Investigating The Relationship Between Teacher Self-Efficacy Beliefs In Mathematics And Teacher Reflection: Do Teacher Thinking Dispositions Play A Moderating Role?

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INVESTIGATING THE RELATIONSHIP BETWEEN TEACHER SELF-EFFICACY
BELIEFS IN MATHEMATICS AND TEACHER REFLECTION: DO TEACHER
THINKING DISPOSITIONS PLAY A MODERATING ROLE?

An Abstract of a Thesis

Submitted

in Partial Fulfillment

of the Requirements for the Degree

Education Specialist

Shawna Hufendick

University of Northern Iowa

May 2009
ABSTRACT

Previous research has shown a relationship between teacher reflection and teacher acceptance of reform curricula. This study looked at the relationship between the variables of teacher self efficacy and teacher reflection, as they might relate to teacher attitudes towards instructional change. This study also looked at whether teacher thinking dispositions moderate this relationship. First and second grade teachers (N=16) participating in a professional development opportunity in mathematics completed an efficacy measure, a thinking dispositions measure, and kept a journal to reflect after mathematics lessons taught. The teacher efficacy, thinking disposition, and journal reflection data was analyzed to see whether relationships emerged. Results showed a significant relationship between effective reflection and acceptance of instructional change, but no relationship was found between efficacy and reflection. Teacher thinking dispositions were found to moderate the relationship between teacher efficacy and effective teacher reflection, but were not found to moderate the relationship between teacher efficacy and acceptance of instructional change. Implications for mathematics reform and future research are discussed.
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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree Education Specialist

Shawna Hufendick
University of Northern Iowa
May 2009
This Study by: Shawna Hufendick

Entitled: Investigating The Relationship between Teacher Self-efficacy Beliefs in Mathematics and Teacher Reflection: Do Teacher Thinking Dispositions Play a Moderating Role?

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CHAPTER 1

INTRODUCTION

Background

At this time reform-oriented mathematics curricula focusing on conceptual understanding is being introduced to elementary teachers (National Council of Teachers of Mathematics [NCTM], 1989, 1991, 1995, 2000). Traditionally, mathematics has been taught to students using drill and practice methods and teachers have used grades on assessments as the primary way of measuring student learning (Thompson, 1992, as cited in Stipek, Givvin, Salmon, & MacGyvers, 2001). Today reformers are asking teachers to aim for conceptual understanding and focus on teaching students the meaning and reasoning behind mathematics, in addition to teaching students rules and procedures for problem solving (NCTM, 1989, 1991, 1995, 2000). As teachers are asked to change their instructional practices in light of new reform initiatives they may struggle to accept this instructional change.

As researchers have looked at variables that may be related to teacher acceptance of change, two variables that have identified as playing a crucial role in acceptance of change are teacher reflection and teacher self-efficacy beliefs. Researchers have found that teacher reflection, when effective, often leads to teacher acceptance of change (Artzt & Armour-Thomas, 1999; Butler, 2003; Farmer, Gerretson, & Lassak, 2003; Franke, Carpenter, Fennema, Ansell, & Behrend, 1998). Researchers theorize that reflection is a means for teachers to think about how their instruction affects student learning, and when teachers recognize that their students are learning they often support the instructional
change that they believe led to student learning. However, some teachers may have difficulty recognizing student learning after moving to reform-oriented instruction, because their past methods of evaluating success are not aligned well with new teaching practices (Gabriele & Joram, 2007). In turn, this inability to accurately judge success and student learning may negatively impact a teacher’s sense of self-efficacy. This is important because self-efficacy beliefs have been found to positively relate to teacher acceptance of change, and low efficacy has been related to low persistence when faced with the challenge of teaching new reform-oriented curricula. (Allinder, 1994; Ghaith & Yaghi, 1997).

Whereas both teacher self-efficacy and teacher reflection have been linked separately to acceptance of instructional change, few studies have included measures of both variables in their design. Also, researchers have not consistently agreed on whether lower teacher efficacy (efficacy doubts about one’s ability to affect student learning) leads to the most effective teacher reflection or if high teacher efficacy most often leads to effective reflection (Allinder, 1994; Ghaith & Shaabon, 1999; Ghaith & Yaghi, 1997; Tschannen-Maran, Woolfolk Hoy, & Hoy, 1998; Wheatley, 2002). These studies will be discussed further in the following literature review. Future studies including both variables would allow researchers to more closely examine how the two variables relate to each other and consider whether a third variable might be moderating the relationship. Given the importance of understanding the process of instructional change for professional development, studies that include measures of both teacher self-efficacy and
reflection, seeking to clarify their relationship, would be helpful in understanding how to facilitate acceptance of instructional change.

**Purpose of the Study**

The purpose of the present study was to examine the relationship between teacher reflection and teacher self-efficacy. As described above, little research has examined the relationship between teacher self-efficacy and teacher reflection, and the research that has been done has not produced a coherent and consistent set of findings. One reason for this may be that a third variable moderates the relationship between teacher self-efficacy and teacher reflection. One variable that may play an important moderating role is a teacher’s thinking disposition. Thinking dispositions are described as “relatively stable psychological mechanisms and strategies that tend to generate characteristic behavioral tendencies and tactics” (Stanovich, 1999, p. 157).

In this study I explore whether thinking dispositions moderate the relationship between teacher self-efficacy and teacher reflection and/or teacher acceptance of change. I hypothesize that the relationship between teacher self-efficacy and teacher reflection and/or teacher acceptance of instructional change may look different depending on the thinking disposition of the teacher. More specifically, I investigate whether the relationship between efficacy and reflection and/or acceptance of change is weaker the more open-minded a teacher is. Teachers who are less open-minded and have lower efficacy may be reluctant to change instructional practices and feel threatened by reform-oriented math curricula, making them less likely to reflect and accept change. For these less open-minded teachers efficacy may be more strongly related to effective reflection.
and/or acceptance of change. However, for more open-minded teachers it may be less important how efficacious they are because they are already more willing to change and feel less threatened by reform. The relationship between efficacy and reflection and/or acceptance of change may be weaker for these teachers.

If thinking dispositions are found to be a moderating variable then reformers may need to tailor professional development opportunities to a teacher's thinking disposition, rather than focus attention exclusively on teacher efficacy, in order to effect teacher change. Since thinking dispositions are relatively stable ways different people approach situations it may not be beneficial for reformers to try to change a teacher's thinking dispositions to be congruent with reform initiatives. Instead reformers would need to design reform initiatives and professional development opportunities with different thinking dispositions in mind, as well as understand that the relationship between efficacy and effective reflection and/or acceptance of change will look different depending on each teacher's thinking disposition.

This paper will begin with a literature review looking at the current research on teacher beliefs about mathematics and why they are barriers to acceptance of change for many teachers. A reform-oriented mathematics curriculum is often inconsistent with teachers' traditional beliefs about mathematics instruction, and this affects whether teachers support reform-oriented curricula. It is important for reformers to understand how different teacher variables may influence beliefs and subsequently acceptance of change. For that reason the literature review will next look specifically at the variables of teacher reflection and self-efficacy beliefs. Both have been found to relate to teacher
acceptance of change, perhaps by first affecting teacher beliefs about mathematics instruction, but the relationship between the two has not been clearly defined. It will be necessary for reformers to better understand this relationship as they work to get teachers to support their reform initiatives. Finally, I will consider teacher thinking dispositions as another variable that may be important. I hypothesize that thinking dispositions may moderate the relationship between efficacy and reflection, helping to explain the inconsistencies of previous research. The paper concludes with a report of an exploratory study that looks at the relationship between teacher self-efficacy and teacher reflection, and then further considers whether teacher thinking dispositions may moderate this relationship.
CHAPTER 2
LITERATURE REVIEW

In today’s educational arena, mathematics curricula is hotly debated as educators are increasingly asked to teach for conceptual understanding of mathematics rather than focus solely on rules and procedures for problem solving. Evidence has established the importance of teaching students the meaning and reasoning behind mathematics, and this is the basis for the standards and principals set forth by National Council of Teachers of Mathematics (NCTM, 2000). Still, reformers have been disappointed with how educators have implemented recommended practice (Schifter & Riddle, 2004). As the focus of mathematics curricula continues to shift away from the memorization of facts and procedures and towards a focus on conceptual understanding, researchers have argued that teacher support of these changes will be essential for success (Gabriele & Joram, 2007; Smith, 1996).

One reason that teachers may resist implementing reform-oriented mathematics curricula as proposed by the National Council of Teachers of Mathematics Standards (NCTM) may be that it conflicts with the more traditional beliefs about mathematics that many teachers currently hold (Gabriele & Joram, 2007; Smith, 1996). Traditional views of mathematics instruction have historically placed the teacher in complete control of his or her classroom and students’ learning (Stipek et al., 2001). The main goal was for students to learn operations and get the correct answers, making it important for teachers to lead instruction and judge accuracy using traditional assessments. Today, reform-oriented mathematics focuses on student inquiry, or giving students choices in how they
approach problems, and valuing variety and student persistence (NCTM, 1989, 1991, 1995, 2000). Traditional assessments are no longer the focus, and instead teachers are encouraged to strive for meaning making for their students.

Teacher Beliefs

Due to the fact that research on reflection is closely tied to the idea that reflection can work to create belief change when preexisting beliefs are interpreted in light of new knowledge (Butler, 2003; Senger, 1999), it becomes increasingly important for researchers to better understand teacher beliefs about mathematics. Teacher beliefs are the different ways teachers think about mathematics curricula, instruction, and student learning (Stipek et al., 2001). In any given school there may be very traditional teachers, teachers who are extremely reform-oriented, and those who fall somewhere between these extremes. This continuum of teacher beliefs is also defined at times as a distinction between “inquiry-oriented” and “traditional textbook-based teaching.” Traditional beliefs include believing that the teacher is in control of student learning, emphasis on rules and procedures, and teacher-controlled motivational techniques (Thompson, 1992, as cited in Stipek et al., 2001). Inquiry-oriented mathematics beliefs include believing that students are motivated by challenging tasks and that the role of the teacher is to point out the conceptual understanding present in student explanations of mathematics and appropriately scaffold student learning (NCTM, 2001; Thompson, 1992, as cited in Stipek et al., 2001).

In the following study the definition of “teacher beliefs” was adapted from Stipek et al. (2001) because of its comprehensiveness from dividing teacher beliefs into three
categories: (a) the nature of mathematics, whether teachers believe mathematics provides procedures for solving problems or is generally a tool for thought; (b) the goal of mathematics learning, or whether teachers believe the goal of instruction should be correct answers or understanding larger concepts; and (c) who teachers believe should ultimately control the mathematical learning environment: teachers or students. This definition of teacher beliefs was chosen because of its comprehensiveness. A clear understanding of how teacher reflection influences teacher beliefs could help mathematics reformers better target teacher beliefs that do not align with reform-oriented curricula.

A study by Stipek et al. (2001) found that teacher beliefs in general are substantially coherent, meaning teachers who held one traditional belief about mathematics instruction (e.g. the teacher should be in control of student learning) were likely to hold other traditional beliefs (e.g. math is a set of operations to be learned). The same principle applied to reform-oriented beliefs. Twenty-one fourth-through sixth-grade teachers were asked to complete a survey entitled “Beliefs About Mathematics and Teaching.” The survey included 57 statements with which teachers could agree or disagree using a 6-point Likert scale. Teacher practices were measured by rating videotapes of at least two instructional periods for each teacher. This study found that teacher beliefs predicted instructional practices. However, this degree of coherence was based on a small sample of teachers (n=19), so future studies attempting to replicate the findings with larger sample sizes would lend credibility to these results.
The Stipek et al. (2001) study showed that teachers who held more traditional beliefs were more likely to emphasize correct answers and speed of procedural use compared to teachers who were more inquiry-oriented. These findings suggest that understanding teacher beliefs is important during periods of instructional change. Teachers in this study who had more traditional beliefs about mathematics tended to focus on the aspects of mathematics curricula and measures of instructional success that are not highly valued by mathematics reformers, such as correct answers and procedural speed. The teachers did not emphasize measures of success that are valued by mathematics reformers, such as whether students could explain their thinking and apply their learning. The results of this study suggest that teacher beliefs about mathematics instruction can become barriers to teacher acceptance of instructional change. Teacher reflection, discussed below, is one method by which reformers have tried to affect these beliefs so that they are more aligned with reform-oriented curricula.

Teacher Reflection

Reflection could be considered one of the primary teacher change agents during periods of educational reform, because it can help transform teacher practice (Clarke, 1995). The act of reflection is not simply thinking about something in retrospect. In education, reflection can be considered to have three specific levels: (1) applying educational knowledge both efficiently and effectively; (2) assessing the educational ramifications of specific teaching actions; and (3) expressing concern about whether the purposes of teacher instruction are being met (Van Manen, 1977). Levels two and three are especially important for understanding how teacher reflection may influence teacher
beliefs about mathematics instruction. First, when teachers reflect upon the ramifications of their classroom instruction they find that they are either content with their current instruction or dissatisfied with aspects of it. If reflection leads to teacher dissatisfaction, there exists the possibility that upon further reflection, teachers will change previously held teaching beliefs about mathematics in order to experience higher teaching satisfaction in the future. Similarly, when teachers reflect upon instruction to see whether their teaching goals are being met, there is also the opportunity for belief change. If teachers, upon reflecting, decide that students are not learning, then this may become motivation for teachers to reevaluate previously held beliefs about mathematics instruction. However, simply targeting teacher reflection may not be enough, and the variable of teacher self-efficacy is often overlooked when thinking about how reflection influences teacher acceptance of change. It may be that teachers need to feel efficacious enough to reflect in the first place, before they ever have the opportunity to judge whether teaching goals are being met.

Many teachers teach one way consistently throughout their careers, but with the introduction of new mathematics programs and curricula teachers are often asked to change curricula and teaching practices and deal with new problems (NCTM, 1989, 1991, 1995, 2000). According to Schon (1983), when new issues arise as a result of reform and instructional change, teachers adapt through reflection on their instruction. However, teacher reflection is recursive, meaning teachers must try to understand and accept new programs in light of the traditional pedagogical beliefs they hold and adjust their held beliefs as they see necessary (Senger, 1999). In this way it seems likely that
more traditional teacher beliefs about mathematics may become barriers to teacher acceptance of reform-oriented mathematics programs and curricula, because traditional teachers’ pedagogical beliefs may prevent some from seeing instructional change as necessary. Through reflection, however, teachers may choose to modify traditional beliefs that are incongruent with new instruction and eventually accept instructional change proposed by reformers.

In his investigation of how teachers translate the theory behind mathematics reform into their teaching practice, Butler (2003) found that they must progress through specific stages before they can actually use what they have learned within the context of the classroom. Using two consecutive two-year long collaborative professional development projects, Butler developed a theoretical framework for how teachers adopt new ideas. Teachers must: (a) see how their beliefs influence their decisions in the classroom; (b) interpret reform ideas in light of existing belief systems; (c) practice reform principles in context to make instructional decisions; and (d) revise their own teaching beliefs through reflection on their instruction. By progressing through these stages Butler’s theoretical framework suggests that teachers are better able to monitor their own learning during periods of instructional reform, interpreting the goals of new instruction using revised belief systems that are more congruent with reform-oriented mathematics instruction (Butler).

**Relationship Between Teacher Reflection and Teacher Beliefs**

It is naive to assume a direct link between the introduction of new mathematics curricula and teacher instructional and belief change. Instead, the current study suggests
that teacher reflection may be a moderating variable; specifically, that reflection may actually lead to teacher belief transformations that are a necessary precursor to acceptance of change. Looking at teachers in a medium-sized, public school, Senger (1999) found that the change process for teachers involved recursive thinking, or the “folding back between different ways of experimenting rather than a linear movement in stages” (p. 210). This study involved many teachers in one school from various grade levels, who took part in group discussions. Only three teachers volunteered to be observed and interviewed. Senger observed the three teachers in their classrooms and watched videotaped lessons. He also conducted follow-up interviews about lessons with teachers focused on probing teacher beliefs about the role of the teacher in mathematics instruction and the importance of teaching mathematics for meaning.

Senger determined that teachers vary in their struggle with instructional change, depending on personal values and beliefs about teaching. He analyzed the interviews and found that as teachers gained new information and awareness about new curricula, they initially held these ideas in a tentative questioning mode. Only with teacher reflection (measured by individual reflection dialogue sessions and studied using case study analysis) did teachers begin to experiment with the new ideas over the course of one year and alter their teaching practices according to how comfortable they felt with the changes, confidence in their teaching abilities, and how well the changes fit into their existing pedagogical belief systems. Some teachers were able to verbalize the concepts of reform mathematics programs, but were unable to actually put them into practice. Other
teachers tried out new ideas immediately without much reflection or critical thinking, and a third group seemed to ignore the new concepts altogether.

Senger's (1999) study was only meant to be a window into the change process, but it does suggest that certain teacher beliefs may make teachers more accepting of instructional change compared to others. The variance of teacher beliefs appeared related to whether the teachers reflected on mathematics instruction and subsequently modified their pre-existing beliefs, after reflecting on whether students were learning and later changing instruction based on perceived need. The findings also showed that belief change did not occur suddenly. Instead change was a time consuming process aided by reflection, experimentation with new ideas, and further reflection.

The results of Senger's study (1999), however, could be expanded on. Senger looked at three volunteer teachers from one school who all taught in self-contained classrooms, and the variables of teacher beliefs and teacher reflection were measured qualitatively through observations and interviews. This study leaves room for future researchers to further investigate this relationship by providing all participating teachers with standardized methods for reflecting and measuring teacher beliefs, for example by using structured teacher interviews or teacher journals to gather reflection data and by using quantitative questionnaire measures of teacher beliefs. Future studies should also consider larger, more diverse, teacher populations to see if similar results are found.

Franke et al. (1998) also investigated the relationship between reflection and beliefs, focusing on how reflection may lead to belief change that subsequently leads to teacher acceptance of instruction change. The study looked at three teachers,
representative of three different patterns of change, who participated in a four-year professional development program. They found that teacher beliefs and depth of reflection greatly affected the longevity of instructional change. Teachers participated in two individual interviews, with one focusing on teacher beliefs and the second focusing on reflecting upon a past lesson taught. Researchers also conducted formal and informal observations. The teacher who seemed most accepting of change viewed understanding student thinking as a way to continue learning and evolving as a professional and was able to use what she learned during professional development in other classroom contexts and for a variety of students. The other two teachers were able to reflect and then decide whether what they learned in professional development applied to their students, but their application of what they learned remained specific to the content they were taught and the degree to which they changed their instructional practices was minimal. Researchers concluded that through reflection the first teacher was able to actually change her beliefs about mathematics and the way she thought about instruction and student thinking. The other two teachers did not change their thinking, but merely grabbed onto pieces of the proposed reform that already fit with their preexisting beliefs.

The results of this study are largely descriptive and based on three case studies, so they provide a foundation for future studies that wish to measure teacher reflection and beliefs quantitatively and across a larger group of teachers so that broader generalizations might be made. Still, the important contribution of this study is that it suggests that teachers can attend the same workshops and be exposed to the same reform initiatives
and yet engage at different levels through reflection. The consequence is different patterns of change or acceptance of change amongst teachers.

Like Franke et al. (1998), Farmer et al. (2003) found that simply having teachers reflect was not enough to sustain teacher change, because levels of teacher engagement vary. The study was comprised of three individual case studies with elementary teachers, and the authors found that having teachers reflect on new mathematics instruction led to teacher belief change, but of varying degrees. Teachers took part in at least two individual, unstructured interviews and were observed teaching in the classroom. Teachers also reflected in journals daily during two different professional development institutes and Saturday seminars. The reflection data was coded and analyzed for important themes. Researchers found that some teachers took an inquiry stance towards their teaching after reflecting on their instructional practices. The study defined inquiry stance as teachers who see themselves as mathematical learners, strive to understand how their students think about mathematics and why, develop interesting and adaptive mathematical activities, and acknowledge that they are never finished learning about mathematics instruction. This inquiry stance supports teachers in becoming lifelong learners and self-sustaining change agents and is consistent with reform oriented mathematics curricula. This was contrasted with teachers who reflected only minimally without analysis of how their teaching affected student learning. These teachers only took a set of facts or skills from learning opportunities and applied them traditionally in the classroom without much adaptation or critical thinking.
The Farmer et al. (2003) study points to the importance of mathematics reformers providing teachers opportunities to reflect on new instruction, challenging them to modify preexisting beliefs that make acceptance of instructional change less likely and adopt an inquiry stance as teachers. One possible drawback of the study, however, was that the participating teachers were selected because they were willing to be observed and interviewed, and they already appeared to be learning from the professional development project being studied. It may be that many of the participating teachers appeared to benefit from opportunities to reflect, when in fact they were already benefiting from the program regardless of reflection opportunities.

A case study by Steinberg, Empson, and Carpenter (2004) also found that taking an inquiry stance towards learning may lead teachers to be more accepting of instructional change and more active change agents during the change process. Through teacher observations and interviews, researchers identified turning points in teacher beliefs and thinking that supported belief change. First, the teacher had to become dissatisfied with how she was using student thinking during instruction, motivating her to become more active and engaged with student thinking. Essentially, teachers had to have a degree of uncertainty or dissonance surrounding what they were doing instructionally to keep the inquiry process going (Wheatley, 2002). Dissonance refers to feeling anxious or uncomfortable when there is a recognized discrepancy between one’s beliefs and actions (Festinger, 1957, as cited in Wheatley). Second, the teacher had to reflect upon her own instruction and identify personal dilemmas. Without reflection she was unaware of any need to change, because she was judging her success as an instructor in traditional ways.
that were not congruent with mathematics reform curricula. Third, as she learned more about her students’ thinking, she became increasingly uncomfortable because new questions arose about her instructional practices. The teacher had to become comfortable with this discomfort in the classroom. She had to learn how to use questions about student learning and her own teaching in productive ways, often through teacher reflection.

The key point made by Steinberg et al.’s (2004) case study is that teachers need to feel a sense of ownership over the change process, which eventually leads to independence and “self-sustaining change,” as defined by Franke et al. (1998). By helping teachers feel efficacious enough to reflect despite the dissonance or discomfort that may precede change mathematics reformers may actually be fostering needed belief change among teachers to help sustain acceptance of reform math practices. Future studies have the opportunity to improve upon this individual case study methodology and look at larger groups of teachers to see if the findings hold true.

With Farmer et al. (2003) and Steinberg et al. (2004) showing the importance of an inquiry stance, professional development opportunities may want to support teachers’ move toward inquiry. One way of looking at the process of change that teachers go through during professional development is to think about teacher change as a move from “experimental” to “principled” teaching practice (Senger, 1999). When a teacher attends a professional development opportunity, grabs onto ideas presented, and continually reflects upon what has been learned in a way that challenges current teaching beliefs, this could be considered experimental practice. However, while the process of belief change
stops here for many teachers, the goal of professional development should be principled practice, which is when teachers actually integrate new knowledge with their preexisting beliefs about mathematics and instruction. The move from experimental to principled practice is dependent upon time and effective reflection (Senger). This supports the idea that mathematics reformers need to focus their attention on targeting teacher variables that influence the process of reflection, in order to increase the likelihood that teachers recognize the benefits of reform-oriented mathematics and support instructional change in the classroom.

Artzt and Armour-Thomas (1999) looked at the relationship between teacher reflection and teacher beliefs, but went further than previous research by focusing on what aspects of reflection are most likely to lead to belief change. Their exploratory study included 14 teachers with varying degrees of experience. Using observation of math lessons and three different interviews with reflection prompts to gather teacher belief data as well as reflection data, the study found that teachers who did not effectively monitor their instruction through reflection (i.e., did not focus on student learning or alter instructional practices based on evidence of student understanding) made subsequent inaccurate judgments about how their lessons went and how much their students had understood. The teachers judged most successful were those who evaluated the success of their lessons in terms of how much students understood, both procedurally and conceptually. Successful teachers also used student feedback as a means of monitoring the effectiveness of their instruction and evaluating the overall success of their instruction during reflection. Less successful teachers focused on their own teaching behaviors rather
than on student learning, and none of them deviated from their original plans during instruction or used student feedback during evaluation and reflection. This may explain why some teachers concluded that the mathematics programs that were implemented in their schools were not effective, and therefore did not change their beliefs about mathematics instruction. The teachers who did not reflect, or did so ineffectively, were more likely to inaccurately judge their students' learning and the effectiveness of the new instruction.

Artzt and Armour-Thomas's (1999) study suggests that teachers who are encouraged to reflect effectively, by focusing on their own instruction and student learning, may modify their overarching cognitions (including beliefs about mathematics instruction, knowledge of mathematics concepts, and goals for instruction). They may then become more accepting of instructional change as compared to teachers who do not reflect or do so ineffectively. Simply asking teachers to reflect is probably not enough to lead teachers to accept reform, because teachers in this study who reflected, but did not use reflection as a means to self-monitor, did not recognize student learning. The act of reflecting alone was not enough. Thus, they did not value the reform curricula or see reason to change their instructional practices. This study was only an exploratory study, but future research may want to measure teacher beliefs quantitatively by having teachers fill out a teacher beliefs survey or report directly on their beliefs about mathematics instruction. The findings of this study were qualitative in nature, and based on frameworks of teacher beliefs that were developed by researchers during the analysis of research results from observations.
Smith (1996) also hypothesized that when teachers transition from traditional mathematics instruction to instruction focused on conceptual understanding they may have difficulty, because their past methods of evaluating their success as instructors are no longer effective. Smith believes there is not a good match between new, conceptually-based mathematics curricula and the way teachers traditionally evaluate their success based on whether students successfully learn mathematical procedures and get correct answers on assessments. When new mathematics programs are implemented, it is likely that teachers who recognize student learning during the early stages will be more motivated to continue with the new programs compared to teachers who are less sensitive to early effects. If the goal of instruction is student learning, then it is important for teachers to consistently and accurately monitor their students' understanding. If they cannot recognize student learning in their classrooms teachers may not feel that their personal teaching goals are being met. Teachers who are unable to recognize student learning may then not support new programs that they feel provide no real educational benefits for their students. Additionally, teachers who are used to traditional mathematics instruction may feel uncomfortable teaching mathematics in new ways. When mathematics reforms are implemented in schools, many teachers are uncomfortable when asked to teach in new ways, and some may actually be paralyzed from reflecting on their instruction and student learning when their reaction to discomfort becomes debilitating (Frykholm, 2004). Without effective reflection teachers can have a difficult time recognizing the benefits of reform-oriented mathematics, making them less accepting and supportive of instructional change.
A study by Gabriele and Joram (2007), which empirically tested Smith's (1996) ideas, looked at the variable of self-efficacy and how this variable might affect teachers' abilities to self-monitor during reflection. Gabriele and Joram explored possible barriers related to self-efficacy that teachers may have to overcome before they are able to reflect successfully. Using verbal reflection data from ten elementary teachers participating in a professional development project, Gabriele and Joram found that teacher sources of efficacy tend to change as they shift from traditional to reform-based instruction. They found that issues of "coverage," "completion," and "success" are interpreted differently by teachers working from traditional perspectives compared to reform-oriented perspectives. Teachers who did not change the way they judged these issues when moving towards reform-oriented practice had difficulty noticing the progress of their students. Subsequently, the teachers who did not notice progress judged their instruction to be less effective, resulting in a lower sense of teacher self-efficacy. The researchers concluded that teachers who rely on criteria, or sources of efficacy, that is related to reform-oriented instructional goals in order to judge success are able to better recognize progress and eventually develop higher teaching efficacy for accepting instructional change and teaching in new ways.

Allinder, Bolling, Oats, and Gagnon (2000) looked specifically at how having teachers reflect effectively, by focusing on evidence of student learning using curriculum-based measurement (CBM), can lead to belief change. They found that teachers who were asked to reflect on student learning revised student instructional plans in significantly different ways compared to those who did not reflect. They also found that
student learning outcomes were significantly better for students whose teacher reflected. In Allinder et al.'s study a total of 31 teachers were assigned to one of three groups. One group was asked to use CBM to assess student progress. Curriculum-based measurement is a system for ongoing measurement of students' learning as they move through the curriculum, and it reflects students' instructional programs. Group two also used CBM but was asked to go one step further and analyze student progress in order to reflect upon instructional changes that could be made for individual students to increase learning. The control group used neither CBM nor reflection. The teachers in group two who were asked to reflect made changes to their teaching strategies, targeted specific student skills, and reviewed student data more often than the teachers who used only CBM or neither CBM nor reflection. If the goal of instruction is student learning, then reaching this goal is dependent upon teachers accurately monitoring student learning through reflection and making changes to their teaching strategies accordingly. Teachers who feel their students are learning are then likely to value the instructional changes that they feel support student learning.

Results of the Allinder et al. (2000) study support the claim that reflection helps teachers to purposefully think about instruction and use their knowledge of student learning to make informed changes in instruction. When teachers willingly make instructional changes it is possible that reflections on their instruction and student learning first lead to belief changes and then instructional changes. The goal of professional development opportunities needs to be getting teachers to reflect and focus
on student learning and their own instruction, otherwise reformers will continue to be disappointed with teacher implementation of reform-oriented curricula.

A challenging characteristic of teacher reflection is that it is frequently preceded by teacher uncertainty or discomfort (Frykholm, 2004). Teachers, especially those who have traditional beliefs about mathematics instruction, may feel uncomfortable when asked to change the way they teach mathematics. In contrast to traditional teaching, teaching for conceptual understanding leads to uncertainty for teachers who may not have the mathematical background or confidence to teach in this new way. Unfortunately, rather than reflect on this uncertainty and work to identify areas for improvement, a teacher's first response to change that challenges their pedagogical beliefs may be to avoid the source of discomfort (Frykholm). Until teachers learn to accept discomfort as a natural part of their learning process, they may be parallelized from reflecting or implementing reform-oriented teaching practices.

Knowing what constitutes teacher reflection it is important now to also look more specifically at how teacher reflection as a means of self-evaluation may relate to teacher efficacy. If teachers reflect and judge their past performances positively, the reflection process may lead to increased teacher efficacy. More efficacious teachers may then be more likely to take control over their personal growth and resolve their own problems, perhaps using reflection as a means of self-sustaining personal belief change (Ghaith & Shaabon, 1999). Reflection may lead to increased teacher efficacy and these higher efficacy beliefs may then reinforce and motivate teachers to further reflect. With
continued reflection, teachers may be more likely to accept new mathematics concepts and thus implement instructional change.

**Self-Efficacy Beliefs**

General teacher efficacy refers to teachers’ beliefs about their ability as teachers in general to affect student learning outcomes. Personal teacher efficacy refers to teachers’ beliefs about their own abilities to affect student outcomes (Wheatley, 2002). In this paper the term *self-efficacy* refers to personal teacher efficacy. Teachers with a high sense of self-efficacy are those who believe they can influence student outcomes in mathematics. Teachers with low self-efficacy are those who believe there is little they can do to affect student outcomes in mathematics, or that they lack the skill to do so. Most past research on teacher self-efficacy has focused on general teacher efficacy, which is consistent across contexts, even though it has become increasingly clear that efficacy beliefs are often context specific (Ross, Cousins, & Gadalla, 1996).

Teacher efficacy was first conceived by researchers at the Rand Corporation as the extent to which teachers think control of reinforcement lay within themselves or the environment (Tschannen-Moran et al., 1998). They found that teacher efficacy was positively related to the percentage of project goals teachers achieved and the amount of teacher change evidenced. Other studies have shown that teacher efficacy is positively related to teachers’ willingness to experiment with new reform-oriented instruction (Allinder, 1994; Ghaith & Yaghi, 1997). These studies have also shown that lower teacher efficacy leads to problems such as low teacher persistence when faced with new and difficult tasks and poor learning outcomes for students.
Although many researchers have shown that teacher reflection can affect teacher self-efficacy beliefs, some researchers also believe that low teacher efficacy can prevent teachers' from reflecting, interfering with their acceptance of instructional reform in mathematics (Allinder, 1994; Frykholm, 2004; Tschannen-Moran et al., 1998). Other researchers believe this dissonance and discomfort can instead be beneficial for teachers. Without feeling some sense of uncertainty about their instruction teachers may not see any need for change. Doubting one's own efficacy and skills may be a necessary component of the change process and a starting point for teacher reflection (Wheatley, 2002). Since a challenging characteristic of teacher reflection is that it is frequently preceded by teacher uncertainty or discomfort (Frykholm), teachers who have traditional beliefs about mathematics instruction may feel uncomfortable when asked to change the way they teach mathematics. Until teachers learn to accept discomfort as a natural part of the learning process, they may be prevented from reflecting on or implementing reform-oriented teaching practices.

Teacher efficacy beliefs are closely tied to the discomfort and dissonance that many feel during periods of instructional change. Teachers with low self-efficacy in mathematics may feel uncomfortable when asked to teach mathematics in a new way that requires conceptual understanding. If a traditional teacher is asked to implement a reform-based mathematics curriculum, but continues to look for traditional evidence of success in the classroom, such as correct answers and adherence to procedural steps, the teacher is unlikely to judge her instruction as successful or feel efficacious (Gabriele & Joram, 2007; Smith, 1996). In an attempt to increase self-efficacy and reduce cognitive
dissonance these teachers may devalue new mathematical instruction and convince themselves that the new curricula are not effective (Wheatley, 2002). More efficacious teachers, however, upon reflecting on their abilities as instructors, may focus on the insights they gain from the reflective process rather than partaking in self-blaming when the implementation of new programs creates uncertainty. Wheatley says this ability to continue reflecting, despite uncertainty, is a necessary predecessor of teacher belief change and acceptance of instructional change.

A teacher’s desire to affect student learning is essential to teachers’ motivation to teach (Sederberg & Clark, 1990), and because of this desire to help students learn a teachers’ uncertainty about whether they are instructing well may be what pushes them to make instructional changes or accept reform curricula. For this reason Wheatley (2002) argues that teacher doubts about their teaching efficacy often have important benefits, such as leading to greater teacher acceptance of progressive, reform-oriented mathematics programs by providing teachers with a reason to change. Teachers who have no doubts about what they are doing instructionally may not see the need to consider instructional changes. The distinction that should be made may be whether teacher efficacy doubts are debilitating for teachers or energizing (Wheatley). Considering that teacher uncertainty is a natural part of teaching, especially during periods of instructional change, it is extremely important to further investigate the inconsistencies surrounding teacher efficacy.

This paper will add to the research that has looked at teacher efficacy by focusing on personal teacher efficacy that is mathematics specific. It could be that some of the
teachers after a four-day staff development program in order to measure teacher self-
efficacy beliefs and attitudes toward implementation of instructional innovation. Results
showed that teachers with a high sense of self-efficacy were more open to the new
program and considered the program to be more congruent with their existing
pedagogical beliefs compared to teachers with low efficacy. Compared to teachers with
low efficacy, teachers with high efficacy were also more likely to view the new program
as easier to implement and more important. These results further suggest that teacher
efficacy beliefs are closely related to teacher acceptance of change, amplifying the
importance of understanding the relationship between teacher efficacy and teacher
reflection.

Not all studies result in findings that clearly support the importance of teachers
having a high sense of teacher efficacy. Swars (2005) examined mathematics teachers'
self efficacy beliefs and how these beliefs were related to effective teaching and
acceptance of reform-oriented mathematics instruction. Preservice elementary education
majors from a teacher education program were asked to complete the Mathematics
Teaching Efficacy Beliefs Instrument (MTEBI), and four from this group were
subsequently chosen to be the subjects of the study. The two highest scoring preservice
teachers and the two lowest scoring preservice teachers were chosen as examples of
teachers with high self efficacy and teachers with low self efficacy. Although all four
participants felt confident in their abilities to be effective mathematics teachers, the two
participants with the lowest MTEBI scores felt it would take more effort for them to
teach effectively.
Based on past research, one would expect that teachers with high self efficacy would be more receptive to instructional reforms and use a greater variety of instructional methods (Enochs & Riggs, 1990). When asked how they felt about the reform-oriented practice of using manipulatives in the classroom, however, the two low self-efficacy participants were split on whether they were comfortable with the practice (Swarz, 2005). In addition, while two of the participants were considered to have low self efficacy, all of the participants were confident in their ability to teach mathematics effectively. Although Swars suggests that the findings of this study are consistent with previous research and show a positive relationship between teacher efficacy and teacher openness to instructional change, it could be argued that these findings do not show a clear relationship. Both of the participants with low teacher efficacy maintained confidence in their abilities, even though they felt they would have to work harder than other teachers.

Whether high or low efficacy is most likely to lead to effective reflection varies depending on the study, as the previous studies show. Some studies have found that high teacher efficacy leads to more productive reflection and subsequent belief change, while other studies stress that being too efficacious may actually impede teacher reflection and belief change. Studies have not looked at how a third variable, teacher thinking dispositions, may moderate the relationship between self efficacy and teacher reflection. If teacher thinking dispositions are found to moderate this relationship, it may help explain these discrepancies.
Teacher Thinking Dispositions

Mathematical reforms can be interpreted by some teachers as threats to their professional identities (Gregoire, 2003). Depending on whether they embrace the threat as motivation to change or are inhibited from reforming because of the discomfort caused by the threat, this threat acts differently upon teachers as they participate in mathematical reforms. Gregoire proposes a Cognitive-Affective Model of Conceptual Change (CAMCC). Developed from three teacher case studies, the model attempts to explain variables that may interfere with teacher acceptance of instructional change in the face of mathematical reforms. Gregoire proposes that when teachers are presented with mathematical reforms, they either are uncomfortable and judge the reform to be a “stressor” or are comfortable and judge the reform to be “benign.” If a teacher has no discomfort when the reform is introduced, the CAMCC suggests that the teacher processes the reform heuristically and any change in instruction and beliefs is superficial. If the teacher is stressed by the reform and experiences discomfort, however, the CAMCC suggests that teacher efficacy plays a role in whether the teacher sees the discomfort as an opportunity for growth (“approach intention”) or interprets it as a threat (“avoidance intention”). It is suggested that only when teachers approach discomfort can systematic processing of reform initiatives occur, with true belief and instructional change resulting.

Gregoire’s (2003) model is helpful for better understanding how the three variables of interest in this proposed study (teacher efficacy, teacher thinking dispositions, and teacher reflection) may be related. It is hypothesized that Gregoire’s
idea of change as a stressor can be equated with inflexible thinking and a teacher's
disposition to avoid new ideas with a close minded attitude. Her constructs of "approach
intention" and "avoidance intention" could then be equated with effective teacher
reflection and a lack of, or ineffective, teacher reflection, respectively. However,
Gregoire suggests that teachers who do not experience discomfort or stress in the face of
mathematical reforms automatically end up processing mathematical reforms
heuristically, resulting in only superficial change. The proposed study does not assume
this and attempts to further clarify the relationship between teacher efficacy and the
process of teacher reflection, paying careful attention to how teacher thinking
dispositions may moderate the relationship.

Stanovich (1999) defined thinking dispositions as "relatively stable psychological
mechanisms and strategies that tend to generate characteristic behavioral tendencies and
tactics" (p.157). There is growing evidence that thinking dispositions may predict
openness or resistance to new or controversial ideas (Stanovich; Stanovich & West, 1997,
1998). It may be reasonable that certain thinking dispositions may predict teachers'
openness to instructional change. Open-mindedness is the disposition to take new
information presented and weigh it heavily against previously held beliefs, spend a great
deal of time on problems before giving up, and carefully consider the opinions of others
before forming one's own (Baron, 1985, as cited by Stanovich & West, 1997). Stanovich
has demonstrated that having the disposition to think open-mindedly and weigh new
evidence against personal beliefs accounts for significant differences in problem solving
performance. Thinking dispositions may also be expected to influence teacher reflection.
Teacher reflection in the midst of instructional change is often a problem solving process and means of teachers redefining themselves as mathematics instructors.

It is suggested that the teachers most likely open to change are those who have thinking dispositions that support knowledge and belief revision. Sinatra and Kardash (2004) introduced a new “teaching as a form of persuasion” metaphor to 182 Educational Psychology students. The teaching as persuasion metaphor was contrasted with the usual teaching as scaffolding viewpoint, which assumes learning involves knowledge acquisition but not restructuring of students’ previously held beliefs. The researchers proposed to students in the study that the persuasion metaphor was better because it “recognizes that learning involves more than assimilating new knowledge; it involves the intention to change one’s ideas” (Sinatra & Pintrich, 2003, as cited by Sinatra & Kardash, p. 484).

Sinatra and Kardash (2004) found that this new way of thinking about teaching as a form of persuasion had the most support among students who were the most open to change, as measured by different disposition subscales developed by a variety of researchers, and used previously by Stanovich and colleagues (Stanovich, 1999). The four scales used were: Belief Identification, Dogmatism, Values, and Need for Cognition. The first two scales measured students’ resistance to change, and the last two scales measured students’ openness to new ideas and enjoyment of critical thinking. Sinatra and Kardash suggest that this study is further evidence of how epistemological beliefs and dispositions predict students’ openness to change or resistance to new ideas.
The study by Sinatra and Kardash (2004) is important to consider when thinking about how teacher thinking dispositions may moderate the relationship between efficacy beliefs and reflection. If thinking dispositions influence individuals' acceptance of new ideas, strategies, and reforms, then it is possible that thinking dispositions have this influence by way of the relationship between teacher efficacy and reflection. Do individuals with certain thinking dispositions reflect more or less effectively, subsequently leading to varying degrees of acceptance of change? Do thinking dispositions moderate the relationship between teacher efficacy and reflection? Perhaps the relationship between efficacy and reflection and/or acceptance of change is stronger for teachers who are more or less open-minded? The following exploratory study's goal is to further investigate these possible relationships.

Conclusion

Based on this review of the literature currently available on the topic of teacher reflection, it seems there is a relationship between effective teacher reflection and later acceptance of instructional change, often by way of reflection first affecting teacher beliefs about mathematics instruction. What is less clear is how teacher efficacy relates to teacher reflection and eventual acceptance of instructional change. Many researchers have shown that high teacher efficacy is related to the most effective reflection and acceptance of change, while a few researchers have suggested the benefits of teacher efficacy doubts. This study will attempt to further investigate the relationship between teacher efficacy beliefs and teacher reflection. The study will also focus on a third variable, teacher thinking dispositions, to see how the addition of this variable influences
the relationship between teacher efficacy and teacher reflection. It is hypothesized that teacher thinking dispositions may moderate this relationship and help explain the differing views of researchers who have studied the relationship between teacher efficacy beliefs and teacher reflection.

In conclusion, this study had three main research questions: (1) Is there a relationship between teacher efficacy beliefs and teacher reflection?; (2) Are teacher efficacy beliefs and teacher reflection related to acceptance of instructional change?; and (3) Do teacher thinking dispositions moderate the relationship between efficacy and reflection as they relate to teacher acceptance of instructional change?
CHAPTER 3

METHODS

Participants

Participants were 16 female first-and second-grade teachers from five different schools in the Waterloo School District that were engaged in a professional development program. These teachers were trained to implement a new “Computational Fluency Curriculum,” consisting of a set of sequenced mini-lessons, and were encouraged to use the mini-lessons daily in addition to the district’s regular mathematics curriculum. The new curriculum was consistent with reform-oriented mathematics because of its focus on students’ conceptual understanding. Teachers using the curriculum were taught to value the different ways students solved math problems, rather than focus on one “correct” way to find the answer. Students were also taught how to verbalize the rationale behind the mathematics strategies they chose to use. Visual representations of the math concepts being taught were also utilized, making the concepts more concrete for students and providing a method for students to learn number/symbol relationships.

Five teachers had been teaching for one year or less, and five had been teaching for at least 21 years. Of the participating teachers, 11 currently taught mathematics to first graders and five taught second graders. However, over the course of their teaching careers three teachers have taught mathematics to more than four different grade levels, six have taught two to three grade levels, and seven have taught only their current grade level.
Measure of Teacher Efficacy

Participants completed a modified version of the Mathematics Teaching Efficacy Belief Instrument (MTEBI) in the fall of the 2005-2006 school year (Enochs, Smith, & Huinker, 2000). The MTEBI was chosen as the teacher efficacy measure in this study because it is a mathematics specific efficacy measure. Due to the possibility of efficacy being context specific, meaning teachers may score higher on efficacy as it relates to reading as opposed to math, etc., the MTEBI was chosen to help control for any differences that could have surfaced if an efficacy measure had been used that was not mathematics specific.

The MTEBI consists of 21 items, including 13 items on the Personal Mathematics Teaching Efficacy (PMTE) subscale and 8 items on the Mathematics Teaching Outcome Expectancy (MTOE) subscale (Appendix A). Each of the 21 items has five response categories on a Likert scale ranging from “strongly agree” to “strongly disagree.” Teacher efficacy data was quantitative, with each teacher having an overall score for the MTEBI, as well as a score for the PMTE subscale and a score for the MTOE subscale. Possible scores on the PMTE range from 13 to 65 and scores on the MTOE range from 8 to 40. High scores on the MTEBI are considered representative of teachers high in efficacy beliefs, and low scores are considered representative of teachers with low efficacy beliefs.

The MTEBI was adapted from the original Science Teaching Efficacy Beliefs Instrument (STEBI-A), and was designed to be used with pre-service mathematics teachers. However, for the purposes of this study the MTEBI was modified to be used
with in-service teachers as opposed to pre-service teachers. This was done by changing items to reflect current mathematics teaching beliefs. The following are sample items from the MTEBI, adapted for use with in-service teachers rather than pre-service teachers: (a) “Even if I try very hard, I cannot teach mathematics as well as I can most subjects,” and (b) “The mathematics achievement of some students cannot generally be blamed on their teachers.” A study by Enochs et al. (2000) reported psychometric data for the MTEBI and found the scale appears to be both valid and reliable when assessing mathematics teacher self efficacy and outcome expectancy. Reliability analysis produced an alpha coefficient of .88 for internal consistency on the PMTE scale of the MTEBI and an alpha coefficient of .77 for the MTOE scale (N=324). Confirmatory factor analysis indicated that the two scales are independent of each other, which adds to the construct validity of the measure.

Measure of Teacher Thinking Dispositions

Participants completed the Composite Actively Open-Minded Thinking measure (AOT composite) in the fall of the 2005-2006 academic school year (Stanovich & West, 1997). The measure was handed out to participants in a group setting at the same time that they were asked to complete the MTEBI. The AOT composite consists of 41 items, and each of the 41 items has six response categories on a Likert scale ranging from “disagree strongly” to “agree strongly” (Appendix B). Teacher thinking dispositions data was quantitative, with each teacher having an AOT composite score.

There are six scales that make up the AOT composite score: Flexible Thinking, Openness-Ideas, Openness-Values, Absolutism, Dogmatism, and the Categorical
Thinking scales. Because these six scales display moderate intercorrelations, the AOT composite was formed by adding together the scores on the Flexible Thinking, Openness-Ideas, and Openness-Values scales and then subtracting the sum of the Absolutism, Dogmatism, and Categorical Thinking scales. High scores on the AOT composite have been found to indicate a willingness to change previously held beliefs and think flexibly, while low scores tend to indicate a person is resistant to belief change and thinks rigidly (Stanovich & West, 1997). Stanovich and West report the split-half reliability of the AOT composite to be .90 (Spearman-Brown corrected) and the Cronbach’s alpha as .88.

**Measure of Teacher Reflection**

The purpose of the teacher reflection measure was to look at each participating teacher and determine what specifically they reflected on and how much. When teachers were given their journals at the beginning of the professional development opportunity they were given the following directions:

> in this assignment, you will write written reflections that focus on your experience implementing the Computational Fluency Curriculum in your classroom over the course of the year. Although there is no set number or length of journal entries that is required, we expect that you should try making entries on a consistent basis, roughly 2 to 3 times a week.

Teachers were also given some ideas of topics they could focus on when reflecting in their journals. These suggestions included examples of student thinking and learning, difficulties they were having and ways they might improve them, and general comments about the professional development program and Computational Fluency Curriculum.
Data from the teacher journals was quantitative in nature. Journals were coded using microanalysis and a total number of teacher comments was recorded for each predetermined category. More specifically, line-by-line analysis of each participant’s journal was completed to find reflection comments that fell into one of three predetermined categories: comments about student learning (both individual students and whole class), comments about teacher instruction (both things that went well and things that could be improved), and comments about the Computational Fluency Curricula (both positive and negative). Examples of comments that were not included in any of these three categories were those unrelated to mathematics instruction such as comments on the weather, forgetting to do a lesson, or commenting on poor student behavior (Table 1). Then for the purposes of this study all comments about student learning (both individual and whole class) were combined with comments about teacher instruction (things to improve) and renamed “effective reflection.” Comments about teacher instruction (things that went well) were renamed “self-enhancing reflection,” and comments about the Computational Fluency Curricula were renamed “acceptance of instructional change.”

Effective Reflection.

Teacher comments that focused on evidence of student learning, or on aspects of instruction that teachers spontaneously reported could be improved, were identified as instances of “effective reflection.” As described in the literature review, these characteristics of effective reflection are consistent with what previous researchers have found to be necessary components of the kind of teacher reflection most likely to lead to
acceptance of instructional change (Allinder et al., 2000; Farmer et al., 2003; Steinberg et al., 2004; Wheatley, 2002).

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Student(s)</td>
<td>Included comments made about the learning of one specific student, or a small group of students</td>
<td>“Finally, one of my high students made the connection with the tens frame to solve the problem.”</td>
</tr>
<tr>
<td>Whole Class</td>
<td>Included comments made about the entire class’ learning as a whole</td>
<td>“Students are making good progress on understanding subtraction.”</td>
</tr>
<tr>
<td>Went Well</td>
<td>Included comments about aspects of instruction the teacher felt she did well</td>
<td>“This year I’m doing a much better job of teaching near doubles than I have in the past.”</td>
</tr>
<tr>
<td>To Improve</td>
<td>Included comments about aspects of instruction the teacher felt could be improved</td>
<td>“When I tried to explain what counting up was I don’t think I explained it very well.”</td>
</tr>
<tr>
<td>Positive</td>
<td>Included positive comments about the Computational Fluency Curricula</td>
<td>“It is beneficial to have this five minute math so that students have computation practice continually throughout the year.”</td>
</tr>
<tr>
<td>Negative</td>
<td>Included negative comments about the Computational Fluency Curricula</td>
<td>“This [card switching] makes students confused and I spend a longer time sorting out the confusion.”</td>
</tr>
</tbody>
</table>
Not all comments that made reference to student performance or teaching were counted as "effective reflection." For example, teacher comments recognizing whole group learning (e.g., "Students are making good progress on understanding subtraction.") or individual student learning (e.g., "Finally, one of my high students made the connection with the tens frame to solve the problem.") were distinguished from comments in which a teacher simply characterized student performance (e.g., "Students did well."). This latter statement was considered not to be an example of effective reflection because the teacher did not refer to student growth or learning from one day to the next. The students in this case may have always done well, regardless of any teacher instruction.

Similarly, not all comments about teacher instruction were considered to be examples of effective reflection. Comments about things that could be improved instructionally were considered part of effective reflection, based on research suggesting that teachers must become dissatisfied with aspects of their instruction and accept a degree of discomfort and uncertainty as part of the learning process before reflecting effectively (Frykholm, 2004; Steinberg et al., 2004; Wheatley, 2002). An example of a teacher noting instruction that did not go well and by implication could be improved was, "When I tried to explain what counting up was I don’t think I explained it very well."

**Self-Enhancing Reflection**

In contrast, teacher comments about things that went well instructionally and were not identified as in need of improvement were not coded as effective reflection, in part because previous research has suggested that less successful teachers focus on their own
teaching behaviors as opposed to focusing on student learning (Artzt & Armour-Thomas, 1999; Gabriele & Joram, 2007). However, Gabriele and Joram noted that some reflection on one’s own instruction may enhance teacher self-efficacy if it is focused on noticing positive change in teaching behavior. To the extent that teacher self-efficacy is related to acceptance of instructional change, this form of reflection may indirectly be linked to acceptance of instructional change. Therefore, I created a separate category to capture teacher comments about things that went well instructionally (referred to as “self-enhancing” reflection) and examined its relationship to acceptance of instructional change. An example of a comment coded as self-enhancing reflection was, “This year I’m doing a much better job of teaching near doubles than I have in the past.”

Acceptance of Instructional Change

Teacher comments about the Computational Fluency Curricula being implemented as part of the professional development project were identified as “acceptance of instructional change.” Teachers who made more positive comments about the curricula were considered to be more accepting of instructional change, while teachers who made more negative comments about the curricula were considered less accepting of instructional change. An example of a teacher commenting positively about the curricula was, “It is beneficial to have this five minute math so that students have computation practice continually throughout the year.” An example of a teacher commenting negatively was, “This [card switching] makes students confused and I spend a longer time sorting out the confusion.”
CHAPTER 4

RESULTS

Reliability Analysis

Analysis of the reliability of the three instruments used in this study was conducted prior to the main analyses and is reported below.

Teacher Efficacy Belief Instrument

Item-total correlations for each subscale of the MTEBI are shown in Table A1. Item-total correlations were similar to the ones reported by Enochs et al. (2000) and ranged from .23 to .89 for the PMTE subscale and from .32 to .75 for the MTOE subscale. Based on this analysis no items were dropped from the scale. Reliability analysis indicated a Chronbach alpha of .92 for the PMTE scale and .77 for the MTOE scale. These internal consistency coefficients are similar to those reported by Enochs et al., who have used this instrument with preservice teachers, suggesting that the modifications made for use with inservice teachers were appropriate and did not adversely affect the reliability of the instrument.

Thinking Dispositions Instrument

Item analyses for the AOT are shown in Table A2. Initial reliability analysis showed six items (items 3, 12, 13, 34, 36, 40) were weakly correlated to the total scale score (<.15). To improve reliability of the overall instrument, those six items were removed. This improved internal consistency of the scale from an alpha of .83 to an alpha of .87.
Teacher Reflection and Attitudes toward Instructional Change Coding Scheme

Reliability of the teacher reflection and reactions towards implementing instructional change coding scheme was computed in two ways. First, the same researcher coded each teacher journal twice, with an eight-week break in between. The first coding of each teacher’s journal comments into the three pre-determined categories was then compared to the second coding, completed eight weeks later. The number of comments coded the same way both times was approximately 87 percent. Second, interrater agreement data was also collected. The researcher taught a second individual to use the reflection journal coding system, and then this individual coded half of the teacher journals, which were randomly selected. The researcher’s coding for the randomly selected journals was then compared to the second individual’s coding for the same randomly selected journals. Interrater agreement was calculated by first determining the number of journal entry statements that were coded in the same way by both coders for each of the randomly selected journals. The number of agreements was divided by the number of agreements plus disagreements and multiplied by 100. This percent agreement for each journal was then averaged for overall agreement. The overall interrater agreement was found to be 81 percent.

Descriptive Statistics for the Main Variables in the Study

Descriptive statistics for the AOT and MTEBI belief instruments are shown in Table 2 and indicate that the variance for both instruments was comparable to previous research. The mean score on the PMTE was 52.25, which is on the high end of the scale range (PMTE scale ranges from 13 to 65). The mean score on the MTOE was 28.50,
which is near the middle of the scale range (MTOE scale ranges from 8 to 40). This suggests that the teacher sample in this study had relatively high Personal Mathematics Teaching Efficacy and average Mathematics Teaching Outcome Expectancies.

Table 2.

Descriptive Statistics for Belief Instruments

<table>
<thead>
<tr>
<th>Belief Instrument</th>
<th>Mean</th>
<th>SD</th>
<th>Skewness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Self-efficacy Subscale (PMTE)</td>
<td>52.25</td>
<td>7.18</td>
<td>-1.69</td>
</tr>
<tr>
<td>Teacher Outcome Expectancies (MTOE)</td>
<td>28.50</td>
<td>4.12</td>
<td>-.36</td>
</tr>
<tr>
<td>Thinking Dispositions (AOT)</td>
<td>150.00</td>
<td>16.94</td>
<td>-.89</td>
</tr>
</tbody>
</table>

There were a couple of unexpected characteristics of the teacher journals. First, there was a large variance in how many total comments teachers made in their journals (Table 3). The standard deviation for total journal comments was 56.97, meaning the spread of total journal comments was wide. However, no matter whether a teacher wrote a lot or a little, there was little variance between teachers when looking at amounts of effective reflection. Comparing teachers who wrote the most to teachers who wrote the least, they ended up making a similar number of comments that could be coded as effective reflection. This suggests that simply asking teachers to reflect more (in length or frequency) may not be enough to increase the amount of effective reflection.
Table 3.

*Descriptive Statistics for Teacher Journals*

<table>
<thead>
<tr>
<th>Journal Entry Coding Categories</th>
<th>Mean</th>
<th>SD</th>
<th>Skewness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective reflection</td>
<td>9.25</td>
<td>4.09</td>
<td>.59</td>
</tr>
<tr>
<td>Self-enhancing reflection</td>
<td>2.19</td>
<td>1.64</td>
<td>.69</td>
</tr>
<tr>
<td>Positive reactions towards instructional change</td>
<td>5.38</td>
<td>3.79</td>
<td>1.10</td>
</tr>
<tr>
<td>Negative reactions towards instructional change</td>
<td>2.00</td>
<td>2.58</td>
<td>.96</td>
</tr>
<tr>
<td>“Other” comments</td>
<td>93.31</td>
<td>50.11</td>
<td>.56</td>
</tr>
<tr>
<td>Total journal comments overall</td>
<td>112.06</td>
<td>56.97</td>
<td>1.46</td>
</tr>
</tbody>
</table>

A second unexpected finding was that the mean for the effective reflection category (9.25) was relatively low compared to the mean for total journal comments overall (112.06). This indicates that participating teachers spent a great deal of time reflecting on topics not considered to be characteristic of effective reflection. This suggests that teachers are not aware of what they should focus on when reflecting and could benefit from professional development in this area.

A third finding was that teachers on average made more positive comments than negative comments about instructional change. The mean score for positive reactions to instructional change was 5.38, while the mean score for negative reactions was 2.00. Considering teachers were being asked to instruct in new ways that might take them out of their comfort zones it was surprising that they did not make more negative comments.
Table 4 shows the results of a correlation analysis (one-tailed) performed to explore the relationship between the efficacy and thinking disposition belief measures, frequency of journal comments coded as reflection, and frequency of journal comments indicating positive and negative reactions towards implementing instructional change. As expected, scores on the personal math teaching efficacy beliefs (PMTE) subscale were positively correlated with scores on the math teaching outcome expectancies (MTOE) subscale (p<.01), indicating that teachers who believe that teachers in general can affect student mathematics learning are also more likely to believe that they can affect student mathematics learning in their own classrooms. A negative correlation was discovered between the MTOE subscale and negative reactions towards instructional change. This indicates that teachers who scored higher on the MTOE, believing that teachers do have the ability to affect student learning, were less likely to make negative comments about the reform-oriented mathematics program they were implementing in their classrooms.

Consistent with research reported in the literature review (Artzt & Armour-Thomas, 1999; Butler, 2003; Farmer et al., 2003; Franke et al., 1998) and my hypothesis, a statistically significant positive correlation was found between effective reflection and positive reactions towards instructional change (p<.01), indicating that teachers who engaged in more effective reflection also more frequently expressed positive comments about the new mathematics instructional innovation they were trying to implement in their classroom (Table 4). This suggests reformers may be able to target the variable of teacher reflection in order to improve the likelihood that teachers will accept instructional
change. However, the relationship found in correlational, so it may also be that teachers who accept instructional change are more likely to reflect effectively.

Table 4.

*Relationships Between Teacher Efficacy, Teacher Thinking Dispositions, and Teacher Reflection*

<table>
<thead>
<tr>
<th></th>
<th>AOT</th>
<th>PMTE</th>
<th>MTOE</th>
<th>Effective Reflection</th>
<th>Self-Enhancing Reflection</th>
<th>Positive Reactions Towards Instructional Change</th>
<th>Negative Reactions Towards Instructional Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AOT</strong></td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PMTE</strong></td>
<td>.38</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MTOE</strong></td>
<td>.04</td>
<td>.71**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Effective Reflection</strong></td>
<td>.18</td>
<td>.27</td>
<td>.31</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Self-Enhancing Reflection</strong></td>
<td>-.14</td>
<td>.08</td>
<td>.26</td>
<td>.48*</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Positive Reactions Towards Instructional Change</strong></td>
<td>.16</td>
<td>.14</td>
<td>.35</td>
<td>.73**</td>
<td>.18</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td><strong>Negative Reactions Towards Instructional Change</strong></td>
<td>.14</td>
<td>-.23</td>
<td>-.44*</td>
<td>.16</td>
<td>.35</td>
<td>.05</td>
<td>1.00</td>
</tr>
</tbody>
</table>

The finding is also consistent with researchers who argue the benefits of efficacy doubts (Sederberg & Clark, 1990; Wheatley, 2002), since effective reflection here included comments about things teachers felt they needed to improve instructionally.
In contrast to the significant relationship found between effective reflection and positive reactions towards instructional change there was no significant relationship between self-enhancing reflection and positive reactions towards instructional change (Table 4). This supports previous research that suggests less successful teachers focus on their own teaching behaviors (Artzt & Armour-Thomas, 1999) and that becoming dissatisfied with aspects of one’s instruction is actually a necessary predecessor for effective teacher reflection (Frykhom, 2004; Steinberg et al., 2004; Wheatley, 2002). Teachers who engaged in more self-enhancing reflection and focused on things they were doing well were not any more likely to have positive reactions towards instructional change.

A positive relationship was found between self-enhancing reflection and effective reflection (p < .05). This suggests that although a teacher’s focus on things that are going well instructionally may not directly relate to acceptance of instructional change, self-enhancing reflection may play an important role in teacher acceptance of change indirectly (as suggested by Gabriele and Joram, 2007). This could be by way of self-enhancing reflection’s relationship to effective reflection.

No significant relationships were found between teacher thinking dispositions (AOT) and the variables of teacher efficacy, teacher reflection, or teacher acceptance of change (Table 4). Although some previous researchers have found significant relationships between teacher efficacy beliefs and effective teacher reflection a significant relationship was not found in this study. There also was no relationship found between teacher efficacy beliefs and teacher acceptance of instructional change. I
hypothesized that the relationship between efficacy, reflection, and acceptance of change may look differently depending on the moderating affect of teacher thinking dispositions and this was investigated using hierarchical multiple regression analysis.

Analysis of Moderator Effects

To test for moderator effects, hierarchical multiple regression analysis was used. In this analysis, both a predictor variable (e.g., teacher self-efficacy) and a moderator variable (e.g., teacher thinking disposition) are entered into the regression analysis in the same block. Statistical testing of a moderator effect is accomplished by including the product (or interaction term) of the predictor and moderator variable at a later step in the regression analysis. A significant increase in the multiple $R^2$ following the entry of the interaction term into a regression analysis already containing the predictor and moderator variables, provides evidence for a moderator effect (Baron & Kenny, 1986; Bennett, 2000).

To assess whether thinking disposition moderates the relationship between teacher self-efficacy and effective reflection, we conducted a three-step hierarchical regression analysis. In step 1, I first entered the variable “total number of journal comments” into the regression analysis to control for individual differences in effective reflection that were simply due to writing more journal comments. In step 2, the predictor variable (teacher self-efficacy) and the moderator variable (teacher thinking disposition) were added as a block to the regression equation. In the final step, the cross-product, Teacher Self-Efficacy x Thinking Disposition, was entered as the interaction term. The amount of effective reflection was the dependent variable.

Results of the hierarchical regression analyses are shown in Table 5. As shown, the interaction term was statistically significant, $F(1, 11) = 5.36, p = .04$. This suggests that teacher
thinking dispositions moderate the relationship between teacher self-efficacy and effective reflection.

<table>
<thead>
<tr>
<th>Variables</th>
<th>$r^2$</th>
<th>$R^2$ Change</th>
<th>$F$ Change</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Self-efficacy</td>
<td>.64</td>
<td>.04</td>
<td>0.60</td>
<td>.57</td>
</tr>
<tr>
<td>Thinking Dispositions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Self-efficacy x Thinking Dispositions</td>
<td>.76</td>
<td>.12</td>
<td>5.36</td>
<td>.04</td>
</tr>
</tbody>
</table>

To assess whether teacher thinking dispositions moderate the relationship between teacher self-efficacy and acceptance of instruction change, I again conducted a three-step hierarchical regression analysis, with frequency of positive journal comments about the new curriculum as the dependent variable (Table 6).

<table>
<thead>
<tr>
<th>Variables</th>
<th>$r^2$</th>
<th>$R^2$ Change</th>
<th>$F$ Change</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Self-efficacy</td>
<td>.44</td>
<td>.01</td>
<td>0.10</td>
<td>.90</td>
</tr>
<tr>
<td>Thinking Dispositions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Self-efficacy x Thinking Dispositions</td>
<td>.44</td>
<td>.00</td>
<td>0.04</td>
<td>.84</td>
</tr>
</tbody>
</table>
As shown in Table 6, the interaction term was not statistically significant, indicating that thinking disposition does not moderate the relationship between teacher self-efficacy and acceptance of instructional change.
CHAPTER 5
DISCUSSION

This study aimed to provide insight into the relationships between the variables of teacher efficacy, thinking dispositions, and reflection (as they relate to teacher acceptance of instructional change). The study specifically sought to investigate the relationship between teacher efficacy and effective teacher reflection and/or acceptance of instructional change, paying particular attention to whether teacher thinking dispositions might moderate this relationship. No relationship was found between teacher efficacy and teacher reflection. A relationship was found between effective teacher reflection and acceptance of instructional change. The moderating role of teacher thinking dispositions was then investigated since no significant relationship was found between the teacher efficacy measure and teacher reflection. Teacher thinking dispositions were found to moderate the relationship between teacher efficacy and effective teacher reflection, but were not found to moderate the relationship between teacher efficacy and acceptance of instructional change.

Relationship between Efficacy and Reflection

The main research question of this study was whether there is a significant relationship between teacher self-efficacy beliefs and teacher reflection. Additionally the study sought to investigate whether teacher thinking dispositions mediate this relationship. Results suggest that there is not a significant relationship between teacher efficacy and effective teacher reflection. However, this may be explained by the fact that
teacher thinking dispositions were found to significantly moderate the relationship between efficacy and effective reflection.

I was surprised to find no significant relationship between efficacy and effective reflection. Previous studies have suggested that this relationship exists, although a majority of past research on the topic involves teacher case studies and qualitative methods for measuring efficacy, reflection, acceptance of change, etc. (Allinder, 1994; Frykholm, 2004; Ghaith & Shaaban, 1999; Tschannen-Moran et al., 1998). An example of a quantitative study looking at this relationship is one by Ghaith and Shaaban. They found that teachers with higher efficacy were more likely to focus on meeting student needs, while teachers with lower efficacy were less likely to focus on meetings student needs. In other words it could be that teachers who are higher in efficacy may be more likely to reflect effectively by focusing on evidence of student learning. The current study did not find this to be true—no significant relationship was found.

I was unable to locate previous studies that have looked at the possible moderating effect of thinking dispositions on the relationship between teacher efficacy and reflection. However, Gregoire (2003) does suggest that the introduction of reform affects teachers differently depending on if they are open or close minded in how they approach reform. This suggests that teacher thinking dispositions may moderate the relationship between reform initiatives and teacher response. This idea that thinking dispositions can have a moderating effect is supported by the results of our study which suggest they moderate the relationship between efficacy and reflection. The fact that thinking dispositions were found to have a moderating effect may explain why some
researchers argue the benefits of higher teacher efficacy while others suggest that efficacy doubts may actually lead to more effective reflection. If the relationship is moderated by thinking dispositions then it would make sense that perhaps both higher efficacy and efficacy doubts can lead to effective reflection if teachers have open-minded thinking dispositions.

**Relationship between Efficacy and Acceptance of Instructional Change**

The current study found a significant relationship between teacher efficacy (specially the Mathematics Teaching Outcome Expectancy subscale) and teachers who were less accepting of instructional change. Teacher thinking dispositions were not found to moderate this relationship. Considering that the relationship between two variables is weakened when a moderating effect is at play it is not surprising that our study found no relationship between efficacy and reflection, due to the moderating effect of thinking dispositions, but did find a relationship between efficacy and acceptance of change because of the lack of moderating effect.

The results suggest that if the primary goal of reformers is to facilitate teacher acceptance of change then teacher efficacy may be a key variable to address. Reformers who work with teachers to increase their efficacy and confidence in teaching mathematics effectively may in the end have more teacher buy-in and support for reform initiatives due to the relationship between efficacy and acceptance of change. If, on the other hand, the goal of reformers is to foster more effective teacher reflection—regardless of whether teachers ultimately accept the reform initiative—then this study suggests that it may
become essential that reformers not only consider teacher efficacy but teacher thinking dispositions as well. The moderating role of thinking dispositions in this case may be key.

**Relationship between Effective Reflection and Acceptance of Instructional Change**

Considering that previous studies have found a consistent relationship between effective reflection and acceptance of instructional change (Artzt & Armour-Thomas, 1999; Farmer et al., 2003; Franke et al., 1998) it is not surprising that the current study demonstrated the same relationship. Fostering effective reflection among teachers continues to be a major focus for mathematics reformers who want teacher support for new initiatives. The results of this study support the importance of reformers focusing on the variable of teacher reflection, trying to get teachers to focus on evidence of student learning, and encouraging teachers to identify ways to improve their own instruction.

The new piece of information that the results of this study can offer reformers is that for teachers who are not reflecting effectively the best course of action may be to pay particular attention to thinking dispositions when trying to foster more effective reflection. We know why effective reflection is important, but previous research has tended to focus on how targeting efficacy is the means to increasing reflection. This study shows that if thinking dispositions moderate the relationship between efficacy and reflection then reformers may actually be more successful targeting reflection by way of better understanding how a teacher’s open-mindedness to change plays a role.

One way reformers might use this knowledge of teacher thinking dispositions as a moderating variable would be to recognize that with open-minded teachers the focus may need to be on specifics, such as feedback on teacher implementation of the reform.
curricula. Since this study suggests that the relationship between efficacy and reflection and/or acceptance of change is weaker among open-minded teachers it may not be effective for reformers to focus on efficacy and reflection with these teachers. However, this study suggests that the relationship between efficacy and reflection and/or acceptance of change is stronger for these teachers, so when reformers are working with more close-minded teachers it may be beneficial to focus time and effort on addressing teacher efficacy and reflection.

**Limitations**

This study did not find a significant relationship between teacher efficacy and teacher reflection. Teacher thinking dispositions, however, were found to moderate the relationship between teacher efficacy and teacher reflection, and this would explain why we did not find a significant relationship. No significant relationship was found between teacher efficacy and acceptance of instructional change either, and thinking dispositions were not found to moderate this relationship. It could be that a relationship between efficacy and acceptance of change does in fact exist, but was not found to be significant here due to the limitations of this study. As with any research the positive aspects of this study could be built upon in future research while the limitations are addressed and improved upon.

Correlational studies, like this one, are affected by specific factors that can limit one’s ability to find significant results, regardless of whether a relationship actually exists or not (Goodwin & Leech, 2006). Some of these factors may have come into play during the current study, including: (a) data distribution differences, particularly the skewness of
the teacher efficacy measure, and (b) characteristics of the teacher sample. Future researchers may wish to address these limitations.

One reason no relationship was found between teacher efficacy and acceptance of change may be the distribution of the PMTE subscale of the efficacy measure. The shape of the PMTE distribution (-1.69) was dissimilar to the effective reflection distribution (.59), which lowered the maximum correlation value that could be found (Goodwin & Leech, 2006). The distribution of total journal comments overall (1.46), as well as positive reactions towards instructional change (1.10), were also not normal. This could also have affected our ability to find significant correlations between efficacy and teacher reflection or acceptance of instructional change. An attempt was made to transform these variables with non-normal distributions using square root and log transformations to see if the distributions would then look more normal. However, transforming these variables did not make enough of a difference to result in any new correlational findings.

Another possible limitation of this study was the sample selection. For one, there was a small sample size. Although this was only intended to be an exploratory study using a group of teachers already involved in a reform-oriented mathematics professional development program, expanding the sample size to include a larger group of teachers may have made this correlational study more informative. A larger sample size may have also helped to make the PMTE distribution more normal.

Additionally the participant sample included 16 participants who were teachers in the same school district located in Northeastern Iowa. The participant pool may not have been as heterogeneous in their beliefs about mathematics instruction and openness to
reform as if the participating teachers had come from multiple school districts across the state. However, participants did have varying demographics as far as age, years of teaching experience, grade level taught, etc. There may have been greater variance in efficacy, thinking disposition, and reflection scores if the participants’ backgrounds had been more diverse. When there is more variability among scores the value of $r$ is greater so we may have been able to find more significant relationships.

A fourth limitation could be the way the variable of teacher reflection was measured and defined. Although there was research to support the significance of the reflection categories looked at specifically by this study (comments about student learning and comments about teacher instruction) there may be other aspects of teacher reflection that could have been coded for, which may have yielded significant correlations. However, there are many components of teacher reflection and it is not feasible to include all possibilities in one particular study. Due to this study’s limitations results should be generalized with caution.

**Unique Contribution of the Methodology**

Despite the limitations of this study the methodology used does provide a unique contribution. Pairing psychometric survey measures (for teacher efficacy and teacher thinking dispositions) with systematic coding of teacher journal comments allowed this study to take a different look at the relationships between the variables of interest. No other known studies to date have looked at the relationship between efficacy and reflection in this way, or have included teacher thinking dispositions as a third variable of interest.
Suggestions for Future Research

Future research looking at the relationship between teacher efficacy and teacher reflection should be done. Knowing that teacher reflection relates to acceptance of instructional change, and being in the middle of many mathematical reform movements, should be reason to further study variables that influence teacher reflection. Reformers need to know about variables that influence teacher reflection so as to better foster effective reflection for all teachers. Reformers should also be aware of moderating variables that influence teacher reflection and/or acceptance of change.

One suggestion for future research is to study the relationship between efficacy and reflection within other contexts such as reading or written language. While mathematics instruction is constantly undergoing reform so are other subject areas, and some of the same questions about how to foster teacher acceptance of instructional change come up regardless of the content area. The specific reform curricula or professional development program teachers are participating in may also affect this relationship.

Additionally, future research could look at the relationship between the variables of teacher efficacy and teacher reflection among middle and high school teachers. There may be fundamental differences in the way elementary teachers approach instruction and student learning compared to teachers of higher grade levels. Such differences could play a role in the relationship between these variables and might shed valuable light on how to foster acceptance of change among all teachers.
The direction of the relationship between teacher efficacy and reflection should also be investigated. For example, by increasing teacher efficacy are reformers likely to see teachers reflect more and become more accepting of instructional change? Or perhaps reformers should focus on increasing teacher reflection so that reflection can lead to increased teacher efficacy. While correlational studies like this one cannot determine relationship direction, researchers may want to look at different ways of investigating the direction of these relationships in the future.

Finally, future research could improve upon the methodology of this study. Including a larger number of teacher participants when investigating the relationship between the variables of interest would likely allow the relationships to be studied in greater depth. Future studies could also include teachers from around the country who teach in both rural, suburban, and urban areas to see whether teacher demographics play a role. Researchers could try measuring teacher reflection in another way, other than using teacher journals. Perhaps individual teacher interviews would lead to more teacher reflection data or greater depth of data.

**Implications for School Psychologists**

School psychologists are constantly introducing new state and local initiatives, teaching methodologies, intervention options, and data collection tools to the teachers they work with, often as part of the consultation process. Sometimes school psychologists are met with resistance from teachers when such changes are suggested. At times this resistance may be attributed to school psychologists and teachers having differing perspectives of student struggles and ways to address them (Athanasiou, Geil, Hazel, &
Copeland, 2002). It is important for all district support staff, including school psychologists, to better understand the teacher variables that affect whether teachers are likely to accept reform. In this way school psychologists may be able to tailor their interactions with teachers, and the professional development they provide, in a way that is likely to foster the most teacher buy-in to the consultative process (Rosenfield, 2002; Zins & Erchul, 2002).

Teacher reflection has already been shown to be related to teacher acceptance of change (Artzt & Armour-Thomas, 1999; Butler, 2003; Farmer et al., 2003; Franke et al., 1998), and school psychologists need to understand the importance of helping teachers to reflect in meaningful ways after professional development is provided or when meeting with individual teachers in a consultative role. School psychologists should also have knowledge of other teacher variables that may influence whether teachers are accepting of the consultation process. These teacher variables could include teacher efficacy beliefs and teacher thinking dispositions, as well as other variables such as teacher demographics, misconceptions held, personal motivation, etc. (Zins & Erchul, 2002).

School psychologists working with teachers can take the findings from this research and use it in a few ways. First, some of the significant relationships that emerged between teacher efficacy and teacher reflection had to do with teachers feeling they teach ineffectively, monitor student learning ineffectively, and are unable to help students better understand concepts that they struggle with. Teachers who felt this way were less likely to reflect upon student learning or their own instruction and were less likely to accept instructional change. By targeting these teacher efficacy beliefs school
psychologists have the potential to greatly impact whether teachers reflect effectively and are likely to accept instructional change. School psychologists are trained to progress monitor and develop class wide and student specific interventions. If school psychologists are willing to provide professional development to teachers showing them ways to progress monitor student learning with curriculum-based assessments and/or graphing then teachers may begin to feel more comfortable with the process (Rosenfield, 2002). School psychologists can also provide consultation to individual teachers who have struggling students in their classrooms, giving teachers intervention ideas to address specific student struggles. This may increase a teacher’s confidence in being able to help struggling students better understand concepts being taught. By helping teachers increase their confidence to monitor student progress and help struggling students school psychologists could be fostering teacher acceptance of reform oriented curricula and instructional change.

Conclusion

As researchers look at variables that may be related to teacher acceptance of change in hopes these variables might explain why some teachers are more open to mathematics reform than others, they have found that teacher reflection, when effective, often plays a key role (Artzt & Armour-Thomas, 1999; Butler, 2003; Farmer et al., 2003; Franke et al., 1998). This study specifically sought to investigate which variables might be related to teacher reflection, paying particular attention to whether teacher thinking dispositions might moderate the relationship between teacher efficacy and reflection. The results of this study indicate that there are relationships between aspects of teacher
reflection (specific reflection categories) and teacher efficacy. However, no significant relationships were found when looking at the teacher efficacy or teacher reflection measures as a whole. This was likely due to the fact that teacher thinking dispositions were found to moderate the relationship between teacher efficacy and teacher reflection. A relationship was found between effective teacher reflection and acceptance of instruction change. Teacher thinking dispositions were not found to moderate this relationship. The opportunity remains for future research to further look at the possible relationships between the variables of teacher efficacy, teacher thinking dispositions, and teacher reflection as they relate to acceptance of change. As teachers are increasingly asked to teach in reform-oriented ways it will become more and more important for us to understand these relationships.
REFERENCES


APPENDIX A

ITEM ANALYSIS TABLES

Table A1.

*Item analysis for MTEBI*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Item</th>
<th>Item-Total Correlations (Enoch)</th>
<th>Item-Total Correlations (Current Study)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMTE</td>
<td>I continually find better ways to teach mathematics. (#2)</td>
<td>0.36</td>
<td>0.23</td>
</tr>
<tr>
<td>PMTE</td>
<td>Even if I try very hard, I can not teach mathematics as well as I can most subjects. (#3)</td>
<td>0.62</td>
<td>0.73</td>
</tr>
<tr>
<td>PMTE</td>
<td>I know how to teach mathematics concepts effectively. (#5)</td>
<td>0.54</td>
<td>0.78</td>
</tr>
<tr>
<td>PMTE</td>
<td>I am not very effective in monitoring mathematics activities. (#6)</td>
<td>0.56</td>
<td>0.78</td>
</tr>
<tr>
<td>PMTE</td>
<td>I generally teach mathematics ineffectively. (#8)</td>
<td>0.55</td>
<td>0.57</td>
</tr>
<tr>
<td>PMTE</td>
<td>I understand mathematics concepts well enough to be effective in teaching elementary mathematics. (#11)</td>
<td>0.59</td>
<td>0.81</td>
</tr>
<tr>
<td>PMTE</td>
<td>I find it difficult to use manipulatives to explain to students why mathematics works. (#15)</td>
<td>0.50</td>
<td>0.66</td>
</tr>
<tr>
<td>PMTE</td>
<td>I am typically able to answer students' questions. (#16)</td>
<td>0.62</td>
<td>0.28</td>
</tr>
</tbody>
</table>

*table continues*
| PMTE | I wonder if I have the necessary skills to teach mathematics. (#17) | 0.62 | 0.87 |
| PMTE | Given a choice, I would not invite the principal to evaluate my mathematics teaching. (#18) | 0.58 | 0.89 |
| PMTE | When a student has difficulty understanding a mathematics concept, I usually am at a loss as to how to help the student understand it better. (#19) | 0.65 | 0.73 |
| PMTE | When teaching mathematics, I usually welcome student questions. (#20) | 0.47 | 0.75 |
| PMTE | I do not know what to do to turn students on to mathematics. (#21) | 0.61 | 0.85 |
| MTOE | When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort. (#1) | 0.49 | 0.36 |
| MTOE | When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach. (#4) | 0.49 | 0.32 |
| MTOE | If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching. (#7) | 0.42 | 0.33 |

Table continues
<table>
<thead>
<tr>
<th>MTOE</th>
<th>Text</th>
<th>Start</th>
<th>End</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTOE</td>
<td>The inadequacy of a student’s mathematics background can be overcome by good teaching. (#9)</td>
<td>0.42</td>
<td>0.46</td>
</tr>
<tr>
<td>MTOE</td>
<td>When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher. (#10)</td>
<td>0.48</td>
<td>0.53</td>
</tr>
<tr>
<td>MTOE</td>
<td>The teacher is generally responsible for the achievement of students in mathematics. (#12)</td>
<td>0.45</td>
<td>0.34</td>
</tr>
<tr>
<td>MTOE</td>
<td>Students’ achievement in mathematics is directly related to their teacher’s effectiveness in mathematics teaching. (#13)</td>
<td>0.53</td>
<td>0.72</td>
</tr>
<tr>
<td>MTOE</td>
<td>If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child’s teacher. (#14)</td>
<td>0.49</td>
<td>0.53</td>
</tr>
</tbody>
</table>
Table A2.

Item analysis for AOT

<table>
<thead>
<tr>
<th>Item</th>
<th>Item-Total Correlations (Current Study)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Even though freedom of speech for all groups is a worthwhile goal, it is unfortunately necessary to restrict the freedom of certain political groups. (#1)</td>
<td>0.56</td>
</tr>
<tr>
<td>What beliefs you hold have more to do with your own personal character than the experiences that may have given rise to them. (#2)</td>
<td>0.25</td>
</tr>
<tr>
<td>A person should always consider new possibilities. (#4)</td>
<td>0.63</td>
</tr>
<tr>
<td>There are two kinds of people in this world: those who are for the truth and those who are against the truth. (#5)</td>
<td>0.53</td>
</tr>
<tr>
<td>Changing your mind is a sign of weakness. (#6)</td>
<td>0.32</td>
</tr>
<tr>
<td>I believe we should look to our religious authorities for decisions on moral issues. (#7)</td>
<td>0.37</td>
</tr>
<tr>
<td>I think there are many wrong ways, but only one right way, to almost anything. (#8)</td>
<td>0.57</td>
</tr>
<tr>
<td>It makes me happy and proud when someone famous holds the same beliefs that I do. (#9)</td>
<td>0.25</td>
</tr>
<tr>
<td>Difficulties can usually be overcome by thinking about the problem, rather than through waiting for good fortune. (#10)</td>
<td>0.69</td>
</tr>
<tr>
<td>There are a number of people I have come to hate because of the things they stand for. (#11)</td>
<td>0.21</td>
</tr>
<tr>
<td>Basically, I know everything I need to know about the important things in life. (#14)</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Table continues
It is important to persevere in your beliefs even when evidence is brought to bear against them. (#15)

Considering too many different opinions often leads to bad decisions. (#16)

There are basically two kinds of people in this world, good and bad. (#17)

I consider myself broad-minded and tolerant of other people’s lifestyles. (#18)

Certain beliefs are just too important to abandon no matter how good a case can be made against them. (#19)

Most people just don’t know what’s good for them. (#20)

It is a noble thing when someone holds the same beliefs as their parents. (#21)

Coming to decisions quickly is a sign of weakness. (#22)

I believe that loyalty to one’s ideals and principles is more important than “open-mindedness.” (#23)

Of all the different philosophies which exist in the world there is probably only one which is correct. (#24)

My beliefs would not have been very different if I had been raised by a different set of parents. (#25)

If I think longer about a problem I will be more likely to solve it. (#26)

I believe that the different ideas of right and wrong that people in other societies have may be valid for them. (#27)
Even if my environment (family, neighborhood, schools) had been different, I probably would have the same religious views. (#28)

There is nothing wrong with being undecided about many issues. (#29)

I believe that laws and social policies should change to reflect the needs of a changing world. (#30)

My blood boils over whenever a person stubbornly refuses to admit he's wrong. (#31)

I believe that the "new morality" of permissiveness is no morality at all. (#32)

One should disregard evidence that conflicts with your established beliefs. (#33)

A group which tolerates too much difference of opinion among its members cannot exist for long. (#35)

Beliefs should always be revised in response to new information or evidence. (#37)

I think that if people don't know what they believe in by the time they're 25, there's something wrong with them. (#38)

I believe letting students hear controversial speakers can only confuse and mislead them. (#39)

People should always take into consideration evidence that goes against their beliefs. (#41)
APPENDIX B

MTEBI MEASURE

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.
   SA A UN D SD

2. I will continually find better ways to teach mathematics.
   SA A UN D SD

3. Even if I try very hard, I will not teach mathematics as well as I will most subjects.
   SA A UN D SD

4. When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.
   SA A UN D SD

5. I know how to teach mathematics concepts effectively.
   SA A UN D SD

6. I will not be very effective in monitoring mathematics activities.
   SA A UN D SD

7. If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.
   SA A UN D SD

8. I will generally teach mathematics ineffectively.
   SA A UN D SD

9. The inadequacy of a student's mathematics background can be overcome by good teaching.
   SA A UN D SD

10. When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.
    SA A UN D SD

11. I understand mathematics concepts well enough to be effective in teaching elementary mathematics.
    SA A UN D SD

12. The teacher is generally responsible for the achievement of students in mathematics.
13. Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.

14. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.

15. I will find it difficult to use manipulatives to explain to students why mathematics works.

16. I will typically be able to answer students' questions.

17. I wonder if I will have the necessary skills to teach mathematics.

18. Given a choice, I will not invite the principal to evaluate my mathematics teaching.

19. When a student has difficulty understanding a mathematics concept, I will usually be at a loss as to how to help the student understand it better.

20. When teaching mathematics, I will usually welcome student questions.

21. I do not know what to do to turn students on to mathematics.

Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) Scoring Instructions

Step 1. Item Scoring: Items must be scored as follows: Strongly Agree = 5; Agree = 4; Uncertain = 3; Disagree = 2; and Strongly Disagree = 1.

Step 2. The following items must be reversed scored in order to produce consistent values between positively and negatively worded items. Reversing these items will produce high scores for those high and low scores for those low in efficacy and outcome expectancy beliefs.
In SPSSx, this reverse scoring can be accomplished by using the recode command. For example, recode ITEM3 with the following command:
RECODE ITEM3 (5=1) (4=2) (2=4) (1=5)

Step 3. Items for the two scales are scattered randomly throughout the MTEBI. The items designed to measure Personal Mathematics Teaching Efficacy Belief (SE) are as follows:

Item 2 Item 11 Item 18
Item 3 Item 15 Item 19
Item 5 Item 16 Item 20
Item 6 Item 17 Item 21
Item 8

Items designed to measure Outcome Expectancy (OE) are as follows:

Item 1 Item 9 Item 13
Item 4 Item 10 Item 14
Item 7 Item 12

Note: In the computer program, DO NOT sum scale scores before the RECODE procedures have been completed. In SPSSx, this summation may be accomplished by the following COMPUTE command:

COMPUTE SESCALE = ITEM2 + ITEM3 + ITEM5 + ITEM6 + ITEM8 + ITEM11 + ITEM15 + ITEM16 + ITEM17 + ITEM18 + ITEM19 + ITEM20 + ITEM21
COMPUTE OESCALE = ITEM1 + ITEM4 + ITEM7 + ITEM9 + ITEM10 + ITEM12 + ITEM13 + ITEM14
APPENDIX C

AOT MEASURE

The items are preceded with the following instructions:
Note: Remove "(Reflected)"

This questionnaire lists a series of statements about various topics. Read each statement and decide whether you agree or disagree with each statement as follows:
1 - Disagree Strongly
2 - Disagree Moderately
3 - Disagree Slightly
4 - Agree Slightly
5 - Agree Moderately
6 - Agree Strongly

Mark the alternative that best describes your opinion. There are no right or wrong answers so do not spend too much time deciding on an answer. The first thing that comes to mind is probably the best response. Be sure the number on the answer sheet corresponds to the number of the statement to which you are responding. There is no time limit, but work as quickly as possible.

1. Even though freedom of speech for all groups is a worthwhile goal, it is unfortunately necessary to restrict the freedom of certain political groups. (Reflected)
2. What beliefs you hold have more to do with your own personal character than the experiences that may have given rise to them. (Reflected)
3. I tend to classify people as either for me or against me. (Reflected)
4. A person should always consider new possibilities.
5. There are two kinds of people in this world: those who are for the truth and those who are against the truth. (Reflected)
6. Changing your mind is a sign of weakness. (Reflected)
7. I believe we should look to our religious authorities for decisions on moral issues. (Reflected)
8. I think there are many wrong ways, but only one right way, to almost anything. (Reflected)
9. It makes me happy and proud when someone famous holds the same beliefs that I do. (Reflected)
10. Difficulties can usually be overcome by thinking about the problem, rather than through waiting for good fortune.
11. There are a number of people I have come to hate because of the things they stand for. (Reflected)
12. Abandoning a previous belief is a sign of strong character.
13. No one can talk me out of something I know is right. (Reflected)
14. Basically, I know everything I need to know about the important things in life. (Reflected)
15. It is important to persevere in your beliefs even when evidence is brought to bear against them. (Reflected)
16. Considering too many different opinions often leads to bad decisions. (Reflected)
17. There are basically two kinds of people in this world, good and bad. (Reflected)
18. I consider myself broad-minded and tolerant of other people's lifestyles.
19. Certain beliefs are just too important to abandon no matter how good a case can be made against them. (Reflected)
20. Most people just don't know what's good for them. (Reflected)
21. It is a noble thing when someone holds the same beliefs as their parents. (Reflected)
22. Coming to decisions quickly is a sign of wisdom. (Reflected)
23. I believe that loyalty to one's ideals and principles is more important than "open-mindedness." (Reflected)
24. Of all the different philosophies which exist in the world there is probably only one which is correct. (Reflected)
25. My beliefs would not have been very different if I had been raised by a different set of parents. (Reflected)
26. If I think longer about a problem I will be more likely to solve it.
27. I believe that the different ideas of right and wrong that people in other societies have may be valid for them.
28. Even if my environment (family, neighborhood, schools) had been different, I probably would have the same religious views. (Reflected)
29. There is nothing wrong with being undecided about many issues.
30. I believe that laws and social policies should change to reflect the needs of a changing world.
31. My blood boils over whenever a person stubbornly refuses to admit he's wrong. (Reflected)
32. I believe that the "new morality" of permissiveness is no morality at all. (Reflected)
33. One should disregard evidence that conflicts with your established beliefs. (Reflected)
34. Someone who attacks my beliefs is not insulting me personally.
35. A group which tolerates too much difference of opinion among its members cannot exist for long. (Reflected)
36. Often, when people criticize me, they don't have their facts straight. (Reflected)
37. Beliefs should always be revised in response to new information or evidence.
38. I think that if people don't know what they believe in by the time they're 25, there's something wrong with them. (Reflected)
39. I believe letting students hear controversial speakers can only confuse and mislead them. (Reflected)
40. Intuition is the best guide in making decisions. (Reflected)
41. People should always take into consideration evidence that goes against their beliefs.