discussion was able to launch the program with a focus to differentiate instruction in math just as the teachers are accustomed to doing in reading. The fact that every teacher was a part of the faculty meeting was important if the staff was to grow and improve their practice as a whole.

During the November session, the math specialist was able to guide the teachers through the new manual. The teachers were starting with a brand new edition of the *Everyday Math* program and there were some substantial changes to the program. Within the manual, some lessons included suggestions for how teachers could differentiate the lesson based on various tiers of ability. The manual also included suggestions for manipulatives or literature connections, which would assist the teachers in planning lessons to meet the needs of students with different learning styles. Another feature included a star marked next to Math Box problems that were to be used as assessments and others were marked in order to inform the planning of future lessons. By allowing the teachers the time to explore the aids already provided, the idea of differentiating to meet the different needs of the students seemed more manageable. Several teachers included references in their journals about how the suggestions given in the manual for differentiating instruction had been helpful in planning the lessons for the year. While it diverted the content of the faculty meeting scheduled to be discussed it was an important

session, because teachers were better equipped to take advantage of the resources within the manual as they planned tiered lessons.

Discussions during the faculty meetings often provided insight into how our students think about math. For example, during the October meeting, Teachers had to work in groups to play the place value trading game. Teachers worked with either base three, base four, or base six and needed to do the same trading activity that their students do with ones, tens, and hundreds. The teachers were able to identify five areas that their students might have trouble with:

- \*Face value versus place value (if was difficult to “read” the number in an unfamiliar system).
- \*Remembering when to trade was difficult.
- \*Decomposing large numbers (this was especially difficult when using two dice)
- \*It was difficult to simply place the rods on the mat. It was necessary to go through the trading process with the unit cubes to keep track of what they needed to represent.
- \*The need for more practice.

In addition to learning about the difficulties students encounter when first learning our system of tens, the teachers also saw different learning styles of their peers in action as well. Teacher participants in most groups took turns, while in some groups certain participants rolled the dice and placed the pieces while others watched.

Based on the Exit Slips from the April Faculty Meeting, another benefit of the embedded professional development opportunities according to the teachers was the use

of the Looking At Student Thinking (LAST) protocol. Study group members had the added opportunity to try the LAST protocol in their study groups so they were more familiar with it. The teachers who only attended the faculty meeting had an opportunity to see it modeled for them using the “fishbowl” approach where the study group participants modeled the strategy in the center and the other teachers observed while sitting in an outer concentric circle of chairs. After having the procedure modeled for them nine out of the thirteen teachers at the faculty meeting, but not in the study groups reported that they liked the strategy and thought it would be helpful. Two teachers mentioned that it could serve better as a general guide, but that it was too restrictive of a format since there are roles to be played and not everyone is given a chance to discuss the work at first. Three teachers also mentioned that finding time to discuss student work in this much detail would be difficult. Interestingly enough, one teacher with professional status who chose not to participate in the study groups remarked, “ LAST provides a forum for discussion among colleagues, but there needs to be time during the school day for it.”

During the study group discussions later in the year, teachers reflected upon their experiences in the faculty meetings, study group sessions, and writing in their reflection journal. Kindergarten and First Grade teachers agreed that while the LAST protocol seemed too restrictive without allowing the discussion to occur back and forth between the presenter and the other teachers with only three teachers on the team. When there were more teachers involved in the discussion, such as the seven person first grade team, the format was helpful as a means to structure the conversation. First Grade teachers also

found it helpful to use the reflection journal to reflect on past entries and develop ideas on how to work through the lessons more effectively. Second grade teachers felt that the study group discussions and the time spent planning ways to differentiate the lessons together was the most valuable of the experiences, “That time spent planning ahead of time as a group definitely paid off when it came to doing the lessons in the classroom.” Second grade teachers also liked the LAST protocol, but mentioned that finding the time to discuss students’ thinking in this fashion was difficult.

*Research Question 3: Which of the newly employed strategies did teachers perceive worked the best?*

In addition to the reflection journals, teachers shared their experiences with successful strategies during the study group discussions. Teachers most often mentioned the use of small group instruction and preparing tiered lessons based on students’ ability as the successful strategy most often employed. Teachers in Kindergarten, Grade Two and Grade Three provided centers where students could choose to explore topics further which highlighted their attempts to differentiate based on students’ interest. First Grade teachers devised centers that involved rotations where each student would visit each center. While they did not provide students with the opportunities to *choose* which centers to visit, these were “high-interest” stations so all students remained engaged in the activities. Two third grade teachers also set up high-interest stations that each student rotated to, but at each station, the teacher facilitating at that station was prepared with several options within each station in order to differentiate by ability once again.

Teachers also indicated that there were specific strategies that helped the students to understand multiplication. Third Grade teachers, for example, explained that using literature such as *The Doorbell Rang* and multi-sensory activities such as “circles and stars” (a Marilyn Burns activity), helped to activate students with different learning styles and help them to understand the concept of multiplication. While it was difficult to find manipulatives that could be sent home easily for students, teachers indicated that providing students with additional practice opportunities at home was also a successful strategy.

Table 18 displays examples of the way teachers in all of the grades used multi-sensory strategies during small group instruction.

Table 18

*Multi-sensory Strategies Used in Small Groups*

	Visual	Auditory	Kinesthetic	Tactile
Kindergarten	<ul style="list-style-type: none"> <li>*modeling</li> <li>*calendar</li> <li>*numberline</li> <li>*group 100 multiple ways (4 groups of 25, 5 groups of 20, etc)</li> <li>*highlighting 5s and 10s on number grid</li> </ul>	<ul style="list-style-type: none"> <li>*teacher asks questions on varying levels</li> <li>*sharing of students' ideas</li> </ul>	<ul style="list-style-type: none"> <li>*painting</li> <li>*writing</li> <li>*singing (<i>15 Pumpkins</i> <i>Sitting On a Fence</i>)</li> <li>*counting aloud</li> </ul>	<ul style="list-style-type: none"> <li>*sand tray</li> <li>*sequencing number cards</li> <li>*dividing seeds on two halves of a pumpkin</li> <li>*shaving cream</li> <li>*number rubbings</li> <li>*playdoh</li> <li>*wikki stix</li> </ul>
First Grade	<ul style="list-style-type: none"> <li>*Color code number grid in each set of ten</li> <li>*numberline</li> </ul>	<ul style="list-style-type: none"> <li>*Teacher demonstration for skills and explanations for concepts</li> </ul>	<ul style="list-style-type: none"> <li>*students make a clock with their bodies</li> </ul>	<ul style="list-style-type: none"> <li>*clocks</li> </ul>
Second Grade	<ul style="list-style-type: none"> <li>*hundreds chart</li> <li>*use balance scales</li> <li>*games with trading mat</li> </ul>	<ul style="list-style-type: none"> <li>* "math talk" during games</li> <li>*providing explanations during introductions and through directed activities</li> </ul>	<ul style="list-style-type: none"> <li>* "math talk" during games</li> <li>*recording actions (number models)</li> <li>*coloring the patterns on the number grids</li> <li>*measuring items with "non-standard" measures (such as students' feet)</li> </ul>	<ul style="list-style-type: none"> <li>*manipulatives</li> <li>*coins</li> <li>*base ten blocks</li> <li>*number cards</li> <li>*clocks</li> <li>*translucent chips to use on number grid</li> <li>*use balance scales</li> <li>*pattern blocks</li> <li>*measure with rulers</li> </ul>
Third Grade	<ul style="list-style-type: none"> <li>*graphic organizers</li> <li>*posters</li> <li>*number grid</li> <li>*manipulatives</li> <li>*dot paper</li> <li>*graph paper</li> </ul>	<ul style="list-style-type: none"> <li>*verbal explanation of information on board</li> <li>*students sharing various strategies aloud</li> <li>*restating ideas in alternate ways</li> </ul>	<ul style="list-style-type: none"> <li>*oral repetition of facts</li> <li>*chant skip counting</li> </ul>	<ul style="list-style-type: none"> <li>*manipulatives</li> <li>*slates</li> <li>*paper money</li> <li>*tiles</li> <li>*unifix cubes</li> <li>*base ten blocks</li> </ul>

Within the small groups, teachers were also providing students with many hands-on learning opportunities. Kindergarten teachers explained, “Overall, manipulatives are used in Kindergarten for most activities involving math concepts.” Table 18 displays some of the ways in which teachers meet the needs of students with varying learning styles. However, this is not an exhaustive list. By visiting any one of the classrooms at any of the grades at Princeton Elementary, one might see any of these strategies in use. These strategies, however, happened to be the ones mentioned during the study groups with these individual teachers. The discussion was also impacted by the concept being covered in the class at the time as well as the different foci of the discussions at the various grade levels. One can see from the chart, however, that teachers have found that multi-sensory strategies are important in order to meet the needs of different learners within one class.

*Research Question 4: What were the challenges of implementing the embedded professional development?*

There were three challenges involved in implementing the embedded professional development at Princeton Elementary School: participation requirements for the study, scheduling difficulties, and obtaining union approval.

*Participation requirements.*

The researcher needed to restrict the participants of the study to members of the staff that had achieved professional status. While there were ample volunteers and while



most of them remained in the study from beginning to end, there were several teachers who had not attained professional status who wished that they could have been a part of the job-embedded study groups. Another leadership challenge was that there were a few professional status teachers who chose not to participate in the study, which, as the school leader, informed the researcher that the staff was not completely on board with the goals of the leadership initiative. Despite the fact that not everyone could participate, the thirteen study participants who continued throughout the session benefited from the embedded professional development.

*Scheduling difficulties.*

Since the study groups were meeting twice per month, it was important to stagger the scheduling to allow for as little disruption to the students' day and learning opportunities as possible. The meetings were held on Wednesdays so there could be some predictability of a schedule but there was a four-week rotation so that teachers would not be missing the same subject area each time nor would they lose their regular planning time or lunch on a regular basis. A few of the teachers agreed to forfeit a portion of their regular planning time in order to be able to participate in the study groups and make the schedule possible. These teachers did not view the opportunity as a loss of planning time, because they understood that there would be an equal, if not greater, planning opportunity with their colleagues. In order to provide adequate coverage, a team of four substitutes was hired to go from class to class with a 45-minute break for lunch. Once the researcher was able to finalize the schedule and the office team was able

to secure the needed substitutes, the study group sessions did not present additional challenges.

However, one of the teachers who elected not to continue to participate in October explained that she was finding it difficult being out of the classroom and did not want to miss that much time with her students. As a special education teacher, she may not see those children for another week and felt that the lack of classroom time would have a negative affect on her students' progress. While substitute coverage would have been provided, she felt strongly that she had an obligation to be present for her students, but she welcomed the opportunity to participate in the faculty meetings and planned jointly with teachers who were in the study groups and were trying new approaches.

*Union approval.*

As mentioned earlier in this chapter, the researcher did confront a challenge with the teachers' union as she implemented the faculty meeting professional development sessions. The year before the study began, the idea of using the faculty meetings as hour-long professional development sessions was broached with the staff. At that time, there appeared to be unanimous approval. After the first faculty meeting, however, the Superintendent notified the researcher that the Union President had voiced a concern she had heard from Princeton Elementary teacher representatives regarding the change in the format of the faculty meetings. The Union questioned whether or not the format could be changed. While the contract did not say what the format *should* consist of, it also did not say that it could be used entirely for professional development.

Before proceeding with the remaining nine meetings, the researcher met with the Union President. The researcher created a survey to the staff asking them to choose one of two options. “Option 1” merged the old format with the new format where each meeting would begin with announcements (5 minutes) followed by a discussion of current issues (10 minutes). In order to still be able to provide ten hour-long sessions, each meeting would need to extend fifteen minutes beyond the traditional hour. Due to the contractual constraints, the researcher was not able to detain teachers beyond one hour. Therefore, if Option 1 had been chosen, any staff member who wished to leave the meeting after being present for one hour could do so freely even if the session was not complete. “Option 2” would allow the researcher to continue as she had planned for the year of the study only and then the following year, the faculty meeting format would return to its previous structure.

Out of 24 respondents, only two teachers chose Option 1, 20 teachers chose Option 2, and two teachers agreed to go with the majority vote. Ultimately, the concerns raised by the Union members in the beginning of the study did not meaningfully interfere with the study itself. The Union President was supportive of the efforts of the researcher to provide a meaningful professional development opportunity to the teachers and agreed to support the majority decision of the staff to move ahead with the plans for the year even though the format of the faculty meetings was different than in years past.

### Conclusion

By analyzing the data collected, the findings reveal several positive changes as a result of the study. The pre-implementation and post-implementation surveys show that

there was an increase in the teachers' use of differentiated instruction in the area of math. In addition to differentiating by ability for small group instruction, the most common type of differentiated instruction reported, teachers also broadened their own practice by differentiating tasks based on student interest as well as addressing the varying learning styles of their students. Based upon the interview data, by the end of the year, ten of the thirteen teachers believed that the most important aspect of teaching mathematics was to get the students to understand the concept. Three of the teachers said that they were equally as important. However, in the beginning of the study some teachers believed that it was more important for students to be able to calculate an answer as opposed to understand the problem and what their calculation represented. This shift in thinking suggests that as teachers became more comfortable with the content (through the faculty meetings and study group discussions) as well as differentiating instruction to meet the needs of all learners, teachers put more emphasis on the importance of having the students understand the mathematical concepts.

Out of the three elements of the professional development provided during the year, the study group was reportedly the most positive and significant experience. The study groups provided opportunities for teachers to differentiate lessons together whereby each members' strengths were accessed. In addition, the study groups provided opportunities to discuss the curriculum itself more deeply, analyze student work, and then design lessons that would meet the needs of their students in order that they could grasp the essential skills. The participants noticed a positive increase in their ability to differentiate lessons effectively once they were on their own back in the classroom as

well. During the study groups, the teachers also had the opportunity to experiment with new practices and tools such as the LAST protocol and the tiered lesson planning sheets. Both proved to be successful in providing a structure to allow the teachers to process more effectively.

In Chapter 5, these findings will be discussed in greater detail with an additional discussion related to the literature review. The implications of the findings will also be discussed in the following chapter as will suggestions for additional research.

## CHAPTER 5: SUMMARY, DISCUSSION, AND IMPLICATIONS

### Introduction

This chapter will be divided into six sections in order to summarize the research study: Summary of Findings, Discussion of the Findings, Limitations to the Study, Implications for Practice, Policy, and Further Research, Leadership Lessons, and Conclusion. The first section will provide a summary of the findings followed by a discussion of the findings in relation to the literature review contained in Chapter Two. The limitations of the study will be discussed with regard to this study and its replicability at other sites. The fourth section will discuss the potential impact that the findings of this study will have on current practice and policies as well as the related areas that require additional study. The fifth section will report the lessons the researcher learned about her own leadership throughout the course of this leadership project leading into the final section concluding the study.

### Summary of Findings

The reported problem was the achievement gap between the regular education students and the special education students in the area of math. Strategies were employed in order to close the achievement gap by differentiating the instruction while using the *Everyday Math* program. Through the course of the leadership project, the researcher provided learning opportunities for the teachers to explore alternative strategies for mathematics instruction and to analyze student progress and their own practice both individually through the use of reflection journals and collectively through the grade level study group discussions and in the larger group discussions facilitated during the faculty

meetings. The remainder of this section will provide a summary of the findings relative to each research question.

*Question 1: What did teachers learn about math content and pedagogy to help special needs children meet standards-based proficiency in math?*

The content of the faculty meeting sessions was designed to broaden the teachers' understanding of both mathematics content and pedagogy. Periodically, teachers filled out exit slips and recorded their learnings during individual faculty meeting sessions. In December, for example, teachers reported that they had learned new computational strategies that were still efficient and might be employed by their students. In January, teachers again reported learning new computational strategies, this time for subtraction, that might help their struggling students understand the concept with greater facility. It was important that teachers have an opportunity to learn additional strategies themselves in order to analyze what their students were doing in their classroom. Vocabulary was also cited as something new they had learned during the session. While responses during the faculty meetings suggested that teachers were indeed learning more about the math concepts of place value, as well as additional strategies to solve computation problems, more often than not, teachers spoke of their learnings of different pedagogical approaches.

Throughout the course of discussions through the year, teachers remarked on the increased use of multiple intelligences and differentiated instruction in order to help special needs children meet standards-based proficiency in math. Teachers started to develop the habit of viewing the lessons through the lenses of their students and

developed tiered lessons to address the needs of students of varying abilities. By the end of the year of the study, teachers had also begun to experiment in differentiating instruction based upon student interest in addition to differentiating by ability. Teachers were also using more small group instruction, or guided math groups, more often than they had in the past. Incorporating multi-sensory approaches was slowly becoming the norm rather than the exception reserved just for struggling students.

During the exit interview, teachers claimed with greater confidence that having students understand the mathematical concept was more important than having them understand how to perform a mathematical procedure in order to solve a problem. After the teachers employed strategies to differentiate the instruction rather than to stay in lockstep with the single procedure laid out in the lesson plan in the manual, teachers appear to be more confident that the students were indeed understanding the concepts. The teachers felt less obligation to directly teach a rote procedure just so the students can arrive at an answer which would remain somewhat meaningless and instead focused on finding the appropriate modes by which students could make meaning from the problem and the method they would use to solve the problem. Teachers began to step away from the “direct teaching” approach in the classroom and allowed a more student-centered structure to prevail. In the reflection journals, teachers reported that they were providing more opportunities for student self-assessment of their progress in learning concepts and skills, allowing students extra time when needed in order to learn at their appropriate pace, providing additional opportunities for students to share their own strategies and



allowing greater “wait time” during activities which conveyed the message to the students that their thinking processes were important.

*Question 2: What were the most helpful components of the professional development program that promoted teachers’ learning?*

There were three components to the professional development program that promoted teachers’ learning: whole-staff faculty meeting sessions, grade level study groups, individual reflection journals. According to the post-implementation survey, 100% of the teachers who participated in the study group sessions agreed that the study group sessions were the most significant factor in promoting teachers’ learning. Most of the staff as a whole regarded the exploration of concepts at the faculty meeting as beneficial. Almost 50% of the staff responding to the survey believed that the readings and handouts were beneficial, but they did not have as great of an impact on teachers’ learning as the faculty meeting activities and study group discussions. Additional time would have been necessary to delve deeply into the readings and to discuss the issues in greater depth in order to have maximum impact on teachers’ learning. The faculty meetings also served to model to the teachers the importance of allowing students to share their thinking. During several of the “math warm-ups” during the faculty meetings, teachers shared their strategies to one another resulting in revelations to their colleagues. Teachers, in turn, were reminded to do the same in their classrooms and allow students to share their strategies with one another.

In addition to the interactive discussions at the faculty meetings and in the study groups, the study group participants also reported that learning how to use the LAST protocol and the tiered lesson plan template were also beneficial. The LAST protocol helped to provide structure to the conversation and keep members focused on the task of analyzing student work. Even though teachers have different students each year, with the exception of the looping and multi-age classrooms, completing tiered lessons plans helped the teachers to compile a variety of teaching strategies for a single concept or skills that provided teachers with a firm foundation to begin with the following years.

Study group participants were required to maintain a reflection journal. This running record of student progress and teaching practices encouraged teachers to continually refine their craft. Teachers periodically reviewed their journals and were then motivated to try new strategies when they realized they had a tendency to resort to an approach they were more comfortable with when, at times, a new approach would be beneficial to the students.

*Question 3: Which of the newly employed strategies did teachers perceive worked the best?*

Teachers were able to cite strategies that were effective for them in differentiating instruction to meet the needs of all learners. Study group participants noted that they were differentiating by the content, the processes through which students would learn the material, as well as the product, or the performance of the task by the students.

Successful strategies for differentiating the content included changing the numbers,

altering the objects of the problems to provide for more authentic problem solving, and altering the language used to accommodate language deficits. The successful strategies for differentiating the process and product included focusing on the receptive and expressive preferences of the students. Teachers reported using a high percentage of visual presentations and representations in order to help the students understand concepts and skills. Teachers were flexible in the way in which they expected students to demonstrate understanding and they were able to accept multiple variations as the “product” in order for students to demonstrate understanding through their preferred mode of output.

In terms of the types of differentiated instruction, teachers most often differentiated on the basis of student ability. Several teachers remarked that it was important to pre-assess students in order to group them appropriately for small group instruction on a given topic. The groups remained flexible as students had strengths in different areas, although there were some groups that tended to remain fairly static since they required specific accommodations and modifications on a consistent basis. A few teachers commented, however, that after differentiating instruction based on students’ interests, that it, too, was a successful strategy. Students were motivated to learn and were able to grasp the concepts and skills necessary to meet the grade level standards.

*Question 4: What were the challenges of implementing the embedded professional development?*

The researcher identified three challenges of implementing the embedded professional development: participation requirements of the study, scheduling difficulties, and obtaining union approval. The first challenge, the participation requirements, was also a limitation of the study. Each participant of the study group had to have attained professional status in order to participate. As a result, non-professional status teachers who wanted to participate in the study group were not able to do so. If *all* teachers who wished to participate could have, then the benefits of having an entire grade level meet together twice per month may have had even greater impact on the teaching and learning at Princeton Elementary.

The scheduling difficulties were challenging in two ways. First, one of the special education teachers left the study group, because she felt that she was not doing the right thing for her students who were scheduled to be serviced at the time of the study group. She sacrificed the time she could have spent with colleagues in order to carry out her primary obligation, teaching the students on her caseload. Second, imposing the embedded study group time within a schedule that did not already allow for that common planning time, created a hectic schedule for the teachers. Based on the positive comments regarding the study group discussions, the teachers felt it was worth the hectic scheduling to participate in the study groups.

The third challenge was the most difficult for the researcher to contend with on a personal level. The intent of the project was to provide additional professional

development during the faculty meetings at no cost to the teachers while they would earn up to ten PDPs and provide common planning time for grade level teams to meet to improve teaching and learning at Princeton Elementary in the area of math. The union was not involved by the study group participants, as these teachers had volunteered to participate. Instead, the union was involved, because the structure of the mandatory faculty meetings had changed. Through the lens of the researcher, this was a win-win situation; the teachers would gain professional development points towards their recertification and the researcher would ensure that the entire staff was working on a common goal, to help each child at Princeton Elementary achieve standards-based proficiency in math by differentiating instruction. There were a number of teachers on the faculty who believed that they should not be forced to learn about a particular area if they did not want to, even if it was a subject that they were teaching. The issue that made this the largest challenge for the researcher was that she had believed that the staff was on board and that she had garnered their support. To have the union brought in unexpectedly was disappointing. After working with the union president, however, the staff and the researcher came to an understanding and the project proceeded with only minor adjustments.

### Discussion of the Findings

The findings of this study relate to the following areas of educational research discussed in Chapter Two: professional expectations in mathematics education, cognitive

development and math acquisition, successful teaching strategies, and collaborative improvement efforts.

*Professional Expectations in Mathematics Education*

According to the National Council of Teachers of Mathematics, teachers need to teach mathematics to meet the individual needs of each child, they must provide necessary support for children to learn the concepts well, and use student assessment to guide further instruction (NCTM, 2000). The faculty meeting sessions were designed to provide teachers with additional strategies to meet the needs of different learners. The staff was able to explore multiple intelligences, experiment with differentiating instruction in various ways, and learn additional strategies to connect with learners who think about math differently than those who adhere to the traditional algorithms.

The study group members were able to take this learning to a deeper level and were provided with opportunities to analyze the student work and their current practices to ensure that each child was able to learn the concepts. By creating tiered lessons together, teachers were able to reflect on their current practice and revise their teaching. However, while some teachers did provide additional learning opportunities during the year of the study, other teachers viewed it as a process that would inform their instruction the following year. Additional work would, therefore, need to occur around the role of assessment and an understanding of the importance of using formative assessments. Regardless, the fact that the focus among the staff shifted from stressing the learning of a procedure to learning the concept is a positive indicator of the teachers' growth being in line with the NCTM standards for the teaching and learning of mathematics.

## *Cognitive Development and Math Acquisition*

According to Piaget (1965), children's understanding of mathematical concepts must begin with the concrete and gradually evolve into the understanding of the abstract symbolic language of mathematics. The findings of the study are consistent with Piaget's six teaching principles:

- 1. Numbers must be meaningful.** Teachers discovered that the students were more successful when they had authentic problems that related to them personally.
- 2. The language used should elicit logical quantification, comparison, and representation of the situation.** Through the faculty meetings, teachers were gaining additional language to share with their students related to the mathematical operations such as *more than*, *less than*, as well as the names of different computational strategies.
- 3. Demonstrate understanding by manipulating objects.** Most of the mathematical tasks in Kindergarten through grade three included a component of each lesson where hands-on materials were involved in the early stages of learning a concept or skill. As Schwartz (2005) indicated, the younger the children are, the more they need to use all of their senses in order to learn new things. The teachers in the study found that the multi-modal presentations were effective since different students within the same class learned best through different modes. It was not enough to listen to a teacher describe how to solve a problem, but instead teachers provided opportunities to watch, listen, and act out the situations themselves.
- 4. Have students prove their logic.** Many of the teachers spoke of the importance of allowing students to share their strategies or to participate in a group discussion at the end

of the lesson. While students were able to use any strategy that worked for them, during the discussions, they were required to prove that their strategy worked. In order for students to be able to prove their logic, they would also need to use the appropriate language to describe what was happening in each step (Principle 2) and possibly demonstrating as they are explaining it (Principle 3).

**5. Decipher how the children are thinking.** By using the LAST protocol, teachers involved in the study groups were focused on this important task. Rather than marking a problem as correct or incorrect, teachers discovered that there is value in understanding how students were thinking about a problem in order to understand how best to teach them the concepts and skills they need to learn.

**6. Encourage students to make connections between what they already know and the new material.** By the end of the study, teachers understood the importance of having the students understand the concept rather than learning a rote procedure simply to find an answer. Only by understanding the concept will students be able to apply what they know to new situations.

Baroody (1987) focused on how understanding relationships was key. Teachers provided multiple learning opportunities in various presentation styles in order for students to be able to see, manipulate, and understand the relationships within the problems they were presented with. By being able to recognize patterns such as the growth of counting patterns within the base ten system, students were learning to be flexible with numbers, deconstructing and reconstructing the numbers again and again depending upon the new information they were given. The students' positive responses



to the center activities and stations support Baroody's theory that active learning opportunities fosters a learning environment where the *learning* is the reward.

### *Successful Teaching Strategies*

From the very beginning of the project, the teachers realized that guided math groups provided promise for mathematics instruction in order to meet the needs of all learners. Teachers recalled how the use of small group instruction allowed students at all levels to progress in language arts activities. By the end of the study, teachers were reporting more use of small groups than they had previously and as they became more comfortable with the management of ability groups, they began to experiment by grouping by interest as well.

Another strategy was to view the learning process as a collaborative one in nature. Costa (2008) spoke of the "ecology of thought" where the thinking of each member of the class was valued. Through the sharing of student strategies, teachers were cultivating this type of learning environment. The use of the LAST protocol encouraged teachers to analyze the students' thinking. Several teachers remarked that looking at the student work in a collaborative approach gave them insight into the thinking present in their own classroom even when the student's work being discussed was not in their class. If teachers were afforded adequate time to do this work on a regular basis, then they would become more and more adept at the types of questions they would need to ask their students in order to foster an even deeper understanding as they challenge or extend their students' thinking.

Stone (2007) pointed out that it was important not to underestimate the role of emotions in the learning process. Jensen (1998) also noted that since the left side of the brain is used for learning novel tasks and since the left side of the brain is also responsible for emotions, if math is a positive experience, then the endorphins that fire will create greater brain activity and therefore the students will learn more readily. Teachers provided the positive experience in multiple ways. One teacher spoke about modeling the enthusiasm for the subject matter. Others reported that the stations and centers provided active, highly motivating activities that maintained student engagement.

Choate and Evans (1992) purported that self-assessment was important for students with disabilities. Several teachers reported that they used self-assessment on a regular basis. Some teachers used self-assessment at the end of a unit and others at the end of a single lesson in order to gauge how much additional reinforcement of the concepts was necessary. Other teachers saw the benefit in raising the students' awareness of the expectations by directly teaching the students how the rubrics would be used before the students completed a task. By making the expectations clear to the students, teachers saw an increase in the students' performance.

By using a variety of strategies to differentiate instruction, teachers were able to challenge all learners. Several teachers noted during the interviews that some students may excel at one task and not at another so that the groupings needed to change depending on the skill being taught. Rather than to only focus on the skills that were difficult for the struggling learners, teachers built upon their strengths as well avoiding the "sense of frustration and futility" that Tomlinson and Eidson (2003) referred to when

students are only involved in the skills the students had not mastered. Tomlinson also spoke about the importance of purposeful planning in order to differentiate instruction. The teachers found that the time devoted to planning differentiated lessons during the study group sessions as the most beneficial aspect of the experience. By investing the time and energy in being proactive in planning, the teachers were able to respect the learning styles of the students with each new essential skill being taught.

### *Collaborative Improvement Efforts*

The professional development opportunities provided during the year of the study followed the guidelines for an instructional model of Sprinthall and Thies-Sprinthall: (1) providing role-taking experiences, (2) Providing experiences neither too high nor too low for the learner, (3) Allow for thoughtful reflection, (4) Provide a balance between experience, discussion, reflection, and teaching, (5) Programs need to extend over a period of time ( at least a year), (6) Personal support and challenge must both exist. The study groups provided teachers with opportunities for role-taking in order to understand students' thinking. By having the participants maintain a journal, ongoing reflection of their teaching practice was encouraged as well. In addition, by holding the study groups twice a month, teachers were able to try new strategies, reflect on the students' performance, alter their strategies and debrief with their colleagues during the study groups. While notable growth was made over the course of one year, teachers realized that it needed to continue in order to continue the pattern of growth. At the end of the study, several teachers chose to continue to meet together over the summer to maintain their momentum and to plan the remaining lessons for their grade.

Elbow (1986) pointed out that there must be a combination of both content and pedagogy in new professional development opportunities for teachers. The faculty meeting sessions provided opportunities to gain a deeper understanding of the math content as well as the successful teaching strategies associated with the different concepts. The tendency for teachers to teach students in the same way they were taught (Resnick, 1998) was still evident in some of the responses on the faculty meeting exit surveys. It is interesting to note, however, that the teachers who were more comfortable relying on the familiar, traditional algorithms had not chosen to participate in the study groups where the teachers were afforded greater opportunities to delve into the concepts themselves and to explore the strategies the students were finding success with. While not every teacher agreed that the focus on mathematics instruction was the focus that each teacher should have, the grade level where there was the greatest number of teachers involved were of a single mind. Just as Judith Warren Little (1999) noted, the teachers at this grade level, with the greatest investment of teachers, had become motivated to learn from one another in their quest to improve student learning. The teachers were involved in the *joint work* of analyzing student thinking and to plan lessons that would maximize the learning potential of their students. While this was not true of each grade level, this particular team showed the promise of study groups as a beneficial professional development experience.

## Limitations to the Study

There were several limitations in this study. With the small sample size, thirteen teachers in the study groups, the findings of the study cannot be generalized to other settings. The findings simply report the benefits of the professional development opportunity on this particular sample of teachers at this particular school during the year of the study.

Another limitation was the fact that the researcher was also the instructional leader of the building and the principal collector of the data. To provide for as much objectivity as possible, the researcher used several data sources and looked for patterns and trends in the data across all of the sources. The surveys distributed to members of the entire faculty were given anonymously with only minimal demographic information to aid in describing the data without revealing the identity of each respondent. The researcher also asked the same interview questions of each of the study group participants to provide as much consistency as possible.

The length of the study is another limitation. This study took place over the course of a single academic year. Due to this short time frame it is not possible to ascertain the impact the changes in instructional practices over the course of the study will ultimately have in helping to close the achievement gap between regular education students and special education students in mathematics.

In addition to the leadership project initiated, the district was also focused on improving reading comprehension. The fact that teachers were involved in more than

initiative at the time may have had an impact on the effectiveness of this particular professional development.

As mentioned previously in Chapter Three, there were several teachers who were taking a differentiated instruction course simultaneously. The grade level that seemed the most invested in the study group experience and chose to extend the learning opportunities over the summer included the three teachers taking the differentiated instruction course. While not every teacher at that grade level was taking the course, the researcher believes that the course and the provision of the embedded study group time worked in concert to improve mathematics instruction at this grade level. Furthermore, rather than focusing on the course as a limitation to the study, the success of this grade level suggests that further exploration of differentiated instruction strategies is warranted at the other grade levels at Princeton Elementary.

#### Implications for Practice, Policy, and Further Research

Throughout the study, the need for more time and support personnel was echoed again and again. Teachers noted that time is a scarce resource and the study group members all appreciated the time devoted just to the topic of math. While teachers meet with their grade level colleagues once a week, they meet on their own time and more often than not, the day to day administrative tasks occupied most of the available time without leaving any room for the discussion of teaching and learning. Regardless of whether the teachers at a grade level were involved in an additional course or not, all study group members reported that the time they spent in their study groups was beneficial towards the improvement of mathematics instruction. In a profession where

continual renewal is necessary, it is essential for educators to be provided with adequate time to review current practices, reflect on the strategies that are most successful, and refine their craft in order to provide opportunities that will maximize student thinking and learning.

In addition to the time needed for colleagues to work together, time was also mentioned with regard to providing additional time and opportunities for students to master essential skills. If teachers continue to feel pressured to “cover” the curriculum as opposed to focusing on their students’ current functioning and where they need to be, then there needs to be a plan in place in order to ensure that additional learning opportunities will be provided if the students continue to struggle to master essential skills.

Teachers were able to employ small group instruction more often and as a result, students were more likely to grasp the necessary concepts, but in order to use guided math groups regularly, additional support in the classroom was a necessity as well. Teachers altered their schedules in order to be able to provide additional adult support in the room for specific lessons, but unlike guided reading groups, teachers were not yet able to use guided math groups on a daily basis without additional support personnel. By the end of the study, teachers were beginning to see how it might work if students were involved in independent activities while groups were pulled one at a time, but if additional support personnel were present, then there would be an increase in “instructional” time as opposed to additional practice opportunities. In order for students to maximize their learning, students at all levels need to be challenged. By facilitating

student learning in small groups, students are more actively engaged and are more accountable for their learning.

As mentioned in the previous section, the course three teachers were taking simultaneously on differentiated instruction had a positive effect on this study as well. Teachers received additional instruction on the theory behind differentiated instruction strategies, more in depth than the researcher could provide during the faculty meetings once per month. The positive effect in terms of the motivation and sense of obligation to differentiate instruction was apparent in the study group's desire to continue their work over the summer. Based upon their successes, providing additional training in differentiated instruction to the staff as a whole may be a promising endeavor for Princeton Elementary School.

With 100% of the study group participants reporting that it was a positive professional development experience, the superintendent agreed to provide the funding for the study group structure to remain the following year. Since each teacher was a part of the district-wide efforts in improving reading comprehension, study group sessions were provided the year following this study and included every teacher at each grade level to further explore successful strategies to improve students' reading comprehension. With two other primary schools in the district of North Edison, this structure may indeed prove to be a successful mechanism for the other schools to utilize as well.

### Leadership Lessons

The completion of this project and the related study yielded many personal learnings about leadership in general as well as revealing areas for personal



improvement. The most significant learning, was the realization that no matter how promising a change may seem, the process of change may be too overwhelming for everyone to overcome. Second, was the importance of providing a structural framework to support the teachers in their work. Third, was the need to view challenges as learning opportunities.

In order for the change to be successful, teachers and the school leader all needed a strong sense of *personal mastery* (Senge, 2006) where they are committed to their own vision, but can also embrace the vision of the school and can accurately interpret the reality before them while identifying what needs to be done to propel the school further towards the vision. While a few of the members of the staff embraced the vision, others remain *compliant* and are following the expectations out of a sense of responsibility as a duty rather than a moral obligation to do what is right for students. Even though a shared vision emerged with the staff during the opening faculty meeting, each staff member still had their own assumptions that were not uncovered. This is an area of personal challenge for the researcher; she needs to move beyond her natural tendency to want to please and be able to lead the teachers through the chaos of identifying the organizational assumptions of Princeton Elementary. As this process continues it is hopeful that “compliant” members of the staff will become more committed to the vision as they see success mount through student performance and the improvements their colleagues are making to their practice of teaching.

There is a constant tension between the ideal, the vision, and the status quo. Heifetz (2002) explains that leadership is disappointing people at a rate they can absorb.

While it is true that some decisions do fall on the principal as the school leader, there are some decisions that teachers *want* the principal to make, when they would be better served being led through the decision making process and being the ones making the decisions. As Heifetz suggests, the work was given back to the teachers, the ones directly in relationship with the students. Teachers were active in analyzing what was working and what was not working in order to help each child succeed. The researcher was challenged not to provide **her** solutions to **our** problems. The researcher needed to instill in others the same sense of urgency so that *they* were the ones identifying the problems as well. As improvements occur, decisions need to be made along the way; it is a constant journey of improvement.

The change process can be intimidating as well as invigorating. In the beginning of the year of the study, teachers readily shared what worked but were hesitant to share strategies that didn't work in hopes of gaining insights from their colleagues' critique. As teachers progressed through the year in the study groups, they began to see the value of the collaboration as they developed lessons and units together. It has increased the sense of accountability they feel towards one another as well as to their students as members of a team. There were a number of structures, or parameters, that the researcher, as the school leader, needed to provide: structures providing support of their colleagues through the study group sessions, a structure to make the work consistent, and support from the leader herself.

The consistent provision of additional planning time for grade level teachers to discuss issues related to the initiative as they arise was helpful in order to keep the goal at

the forefront. The uninterrupted block of time, provided by the researcher, allowed for issues to unfold, be understood, and allow the teachers to plan a course of action. As teachers were changing how they planned mathematics lessons, providing extra time helped to mitigate the feelings of uncertainty and prevented the teachers from feeling too overwhelmed and abandoning the initiative.

Within the study groups, the leader provided several tools to aid the teachers in their work and to ensure consistency so that it was possible for the initiative to become, as Freire (2007) would term, “praxis”. Providing a protocol for discussing student work (the LAST protocol) allowed the teachers to explore how to become more diagnostic in their approach while the strict script prevented teachers from feeling too vulnerable. Teachers put so much of themselves into their teaching practice and when the student work is analyzed, teachers can, at times, feel that their teaching abilities are called into question. The protocol, allowing only certain members to interject at a time aided by the facilitator, diffused the anxiety. In addition, the scripting provided modeled non-judgmental language for the teachers to use. While stilted at first, it allowed the difficult conversations to begin leading to what will hopefully become a group of teachers able to provide the necessary critique to allow improvement to emerge. Lastly, the tiered lesson template, provided a guideline for differentiation which was user-friendly and highlighted the necessary components for lessons to be able to reach students of all ability levels.

The leader had underestimated the importance of the moral support needed from the principal as the teachers embarked on their journey to make mathematics lessons accessible and successful for all learners. Several teachers noted that when the time was

left open for the discussions that the team members felt necessary, they felt somewhat unsure of where to begin. As the leader asked questions of the participants, the teachers felt that they had an understanding of where they were headed. This was true not only for the study groups, but in the reflection journals as well. By asking questions, the leader was able to facilitate the teachers' deeper thinking about the decisions teachers were making in their instruction and where to go next.

The largest personal lesson was the need to embrace challenges along the way as learning opportunities. What appeared to be a “win-win” situation to the leader, was interpreted by some to be an imposition impacting current working conditions. The leader, as someone who would prefer to leave “administrivia” behind and best utilize the little time that the faculty is altogether, believed that the idea that each faculty meeting could be devoted to a relevant curriculum issue seemed like a promising improvement. It required no additional work of the teachers outside of the meeting and they would be compensated for their efforts by the awarding of PDPs. The leader underestimated how the proposed change would impact the faculty. Discussing curriculum is indeed more work than listening to the directives regarding administrative tasks or discussing other issues not directly related to teaching and learning. The teachers were required to think more deeply about the subject matter and in some cases it was not of personal interest to them. Each teacher seems to have a passion for a certain area of the curriculum; if math was not an area of interest for the particular teacher or if the teacher believed that what was currently happening was working, it was difficult for them to embrace the need to devote time to improving mathematics instruction. Elementary educators, however, do

have to teach mathematics as well as other subjects that may not be their preferred areas of study. Each area the teachers are responsible for teaching should be improved and renewed on a regular basis, but until that is a shared belief, it will be difficult to continue improvement efforts in this vein.

Over the course of the three years the entire leadership project took place including the planning, the implementation, and the study, there were many small lessons that resulted in the creation of a new leader. While there were discreet “lessons” learned, the researcher’s leadership style has also evolved over the course of the study. In the beginning, the leader sought to implement changes immediately if they showed promise. This propensity did not allow the leader at first to examine the issues fully by reflecting upon all of the possible ramifications. By viewing situations through Bolman and Deal’s four frames or lenses (Bolman & Deal, 2003) a leader of an organization can see the same situation from four distinct vantage points.

Over time, the leader has become more confident and comfortable in taking the necessary time to reflect on the implications of actions within the structural, human resource, political, and symbolic frames. If the leader had initially taken the time during the planning stage to view the redesigned faculty meeting issue through the human resource frame, for example, she would have been able to focus on what the change would mean for the teachers. The leader saw benefits for both the organization and for the teachers, but only as seen through the lens of her values and what was important to her in terms of consistent improvement. Teachers, on the other hand, were being asked to forego the familiar faculty meeting routine for a novel structure and the outcome of the

changes were unknown and without assurances. An idea that sounded good in theory such as “free professional development” was being offered at an unknown cost of time, effort, and accountability.

After being led *by* experiences such as this throughout the project, the leader is better able to analyze the potential issues and has learned the importance of building relationships first. She has learned to listen more to what others say and do not say and to ask more questions than she provides answers. Most importantly, the leader has learned to question her own rationale for changes to determine what is truly necessary to change and what of existing practices can be retained. While it is important to constantly reevaluate where the school is in relation to its vision, it is equally as important not to lose sight of the smaller victories along the journey while still maintaining the school’s vision as the focal point. Along the way, the leader has learned, that it is essential to notice the subtle changes in the climate within the culture of the school in order to know when to challenge and extend and when to slow down the pace and provide additional support.

### Conclusion

The goal of the leadership project was to differentiate instruction to close the achievement gap for special education students using *Everyday Math*. The teachers were provided with three different opportunities for professional development to support their efforts in differentiating the lessons. Whole-staff professional development sessions were planned during each of the hour-long faculty meetings. Additionally, thirteen teachers volunteered to participate in study groups twice per month as well as

maintaining a reflection journal documenting their successes and challenges as they strive to improve the teaching and learning of mathematics at Princeton Elementary.

The whole-staff professional development sessions were successful in raising teachers' awareness about the different strategies that students and teachers could employ. Since mathematics achievement was an area of focus on the School Improvement Plan, the faculty meeting sessions kept mathematics as a consistent focus for the school. Teachers were able to delve into the topics themselves and understood some of the difficulties that their students encounter as they are learning new concepts and skills. By leading them through the process and sharing alternate strategies, teachers left the sessions equipped with additional strategies to try if their students were struggling.

As stated previously, each member who participated in the study groups reported that they benefited from the experience discussing work with their peers and reflecting about their work in the journals as they differentiated instruction in math. One teacher remarked in the following October, "Just wanted to thank you again for the time last year to explore differentiating the math program. It has put me on a different page this year in first grade. I am able to look at the math lessons with a new perspective and differentiate some of them this year. I feel it is making me a better teacher of math... and more reflective."

Princeton Elementary students in the Spring of the year of the study performed well on the state test. Well above the state average, 86% of the third graders at Princeton Elementary performed in the "proficient" or "above proficient" category. However, in

order to truly measure if the efforts in differentiating the instruction had the effect of closing the achievement gap, there would need to be a longitudinal study tracking student progress over the course of several years with a diminishing gap between the performance of regular education students and special education students. However, as seen in Chapter Four, the teachers appeared more confident in their students' ability to understand the concepts in the post-implementation interviews than they had before the initiative.

The professional development structure of providing common planning time twice per month devoted solely to improving teaching and learning was perceived as a successful structure for future professional development. The teachers at Princeton are all currently participating in embedded study groups once per month devoted to the area of improving reading comprehension skills. As a result of the study groups continuing for an additional year, Princeton is slowly institutionalizing this practice.

In general, there needs to be a shift at Princeton Elementary to become an actual learning organization rather than an organization of learning. There are some mechanisms in place already that bring the organization forward such as the School Council whose improvement plan is viewed as an opportunity to reinvent and renew the school; it is an energizing process. The study groups experienced the same positive energy through their collaborative efforts to improve and maximize the potential of the mathematics lesson plans by differentiating instruction and by analyzing student work together.



In line with Starratt's and Sergiovanni's (2007) work, after leading the study group participants through a collaborative model, the virtue of collegiality has become more clear as a substitute for leadership. It was necessary to build the culture of collegiality throughout the school so it becomes ingrained in the organization. The value of the collaborative work was felt so strongly that the teachers relayed their positive experiences to others and the initiative blossomed into a school-wide initiative the following year. While the teachers only meet once a month currently, the entire grade level team is involved in the discussions, which proceed without the school leader being present. With a shared vision, and support of the leader in providing the time and substitute coverage, the teachers were able to embark on a journey of self-discovery towards improving their own teaching while working through the tension between the reality and the vision together.

The sense of collegiality at Princeton is slowly strengthening. During the year of the study, teachers were encouraged to visit each others' classes and substitute coverage was offered, but no one took advantage of the opportunity. However, during the current year, one teacher approached the principal with a lesson that she would demonstrate and the other teachers eagerly jumped on board to observe the lesson and debrief and discuss what occurred together as a team. Hopefully, this will be a successful experience and will be the start of an additional mechanism for collaboration.

Ultimately, if every misstep is viewed as a "learning opportunity" then you can look forward positively. Whether it is student behavior, instructional practices, or personal interactions, breaking a pattern and recreating new behaviors and practices will

result in positive action in some way. By looking at things in this light, we can keep our heart open and continue to serve and to lead our schools forward.

## NOTES

♦ p. 62

This statement is based on Little's research of Miles and Darling-Hammond from the following sources:

Miles, K.H. "Freeing Resources for Improving Schools: A Case Study of Teacher Allocation in Boston Public Schools" *Educational Evaluation and Policy Analysis*, 1995, 17(4), 476-493.

Darling-Hammond, L. *The Right to Learn: A Blueprint for Creating Schools That Work*. San Francisco: Jossey-Bass, 1997.

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# APPENDIX A

## MATHEMATICS INITIATIVE SURVEY

### 1. Introduction

The results of the MCAS tests over the past few years have identified a large achievement gap between the regular education and special education students in the areas of mathematics. It is noteworthy that the achievement gap in math is greater than the achievement gap in reading. Please answer the questions below in order to inform the professional development opportunities that will be provided next year to focus on improving student achievement and closing the achievement gap in mathematics.

Click "Next" to get started with the survey. If you'd like to leave the survey at any time, just click "Exit this survey". Your answers will be saved.

### 2. Basic Information

#### 1. What grade do you teach?

- Kindergarten
- First Grade
- Second Grade
- Third Grade
- Multiple Grades

#### \* 2. How many years have you been teaching at your current grade level(s)?

- Less than 1 year       1-3 years       5-10 years       More than 10 years

#### \* 3. How many years have you been teaching mathematics at your current grade level(s)?

- Less than 1 year       1-3 years       4-10 years       More than 10 years

#### \* 4. Describe the ways in which you differentiate instruction in the area of Reading.

#### \* 5. Describe the ways in which you differentiate instruction in the area of Mathematics.

#### \* 6. Describe any additional resources (time, personnel, money) that are needed in order to differentiate instruction more effectively.

#### \* 7. Describe the way in which you assess students' understanding of mathematics concepts.

## MATHEMATICS INITIATIVE SURVEY

- \* 8. Please explain how you use data (observations of student performance in the classroom, student work samples) to drive your instruction.

### 3. Everyday Math

Please answer the questions below pertaining to Everyday Math.

9. Thinking solely about Everyday Math, please rate the program's effectiveness in providing adequate experiences in each of the strands. (1 being the most effective)

	1	2	3	4	5
Number Sense and Operations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Patterns, Relations, and Algebra	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Geometry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Measurement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Probability and Statistics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10. Please rate the Everyday Math program's lessons in terms of the level of effectiveness for the following sub-groups.

	Very Effective	Effective	Somewhat Effective	Not Effective
Special Education	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Free/Reduced Lunch	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ELL	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students new to Easton	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11. Please explain your reason for listing one or more of the above as "Not Effective". (This information will help me to provide more effective support for your work with your students.)

Please type your answer here.

- \* 12. What portions of the Everyday Math program are helpful in analyzing student work?

### 4. Professional Development

Please reflect on the Everyday Math professional development opportunities in "North Edison".

## MATHEMATICS INITIATIVE SURVEY

**13. Please rate the positive impact the professional development opportunities listed below have had on your students' success with mathematics skills and concepts. (1 being the strongest, 4 being the weakest)**

	1	2	3	4
Overview with the consultant in the beginning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Embedded PD with the consultant during the year.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
"Everyday Math for Everybody"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assessment Assistant Software	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### 5. Problem Solving

**14. We have included some "Problem Solver" and "Exemplars" prompts this year as well as Everyday Math. Please share your experience using these materials in conjunction with the Everyday Math program. (Please include your observations of student successes and challenges with these programs.)**

### 6. Thanks!

I appreciate your feedback. Your ideas will help Princeton Elementary to move ahead and help all of our students to be successful in math.

Thanks again!

Vanessa Beauchaine

## Post MATHEMATICS INITIATIVE SURVEY

### 1. Introduction

The results of the MCAS tests over the past few years have identified a large achievement gap between the regular education and special education students in the areas of mathematics. It is noteworthy that the achievement gap in math is greater than the achievement gap in reading. Please answer the questions below in order to inform the professional development opportunities that will be provided next year to focus on improving student achievement and closing the achievement gap in mathematics.

Click "Next" to get started with the survey. If you'd like to leave the survey at any time, just click "Exit this survey". Your answers will be saved.

### 2. Basic Information

#### 1. What grade do you teach?

- Kindergarten
- First Grade
- Second Grade
- Third Grade
- Multiple Grades

#### \* 2. How many years have you been teaching at your current grade level(s)?

- Less than 1 year       1-3 years       5-10 years       More than 10 years

#### \* 3. How many years have you been teaching mathematics at your current grade level(s)?

- Less than 1 year       1-3 years       4-10 years       More than 10 years

#### \* 4. Describe any NEW ways in which you differentiated instruction in the area of Reading this year.

#### \* 5. Describe any NEW ways in which you differentiated instruction in the area of Mathematics this year.

#### \* 6. Describe any additional resources (time, personnel, money) that are needed in order to differentiate instruction more effectively.

#### \* 7. Describe the way in which you assess students' understanding of mathematics concepts.

## Post MATHEMATICS INITIATIVE SURVEY

- \* 8. Please explain how you use data (observations of student performance in the classroom, student work samples) to drive your instruction.

### 3. Everyday Math

Please answer the questions below pertaining to Everyday Math.

9. Thinking solely about Everyday Math, please rate the program's effectiveness in providing adequate experiences in each of the strands. (1 being the most effective)

	1	2	3	4	5
Number Sense and Operations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Patterns, Relations, and Algebra	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Geometry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Measurement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Probability and Statistics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10. Please rate the Everyday Math program's lessons in terms of the level of effectiveness for the following sub-groups.

	Very Effective	Effective	Somewhat Effective	Not Effective
Special Education	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Free/Reduced Lunch	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
ELL	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Students new to Easton	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11. Please explain your reason for listing one or more of the above as "Not Effective". (This information will help me to provide more effective support for your work with your students.)

Please type your answer here.

- \* 12. What portions of the Everyday Math program are helpful in analyzing student work?

### 4. Professional Development

Please reflect on the Everyday Math professional development opportunities in "North Edison".

## Post MATHEMATICS INITIATIVE SURVEY

**13. Please rate the positive impact this year's school-based professional development has had on your students' success with mathematics skills and concepts. (1 being the strongest, 4 being the weakest)**

	1	2	3	4	N/A
Exploration of math topics at Faculty Meetings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Opportunities to share examples of differentiation with colleagues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Readings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Handouts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Grade Level Study Groups	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other (please specify)

\* **14. Consider the following scenario:**

**Imagine that there is a school that holds 10 faculty meetings a year. That same school uses those faculty meetings to focus on the study of a different curriculum area each year. As a result the teachers who participate in the faculty meetings receive 10 PDPs for each of the five curriculum areas they teach.**

**If this type of opportunity were available to you AND it was supported by the other policy-making structures in your district, would you want to take advantage of this type of free professional development opportunity?**

**(Please answer YES/NO and explain why.)**

## 5. Thanks!

I appreciate your feedback.

Thanks again!

Vanessa Beauchaine

## APPENDIX B

### Interview Questions (13 Volunteer Participants)

1. Describe an ideal math lesson that would help every child achieve to the grade level expectations.

2. Define what the term *differentiated instruction* means to you.

3. Since all students in this state are expected to achieve to certain standards, how can this be achieved in a class with students at various levels of performance?

How do you know how to modify or accommodate the lessons to meet the needs of different learners?

4. What do you think is most important in mathematics? Is it understanding the process or procedure for completing a specific task or is it understanding the overall concept?

Do you think the import of the concept versus the procedure changes as the date of the state test approaches?

5. What has been your most challenging experience in teaching mathematics to students with special needs?

6. In your ideal school what supports would be provided in order to ensure that every child would succeed in math?

7. Is there anything else you would like to share about your experiences?