Implementing Standards-Based Mathematics Curricula: Instructional Practices Versus Reform Vision in the Middle and High School

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Abstract

This paper reports the results of an interpretive study of two middle school teachers from a district that had adopted the Connected Mathematics curriculum and two high school teachers from another district that had adopted the Core-Plus: Contemporary Mathematics in Context curriculum. Analyses of teachers' instructional practices are compared with curricular objectives and teachers' responses to interview questions. Data were collected through classroom observations and individual interviews. Initial findings indicate a wide variance between the classrooms envisioned by the authors of the curricula and described in the *Standards* and the actual classroom practices of the teachers observed in this study. A similar gap existed between the authors' vision and the teachers' statements regarding their beliefs about the curricula.

A substantial body of evidence exists documenting the positive impact of implementation of mathematics reform curricula[1], in terms of student achievement in the areas of problem solving and conceptual understanding (Senk, 2003). These reports, along with increased interest in raising standards, have encouraged many districts to adopt such curricula. It is seldom clear who is involved in the adoption decision process, though the schools in this study seem to have initiated the process at administrative levels with teachers becoming involved later. Reform curriculum implementation under such conditions can prove problematic on many levels and may present serious consequences for the overall mathematics reform effort and realization of the vision upon which these curricula are based. In addition, there remains an atmosphere of controversy surrounding *Standards*-based curricula and the vision of mathematics education described in the NCTM *Standard*s that encourages polemics rather than rational evaluation. Given that there seems to be an underlying assumption that adoption of reform curricula will suffice as a tool of change in instructional practice, and thus implementation of the *Standards*, it becomes essential that the instructional practices of teachers under these conditions be documented.

Background

The mathematics education reform debate in this country played out in journals, newspapers, on the Internet, and most critically, in several states' departments of education[2], intensifies when the issue becomes implementation of reform or *Standards*-based curricula. The two curricula relevant to this study embrace the core of ideals that are at the center of the debate and upon which *Standards*-based curricula are generally founded. That is, they are problem-centered curricula that promote (i) mathematical reasoning and communication through investigations, (ii) the formation and verification of conjectures, and (iii) an emphasis on understanding and explanation of the problem solving process. Furthermore, both curricula emphasize the use of cooperative learning and the integral use of calculators as means of developing richer understanding. Opponents argue that these foci result in a lessening of algorithmic emphasis and thus a reduction in basic skills (Loveless, 2003; Wu, 1999).

A number of studies have attempted to resolve this conflict by comparing student achievement in reform classrooms with those offering a more traditional approach. This has resulted in a growing body of evidence that suggests students learning in reform environments tend to be better problem solvers and to have a richer understanding of mathematical concepts[3] (McCaffrey et al., 2001; Reys, Reys, Lapan, Holliday, &

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[1] *Standards*-based or reform curricula are curricula designed to bring about the vision of the National Council of Teachers of Mathematics proposed standards for content, instruction, and assessment as described in several documents (collectively referred to as the *Standards*). (National Council of Teachers of Mathematics, 1989, 1991, 1995, 2000)

[2] For a comprehensive discussion see February, 1999 Phi Delta Kappan, vol. 80(6)

[3] Criticisms of the several of these studies as well as general anti-reform perspectives can be found at http://mathematicallycorrect.com/

Wasman, 2003; Senk, 2003). However, Jo Boaler (2002) notes the inherent problem underlying such studies.

> The "math wars"…are unfortunate for many reasons, not the least of which is that the broad focus on curricula necessitated by such arguments has served to reduce the learning experience to an interaction between students and curriculum. This has drawn attention away from the teaching practices that mediate student success and that require considerable understanding and support. (p.244)

Thus, much of the research on student achievement has neglected to address the nature of the classroom environment and the ways in which students and teachers interact with the curriculum. The underlying assumption has been that adoption of a curriculum is sufficient evidence for change in teaching practice. In reality, the actual classroom environment following reform curricula adoption varies from teacher to teacher. Ball and Cohen (1996) observe that the "…enacted curriculum is actually jointly constructed by teachers, students, and materials in particular contexts". Schoen et al. (2003) discuss several studies and report the results of their own large-scale study that suggests high levels of student achievement in reform classrooms are associated with a high level of reform instructional practice. This is significant in that many of the studies completed to date have involved teachers who have volunteered to pilot and implement the various reform curricula during the 1990's. It is likely that these teachers had practices or beliefs aligned with *Standards*-based curricula and thus may have had more success and/or an easier transition to that environment. However, many teachers involved in system-wide adoptions of reform curricula may not share the same core beliefs or may have reservations about reform and the vision promoted in the *Standards*.

It is appropriate within this context to consider some lessons from past attempts at mathematics education reform. In looking back at the "new math" era, Usiskin (1999) referred to the phenomenon of early curriculum adoption during the 60's as "use by the disenchanted"– that is, those who were dissatisfied with the current curricula were the first to adopt the new. Those who later joined the "new math" movement he describes as "piggybackers"– those who follow along with the crowd. It is the last group who raise the biggest concern and are relevant to this study. Usiskin refers to the coercion of a large group of people who were quite content with their instructional practices and the curricula, but were nevertheless, pushed to adopt new math curricula as the "forcing of the enchanted". He summarizes the consequences of such practices in the following way.

> The change is not likely to fare well when implemented by those who are forced, often against their will, to adopt it. Some of the people who were against the change do wind up being new apostles and adopting the spirit and substance of the change, but most will give up the change at the first chance. (stage 6, ¶1)

The districts in this study initiated the adoption of Standards-based curricula at the administrative level. One district used adoption at previous grade-levels as a lever to advance the need for adoption at upper levels. In each case, teachers were involved in the decision regarding *which* curricula to adopt, but not whether to adopt. Given the current

state of controversy around *Standards*-based curricula, it is imperative that reports of studies on student achievement include descriptions of the adoption and implementation process as well as document the classroom practices of the teachers implementing the curricula so the fidelity of implementation may be ascertained.

The present study describes four teachers' experiences during their initial years of implementation of *Standards*-based curricula. The teachers' instructional practices and interview responses were documented on a variety of issues related to implementation of *Standards*-based curricula. The purpose of this study is to describe the teachers' response to the curriculum and to the implementation process through observations and interviews and to assess the extent to which the curricula are fully implemented in line with the authors' vision and that of the *Standards*.

Method

This collective case study (Stake, 1995) included two middle school teachers and two high school teachers in two districts' initial years of implementation of standards-based curricula. The high school was situated in a rural community where students were predominantly White (97.5%) and from poor to middle class backgrounds with 47.5% of the students participating in the free or reduced lunch program. The middle school was located in a suburban area and its students were also predominantly White (93.7%) with approximately 25% of the students participating in the free or reduced lunch program. The middle school data were collected through 40 observations during the first three quarters of the 2002-2003 school year, while the high school data were collected through 20 observations during the third quarter of 2000-2001.

The teachers at the high school taught ninth grade students the first course of the Core-Plus: Contemporary Mathematics in Context (Coxford et al., 1997) sequence during the first year of implementation. One teacher was in her second year of teaching while the other was a veteran of 15 years. The teachers at the middle school taught the sixth grade and seventh grade units of Connected Mathematics (Lappan, Fey, Fitzgerald, Friel, & Phillips, 2002a) and were both veterans. Since the district initially implemented the curriculum across the sixth grade in 2001- 2002, it was the second year of teaching the curriculum for the sixth grade teacher, but the seventh grade teacher's first year. All of the teachers had participated in several days of professional development to acquaint them with the expectations of the new curriculum. High school teachers were interviewed following the 10 weeks of observations, while the middle school teachers were interviewed in the middle as well as at the end of the study.

This study began as an attempt to describe the nature of interactions among students in small groups in a *Standards*-based classroom. However, initial analyses of the data from the high school teachers' classrooms revealed two environments that exhibited dramatically different instructional practices. One of the classrooms was much less teacher directed and more focused on the group learning process, while the other provided a physical structure resembling the first classroom, but without the fostering of student-centered learning. It was at this point in the study that my research questions

began to focus on the teacher and the ways in which one teacher had developed an environment reflecting the classroom model envisioned by the authors of Contemporary Mathematics in Context, while the other hadn't quite captured the essence of a reform classroom. Thus, my focus from here on became a search for the factors that led to the differences existing between the two classes and how teachers adapt to reform curricula.

The findings from the initial work in the high school revealed such differences in teacher implementation of the curricula that I wanted to further study instances of teachers' initial experiences implementing reform curricula. The opportunity arose within a local middle school engaged in the process of implementing Connected Mathematics. Two teachers, one sixth grade and one seventh grade, volunteered to participate in the study.

Each of the four teachers were interviewed both formally and informally. Field notes were taken during each classroom observation from the role of participant observer (Creswell, 1998). Thus, data were collected from many informal conversations as well as from formal interviews. In the analysis of data from each setting, Glaser and Strauss' (1967, cited in (Bogdan & Biklen, 1998) method of constant comparison allowed the features and trends in the students' and teachers' actions and interactions to emerge. New data from continued observations and interviews were then analyzed to contradict or verify the categories. In addition, whenever possible I examined student work including projects, quizzes and tests, as well as in- and out-of-class assignments. While this was not the focus of the study it provided me with insight into the student learning in each classroom and provided additional fodder for conversations with the teachers.

Results

Analyses of data revealed distinct differences between the visions of *Standards*-based classrooms as described in the *Standards* and by the authors of the curricula, and in what the teachers involved in this study seemed to value regarding student knowledge and classroom experiences as well as in their epistemological beliefs. In brief, the *Standards* (National Council of Teachers of Mathematics, 1991) recommend the following changes in the teaching and learning process:

- toward classrooms as mathematical communities- away from classrooms as simply a collection of individuals
- toward logic and mathematical evidence as verification- away from the teacher as the sole authority for right answers
- toward mathematical reasoning- away from merely memorizing procedures
- toward conjecturing, inventing, and problem solving- away from an emphasis on mechanistic answer-finding
- toward connecting mathematics, its ideas, and its applications- away from treating mathematics as a body of isolated concepts and procedures

The curricula that were developed to implement the Standards reflect these desired outcomes. The Connected Mathematics materials (Lappan, Fey, Fitzgerald, Friel, & Phillips, 2002b) state the need for students to "…be able to reason and communicate

proficiently in mathematics…. [and] define and solve problems with reason, insight, inventiveness, and technical proficiency" (p. 1). Similarly, the Core-Plus curriculum approaches teaching and learning through the "…provision of engaging problem situations that involve students…in investigating, conjecturing, verifying, applying, evaluating, and communicating mathematical ideas" (Hirsch & Coxford, 1997, p. 233)

All the teachers in this study found aspects of these curricular goals valuable and in particular mentioned the understanding that was developed. The 7th grade teacher summed up the overall feeling stating "I love the way Connected Math gives them the reasoning behind it. So that they can see what's happening and why it's happening- why we do this". However, it was apparent through the teachers' actions and statements that while they appreciated the developing understanding they questioned the lack of emphasis upon more traditional objectives of mathematics instruction.

The sixth grade teacher was troubled by her students' lack of knowledge of area formulas as they were completing the unit on area and perimeter. The students tended to count the number of squares to calculate the area of a given figure while the teacher would have preferred they use the formula. She commented on her frustration with this apparent weakness in the curriculum.

> I noticed after the first few lessons that they weren't transferring that knowledge to– for instance length times width for the area or and it was bugging me. I don't want to poo-poo the book, but it bothered me that the kids weren't making that connection and the lessons are designed so that you can wean them off the counting and that they get the formulas, but that wasn't happening.

The seventh grade teacher responded similarly in her discussion of their understanding of mixed numbers and the inability to quickly convert them to fractions.

> I'm finding that they know the basics of what's behind something, but they have no clue in terms of the shortcuts of how to get around it. Let me just give you an example. [When] we were changing mixed numbers to improper fractions, they had no concept that you take the denominator times the whole number and add the numerator, and that's the shortcut to find it. So, if they had, let's say 2 and 3/4, they would take the 2 and break it into one and one and then change it to 4/4 and 4/4 and then the 3/4, so they still came up with the 11/4. But that's a small number- what if you get something like 12 and 7/8?

This teacher did not appreciate the understanding that was being developed when it appeared to be in lieu of the students' knowledge of procedures and formulas. There was no acknowledgement of the understanding demonstrated in the above process or of the success of the sixth grade curriculum in developing this understanding of mixed numbers. The emphasis on rules and procedures and this teacher's belief in their importance was evident on multiple occasions. Perhaps the most significant example of the extent to which she valued students' knowledge of rules occurred when she reached an impasse with curriculum in the unit on positive and negative numbers. She had piloted the unit the

previous year and described her dissatisfaction with the students' ability to perform operations on signed numbers in an efficient way.

> Well, right now, we've kind of thrown the book out. We didn't like this book….I thought–well this would be maybe an easy way to deal with positive and negatives because the kids just don't understand positives and negatives….So with positive and negatives, they [Connected Mathematics] gave them 2 different colored chips– blues were positive and the reds were negative….well my kids never learned the rules. So my kids on their test would always be writing circles- because I mean eventually you take the chips away from them so now they are writing positive and negative circles and never learning the rules or reaching for the calculator.

Thus, the students were able to add and subtract successfully via a model, yet because they could not recite and use the traditional "rules", they were judged to be inadequately prepared, even though she acknowledges the general problem that "...they just don't understand positives and negatives." This response to children's strategies of solving problems speaks loudly to the issue of what is valued in terms of student knowledge and understanding. For this teacher, a concrete method for finding the sum or difference of two signed numbers that lays the foundation for understanding, isn't as valued as a set of rules that are without context, difficult to remember, and commonly misused. In addition, this teacher found value in the time that could be saved through teaching the rules as she states "…you know the book would have taken us 6 or 7 weeks, but this way it will take us 2 and we'll be finished."

The value placed on procedural knowledge isn't inappropriate. Rather, it is reflective of a failure of professional development to clearly articulate how the curriculum is designed so that the teachers are confident that the students will attain this knowledge at an appropriate time. The seventh grade teacher *was* aware that the students would be encountering signed numbers in the units that follow, but as the following exchange reveals, her vision of student learning through the curriculum is incompatible with her own.

> DW: So in the eighth grade there isn't a follow-up where it [signed numbers] becomes more formalized?
> T7: No, once they have [introduced them] then they start using it and the negatives happen to be cropping up all over the place.
> DW: And the book doesn't wean them off the chips?
> T7: No, they say that you don't have to worry about it. You know, however they [the students] can figure it out as long as they come up with the right answer it doesn't matter. And I'm not quite in that philosophy.

It is clear from the comments above that the teacher understood that there would be additional opportunities for students to work with signed numbers, but her beliefs and experience dictated her actions in directions contradictory to that of the curriculum. The early focus on formulas and procedures is in direct conflict with what is valued in

Standards-based curricula. The curricula's intent is to develop rich conceptual understanding *and* knowledge of formulas through repeated exposure to problems in multiple settings over the multi-year sequence of units. This conflict is in part, reflective of the larger issue of adoption of a broader set of learning objectives for students and the corresponding shift in teaching practice that is promoted within the curricula. Below, the Connected Mathematics authors address this issue directly.

> Problem-centered teaching opens the mathematics classroom to exploring, conjecturing, reasoning, and communicating….This model is very different from the "transmission" model in which teachers tell students facts and demonstrate procedures and then students memorize the facts and practice the procedures.

While all the teachers had been provided with professional development, their responses indicate that they may not have been provided with the opportunity to develop an understanding of the complex learning model underlying the curricula, the learning outcomes and data supporting the programs' success in achieving those outcomes, and the shortcomings that result from traditional practice using a "transmission" model. Their beliefs and related practices that were in conflict with the *Standards*-based vision were evident in the classroom as well as in conversation. For example, during one observation of a lesson involving circle graphs, the teacher began the lesson by stating "If we don't do this step by step, you guys are going to be confused. I don't want you confused. I want it good from the beginning." The task the students were about to do expected them to connect their previous work on angles, percents, and the circle, and create a circle graph of the data presented in the text. The belief that students would be confused and unable to complete the task without preliminary direct-instruction reflects the larger issue at work here– that of how students learn and what sorts of tasks they have the capacity to complete, and consequently what environments are conducive to teaching and learning.

Further evidence of a failure to successfully communicate the outcomes of the curricula was apparent through the teachers' intermittent use of supplemental materials. The teachers expressed concerns over the development of "basic skills" and topics that did not appear to be addressed in the curricula. The seventh grade teacher discussed her dissatisfaction with the types of problems the students work on regularly.

> I mean they are never practicing their facts. There is always a worldly problem– an everyday life problem. Which is ok, but somewhere along the line they have to practice some of these basic facts that they don't know.

The differing beliefs in regards to desirable learning outcomes was evident in all of the classrooms. Each teacher supplemented the curricula with traditional materials to help reinforce what they felt was valuable and was lacking in the *Standards*-based curricula. The authors of Connected Mathematics anticipated this response and discourage the practice in their implementation materials (Lappan et al., 2002b).

> In the first year of implementation, some teachers may feel the need to supplement the materials with drill and practice. This will take time away from

> *Connected Mathematics* and slow the pace. Over time, teachers will learn the curriculum and understand that drill is incorporated into the lessons. (p. 52)

Despite the authors' discussion and reassurance, the teachers' in this study felt compelled to address what they perceived as deficiencies. It is interesting to note that the motivation for emphasis on basic skills did not appear to be related to testing as might be expected. One teacher remarked how you could "…say that you are frustrated with their [Connected Math] questions, [but] their test questions are perfect precursor to the [New York State] 8th grade Assessment." Thus, the role of the beliefs and values regarding subject matter, rather than pressures of testing, appear to be a major impediment to the complete implementation of *Standards*-based curricula.

A second aspect of Standards-based curricula that failed to materialize in the classrooms involved the expectation of students working cooperatively and communicating their ideas as they engage in rich problem settings. While all of the teachers recognized the intent of the curricula to be student-centered with cooperative learning playing an integral role in students completing investigations, few went beyond arranging the seating into patterns reflective of a cooperative environment.

One of the high school teacher's comments reflects the disconnect between her beliefs and the outcomes she was observing in her classroom and the authors' expectations of "… [the] pivotal roles played by small group collaborative learning, social interaction, and communication in the construction of mathematical ideas" (Schoen et al., 1999, p. 448). She talked of the importance of her role in the learning process following collaborative investigations in the following way.

> You've got to have really good "calling it back together" type discussions. Kids go through and get all the data and they don't get the point… so you have to have good full class discussions after some of the stuff.

The majority of observations of this teacher's classroom revealed a teacher-centered environment. While the students worked on several investigations, there was an expectation that either she or the most able student in the group would have to provide direction to the others. This teacher revealed some of her beliefs regarding the opportunities for students to learn in cooperative settings when I asked what she felt were the most successful aspects of the group learning process. Her response of "…kids who actually have others in their group help them understand what's going on" reflect a view of learning that is out of sync with those underlying the curriculum. She reinforced this view later as she commented "I kind of think that you get to know the kids better this way, but I'm not sure why. Maybe you pick them out- which ones are leaders, or which ones can help other kids…"

The students in this teacher's classroom came to expect her to provide them with the "important" material following the investigations and thereby lessening the opportunities for developing their own understandings as expected by the authors and the *Standards*. This is exemplified in the following conversation between myself and a group of

students. Following one investigation involving sugar cubes and volume, I had the opportunity to ask the students how they came to their conclusions.

> DW: You found out how many sugar cubes that [box] could hold?
> Don[4]: Yeah, kind of.
> DW: How did you do that?
> Don: I have no clue……..I don't know, I kinda like…
> Cathy: Estimated.
> Don: Estimated.
> DW: How did you estimate?
> Cathy: You probably could take like …say how many are in here [the box]
> Don: There's some kind of equation that goes to it. I'm going to wait for her to go over it.

The group of three students did not know how to proceed to find the number of sugar cubes each of their respective boxes would contain, and yet they had written something down on paper and had decided their work was completed until the teacher reviewed it. This level of engagement was typical in this classroom. The students' engagement reflected the teacher's belief that unless there was a leader or someone to help them learn, there was little they could do on their own.

The other high school classroom revealed a significantly different level of interest and willingness to engage in the group process. The perspective on learning through group investigations and whole-class discussions stemming from those investigations was characterized in a very different way by the other high school teacher who found the cooperative process to be a valuable learning practice. She responded to what she felt was the most successful aspect of the group process stating:

> When all of them are participating and doing their role and fulfilling their obligations within the group…I'll see them bounce ideas off each other until they get the right one and then they all come together with that.

Her comments reveal beliefs aligned with a key component of these *Standards*-based curricula– that is, learning through group investigations in structured cooperative settings where students fulfill a variety of roles within the group.

The contrast between the former classroom and this one in terms of the interaction and the group focus can easily be observed by examining a sample of the verbal exchange during an investigation. The students below had been working on a problem involving a rectangular garden with a perimeter of 30 meters. They had first determined the various sizes it could be (e.g., 5 by 10, 2 by 13, etc.) and then which of those would have the largest area. They had moved on to the next part of the problem involving an algebraic representation of the dimensions and area and one student began to read ahead.

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[4] All proper names are pseudonyms

> Ann: Hang on, let Diane catch up.
> Diane: (reads part c) Let x represent the width of a garden whose perimeter is 30. Write an expression for the length of the garden
> Kurt: It would be like x + b=... or x+1=14.
> Jamie: Wait, what?
> Diane: x+1?
> Kurt: or x times 1 =14
> Jamie: Yeah, but it says it's got to equal 30 though...so it would be 2x... it's 2x cause there's 2 x's.
> Kurt: All the perimeters are 30 already.
> Jamie: Right, so it's got to be something something =3 0 and there's 2 x's cause there's 2 sides- you get what I'm saying Kurt?
> Diane: you have 2 widths and 2 lengths to make 30 so 2x...

This brief interchange was typical of the interaction among students as they worked on their investigations and problems in this classroom. The differences are striking when contrasted with the previous classroom. Here students are discussing their ideas, sharing their concerns about proposed answers, monitoring each other for understanding and pace, and in general functioning as the Contemporary Mathematics in Context authors' describe.

Unfortunately, only the above teacher gave any indication of valuing this process. All four of the middle and high school classrooms were arranged with students seated adjacent to their peers, though the shared perspective appeared to be that simply allowing them access to each other through their seating arrangement was sufficient for the type of learning described in the curricula to occur. One of the middle school teachers acknowledged the value of cooperative learning, but as her comments below indicate, it was not something that she valued enough, or had enough confidence in, to develop.

> Last year's class was amazing at cooperative learning- I never had to teach what it meant…you would come in my room and you would not need me. Like that's how skilled they were at just knowing what to do. I didn't feel that way this year. And with the group that you watched in particular there was a larger amount of fall off that would occur. So a lot of times I just– it was limited what I gave them to do because I really felt the need to go back and it's like–…you know you lose so many children cause they just don't want to listen. You have to just keep switching it up and hoping that eventually they'll pick up more or else you'll hammer it in that "look, come after school– we'll go over it".

This teacher did offer opportunities for her students to work cooperatively and at times encouraged them to take on roles and share their thoughts with each other. However, the vast majority of this teacher's instruction was teacher-centered. Her students frequently worked independently in a "work-in-silence" atmosphere as she did her best to circulate about the room and help clarify their thinking.

The other middle school teacher made even less use of the cooperative setting in ways that would allow the students to truly learn through collaboration with their peers. The classroom observations revealed an openness to students working together, but there was never any structured emphasis encouraging it to happen. The students were all seated in pairs or three's, but throughout the observations I only saw students' self-initiative as a factor in sharing their ideas.

The classroom scenarios described above in three of the four classrooms are in serious contrast to the vision set forth in the curricula and in the *Standards*. The lack of attention to developing the knowledge foundations of, and commitment to, cooperative learning on the part of participating teachers, and the role such knowledge has within the curricula, are major shortcomings of the professional development the teachers completed.

Conclusions and Implications

The studies of standards-based curricula to date have generally provided evidence of growth in student achievement. One of the outcomes of such findings is an increase in the adoption of such curricula in districts where teachers have little or no experience with the type of learning experiences and learning goals valued in these curricula. In both of the schools in this study, the upper echelon of administration made the decision to adopt a *Standards*-based curriculum. That is, the idea did not come from the teachers; rather, it was presented to the teachers in both of these school systems.

This study documents some of the struggles, questions, and frustrations teachers experience under these circumstances, and raises the possibility that many teachers will fail to fully implement *Standards*-based curricula as they were intended to be. This is likely to have a negative impact on student learning as teachers try to compensate for what they believe are shortcomings in the curricula. The frequent use of supplemental materials and emphasis on rules and procedures reflect the larger value and belief systems these teachers held regarding content and teaching and learning. The difficulties arising from these differences were further compounded by the teachers' lack of attention to developing effective cooperative learning environments. The magnitude of the expected change in beliefs and practice needs to be recognized and accounted for particularly when the teachers are presented with reform opportunities that originate in the administrative offices.

The teachers in this study were all provided with professional development that intended to present the goals of the curricula and the specific curricular structure that allowed for the realization of these goals. However, it is apparent from the interviews and observations that while key components of the curricula were presented in ways that allowed the teachers to be proceed with implementation, there was a failure to develop an understanding, or more importantly a belief structure, that would allow for implementation that was aligned with the authors' vision. There is a need for professional development that reflects and emphasizes the underlying principles of teaching and learning upon which these curricula were based. The recognition of need for professional development to support teachers before and during their efforts of implementing reform

curricula is not novel. However, the findings in this study, albeit a small study, provide additional support for the call for professional development beyond that which focuses on introducing the curricula to the teachers. Cohen and Ball (1999) in their report Instruction, Capacity, and Improvement noted that

> Even when interventions explicitly introduce new curricular materials or provide teacher "training," they rarely create adequate conditions for teachers to learn about or develop the knowledge, skills, and beliefs needed to enact these interventions successfully in classrooms. (p. 1)

Cohen and Ball's observation appears to have adequately captured the outcome of the professional development provided to the teachers in this study. The question then becomes one of what professional development should target when the magnitude of change in the teachers' beliefs and practices are this great. Cohen and Ball offer one success story as a possible model. Efforts at mathematics reform in California in the late 80's and 90's were ambitious with new curricula, professional development opportunities, and new assessments. Unfortunately, research revealed no significant changes in teachers' practices or in student achievement for the most part. Only in a minority of teachers were the changes significant. These select teachers had opportunities to

> learn about the purposes and methods of the curriculum, and to consider how it might be taught and learned….and to learn about the nature of the state assessment and how the curriculum implied in it, and about how students dealt with the tasks that were presented…(p.16)

These teachers were found to have significant changes in their goals for mathematics instruction– something that had not occurred for the most part in this study. Thus, professional development targeting the ways in which children construct knowledge, why the types of knowledge advocated for in the *Standards* are valuable and worthy of time in the classroom, how the specific curricula develop such knowledge, what the teachers' and students' roles are in developing that knowledge, and what students know and are able to do when they complete the curricula, should form the preliminary foundation for professional development to be built upon by specific curricular elements. Teachers who are then offered opportunities to share and reflect on their experiences regularly as a part of their ongoing development, may become successful in the transition to, and implementation of, the vision offered by the *Standards* and the *Standards*-based curricula.

The consequences of poorly or incompletely implemented reform curricula could have severe consequences. Reports of districts' achievement struggles would spread quickly and once again mathematics reform would be a short-lived phenomenon. The district in this study that had adopted the Contemporary Mathematics in Context series has since returned to a more traditional text after student achievement wasn't in line with expectations. Without particular attention being devoted to professional development, it is likely other districts will have similar experiences. In addition, research that documents

the professional development opportunities during *Standards*-based curricula adoption, and describes the nature of the change in teachers' beliefs regarding teaching and learning, is imperative. Such research will provide insight into ways in which districts can truly support teachers in their efforts to implement reform curricula and develop practices that are aligned with the *Standards*.

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