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AUTHOR	Frykholm, Jeffrey A.
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ABSTRACT

This paper describes a 2-year investigation of pre-service teachers in mathematics. Of particular interest is the degree to which the National Council of Teachers of Mathematics (NCTM) "Curriculum and Evaluation Standards for School Mathematics" (1988), the NCTM "Professional Standards for Teaching Mathematics" (1991), and other reform agendas impact preservice teacher' thinking and practice. The beliefs, perceptions, philosophies, and classroom actions of four cohorts of student teachers (n=44) were examined throughout this 2-year study. Of particular interest were the pressure student teachers felt to implement the "Standards" in their teaching, their perceptions of their own teaching with respect to the "Standards," the content of their lessons, and the impact of cooperating teachers on the development of student teachers. Data were collected through a variety of sources (classroom observations, lesson plans, interviews, seminar sessions, survey questionnaires, and informal conversations); they were organized and analyzed from an ethnographic perspective. Analysis of the data revealed general agreement among the student teachers in their regard for the "Standards." Although they appeared to affirm "Standards" goals and content, the student teachers almost uniformly suggested that they lack the tools to implement the "Standards" appropriately in the classroom. The consistency in the types and content of lessons observed appeared to validate this concern. An overwhelming majority of the lessons observed bore little or no resemblance to the values so highly espoused by the student teachers. Student teachers perceived pressure from the education program to include the standards in their practices, while feeling little pressure from cooperating teachers. They also pointed to cooperating teachers as the most significant influence on their teaching. (Contains 35 references.) (Author/JB)

The Impact of the NCTM *Standards* on Pre-Service Teachers' Beliefs and Practices

Jeffrey A. Frykholm

University of Wisconsin-Madison

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The purpose of this paper is to describe a two-year investigation of pre-service teachers in mathematics. Of particular interest is the degree to which the NCTM (1989) *Curriculum and Evaluation Standards for School Mathematics*, the NCTM (1991) *Professional Standards for Teaching Mathematics*, and other related reform agendas impact pre-service teachers' thinking and practice. I will begin by providing some background on recent reform movements in mathematics, followed by the theoretical underpinnings of the investigation.

Background

In recent years, researchers and reformers in mathematics education have been advancing new visions for appropriate instruction in mathematics classrooms (Knapp & Peterson, 1995). These visions are based largely in part on constructivist theories of learning and interpretive definitions of knowledge (e.g., MSEB, 1989, 1990; NCTM 1989, 1991; Romberg, 1992; Steen, 1990). Central to this position are several assumptions about the nature of mathematics, the way it is best learned, and its intended purposes. These include the following:

1. Mathematics is not a fixed system of facts and procedures, but a fallible, changing body of knowledge (Ernest, 1989; MSEB, 1990; Romberg, 1992).

2. Mathematics is learned not by transmission, but rather through an active process of construction (MSEB, 1989, 1990; Davis & Maher, 1990).

3. "Mathematical Power" should be the goal of mathematics instruction; i.e., empowering learners with the confidence and ability to explore, conjecture, and reason logically, as well as use a variety of mathematical methods effectively to solve nonroutine problems. (NCTM, 1989).

These foundations for reformed mathematics instruction contrast sharply with the way that most teachers (and in this case, pre-service teachers) learned mathematics under earlier traditions (Knapp & Peterson, 1995; Cohen & Ball, 1990). Research on teacher socialization has paid considerable attention to the influences on teacher learning that occur prior to enrollment in teacher preparation programs (Zeichner and Gore, 1990).

Abstract

The Impact of the NCTM *Standards* on Pre-Service Teachers' Beliefs and Practices

The purpose of this paper is to describe a two-year investigation of pre-service teachers in mathematics. Of particular interest is the degree to which the NCTM (1898) *Curriculum and Evaluation Standards for School Mathematics*, the NCTM (1991) *Professional Standards for Teaching Mathematics*, and other reform agendas impact pre-service teachers' thinking and practices.

The beliefs, perceptions, philosophies, and classroom actions of four cohorts of student teachers (n = 44) were examined throughout this two year study. Of particular interest were the pressure student teachers felt to implement the *Standards* in their teaching, their perceptions of their own teaching with respect to the *Standards*, the content of their lessons, and the impact of coöperating teachers on the development of the student teachers.

Data was collected through a variety of sources, organized and analyzed in the spirit of ethnographic work. Data was generated through classroom observations, lesson plans, interviews, seminar sessions, survey questionnaires and informal conversations. A minimum of four classroom observations were made for each student teacher.

Analysis of the data revealed general agreement among the student teachers in their regard for the *Standards*. Although they appeared to affirm the goals, content and recommendations contained therein, they almost uniformly suggest that they lack the tools to implement the *Standards* appropriately in the classroom. The consistency in the types and content of lessons observed appeared to validate this concern. An overwhelming majority of the lessons observed bore little or no resemblance to the values so highly espoused by the student teachers. Student teachers perceived notable pressure from the education program to include the *Standards* in their teaching practices, while feeling little pressure from cooperating teachers. They also point to cooperating teachers as the most significant influence on their teaching.

Lortie (1975), for example, argues that the predispositions of pre-service teachers are fundamental in the process of becoming a teacher, and that they exert a much more powerful socializing influence than either pre-service training or later socialization in schools. If teachers are to be the mediating agents for reform as Cohen (1989) suggests, and yet teachers have already been socialized to teach in ways contrary to reform movements by virtue of their experiences as students, then realizing change in mathematics classrooms will not be easily facilitated (Cuban, 1990; Richardson, 1990).

Part of the success of reform in mathematics education, then, necessarily rests on the effectiveness of pre-service teacher education programs to challenge the conceptions of beginning teachers, and to create lasting belief structures that will guide teaching practices. Knapp and Peterson (1995) suggest that lasting reform "will require considerable change in most teachers' beliefs and implicit theories about mathematics and mathematics teaching." As Brown and Borko (1992) and Thompson (1992) suggest, not only is this a significant challenge, it is one made more difficult by the lack of current research that examines teacher education under the reform visions of recent years.

Theoretical Framework: Teachers' Beliefs and Practices

One theme within the broad area of research on teachers' beliefs, knowledge, dispositions and thinking is the effect of beliefs and knowledge on classroom behavior (Thompson, 1992). Much of this scholarship has drawn from theories of cognitive psychology that suggest that teachers' knowledge structures are fundamentally linked to perceptions, thoughts, and actions (Putnam, Lampert, & Peterson, 1990). Brown and Borko (1992) explicate this argument to suggest that knowledge structures directly influence thinking, which in turn influences actions of teachers in the classroom. The implications of this assertion for reform-based teacher education programs in mathematics follow below.

The NCTM (1989) *Curriculum and Evaluation Standards* are built on the assumption that mathematics is a fallible, changing body of knowledge (Romberg, 1992).

Further, they (the *Standards*) suggest that learners construct their own understandings of mathematics and, therefore, the content and teaching methodology of school mathematics classrooms should be structured to facilitate this process. These conceptual foundations, along with the *Standards* themselves, guide many mathematics teacher education programs. As was the case for the students in this investigation, prospective teachers often receive extensive exposure to the content of the *Standards*, as well as an introduction to the constructivist theories of learning upon which they are based. The knowledge and belief structures these developing teachers construct as a result of this exposure are intended to affect their classroom organization, practices, and actions.

Several studies confirm this theory. Barr (1988) found that "teachers' beliefs clearly influenced content coverage, particularly coverage of those topics not highly valued" (p. 406). Similarly, Thompson (1984) concluded that "teachers' views, beliefs, and preferences about mathematics do influence their instructional practice" (p. 125). Shulman and Grossman (1988) found that teachers' knowledge of the subject matter affected not only classroom instruction, but content, activities and assignments, textbook selection, problem solving emphases, and conceptual explanations during lessons. Grant (1984) also found that teachers' beliefs were generally congruent with their classroom practices.

Other evidence suggests, however, that actions do not always follow beliefs. Shaw (1989) and Thompson (1982) have found sharp contrasts between teachers' professed views of mathematics teaching and their instructional practices (Thompson, 1992). Kesler (1985) also reports noteworthy degrees of variability between knowledge and practice.

Perhaps most relevant to this investigation, another well known example of disparity between beliefs and practice is found in the case of Fred, a beginning mathematics teacher in a rural Georgia high school (Cooney, 1985). Fred's conception of mathematics as problem solving was evident, as was his conviction to structure his teaching around problem solving activities. As his first year of teaching evolved, however, he found his students resistant to his problem-solving approach. Not equipped with the experience to negotiate these struggles, Fred eventually began to compromise his ideals, and teach in ways more readily accepted by his students. Fred's story parallels the experiences of student teachers described in this paper. It is an example of how beginning teachers, with little experience and still-evolving conceptions of how to best teach mathematics, struggle with the realities of the classroom.

The Investigation

Overview

My role as a supervisor of pre-service students in mathematics education for two years allowed me to interact with student teachers as they struggled to understand the *Standards* documents and implement them in their daily teaching practices. Early in my first semester with these students, I recognized some commonalities both in the ways they were teaching, and the issues we often discussed. Many struggled to reconcile the vision of the *Standards* as presented by the university education program with the realities of the classroom. As I began analyzing lessons, lesson plans and my many conversations more carefully, several themes emerged which I felt were significant enough to be shared at a broader level. This paper is a result of that concern.

The goals of this investigation were to examine the effects of the NCTM (1989) *Curriculum and Evaluation Standards* on student teachers, noting in particular the following questions: 1) What pressure do students feel to implement the *Standards*, and from what sources does that pressure come?; 2) How do student teachers perceive their own teaching with respect to the *Standards*?; 3) Are student teachers' perceptions of their own teaching accurate?; and, 4) What factors are most significant in the development of student teachers' philosophies and teaching practices?

Methods

This investigation reflects the assumptions and recommendations for qualitative research suggested by Erickson (1986). Collection of data for a two year period was comprised of classroom observations, interviews, survey questionnaires, informal conversations, and analysis of documents (primarily lesson plans). This process, as well as the participants of the study, are described below. (Note: This investigation is still in progress. The second year of data collection will be completed in May, 1995. As such, the data set, particularly survey questionnaire responses and interviews, were incomplete at the writing of this draft. Data from lesson observations, however, is current to date (March 30, 1995) and have been included.)

Participants

The participants in this study were 44 student teachers (19 female, 25 male) enrolled in a secondary (9-12) pre-service mathematics education program. These 44 students represented four cohorts, one for each of the following semesters during which they did their field-based student teaching: fall, 1993; spring, 1994; fall, 1994; and spring, 1995.

Data Collection

<u>Interviews</u>

As with most research investigating teachers' thoughts and beliefs, this project relied partially on self-report data. Initial bodies of information came through interviews which were based on Spradley's (1979) model of the ethnographic interview.

The interviews were conducted at the conclusion of each classroom observation. They ranged from 15 to 60 minutes in length, and focused on the contents of the lesson observed. Following Spradley's (1979) recommendations, I prepared three or four primary questions to guide the discussion. The flow of the conversation depended greatly on the responses of the student teachers, as new questions and themes emerged and were pursued. Notes of the interviews were recorded and filed with the student's lesson plan, as well as my formal supervisory comments.

Questionnaires

Early in the first semester of the investigation, the content of the previously described interviews suggested that many of the student teachers were struggling with similar issues. Generated in part from the contents of the interviews, I designed a questionnaire to solicit additional information regarding students' perceptions and knowledge of the *Standards*, as well as the value they placed upon them. The purpose for the questionnaire was to not only examine the conceptions held by the student teachers, but to note in particular the amount of agreement among the students on certain issues. The questionnaire was administered at the conclusion of the student teaching experience.

In approximately half of the survey questions, students were asked to select one of five choices in response to each question using a Likert scale with the following options: 1) very little, if at all; 2) a little; 3) some; 4) a good amount; and 5) a great deal. Other questions were open ended, free response items. To date, twenty-nine questionnaires have been returned for analysis. A copy of the questionnaire appears in Appendix A.

Documentation

Lesson plans given to me prior to each observation were also analyzed. Although the content and format of these lesson plans varied somewhat with each student teacher, they became an important source of data. These lesson plans extended my understanding of the student teachers, as they provided a unique window to observe the match between the students' planning with what actually happened as they taught their lessons.

Lesson Observations

The other primary source of data came through classroom observations. In all, 41 of the students were observed, and, to date, 127 classroom observations have been made. Following departmental guidelines, all student teachers for whom mathematics was their primary endorsement (n = 36) received four classroom observations. Those students for whom mathematics was a second endorsement (n = 5) received two observations. The remaining students (n = 3) received their supervision from another supervisor. Because of concerns for reliability, I did not include data from the lesson observations for these three students.

During observations, particular attention was given to the structure of the class period (teacher activities, student activities, procedures, etc.), the length of time spent on those activities, and teaching practices of the student teachers. One particular focus of the observations was to identify elements of the lesson that were consistent with the *Standards* recommendations. Because the *Standards* are themselves somewhat vague and open to interpretation, I tried to be as objective as possible when evaluating student's lessons. To establish validity for my observations, I took the following steps.

The *Standards* recommends the inclusion of a number of general teaching strategies (e.g., problem solving, mathematical connections, mathematics as communication, group interaction, high level reasoning, etc.) as desired attributes of mathematics instruction. Twelve of these recommendations became focuses for my observations. Based on the definitions provided by the *Standards* for these twelve recommendations, I used a separate observation sheet to record if and when I saw evidence of any of these twelve traits in the lesson. Appendices B and C contain the observation sheet used in this evaluation, and the twelve recommendations as defined explicitly by the *Standards*.

Table 1 below illustrates the breakdown of student teachers across the four semesters of this investigation, including the number of student teachers each semester, the number of observations made in each semester, and the number of questionnaires returned each semester. It should be noted that two students did not return the questionnaires--one during the fall semester of 1993, and one during the fall semester of 1994. Also, as described above, in the spring semester of 1994, the large number of student teachers required two supervisors. As the table indicates, I observed eleven of the fourteen student teachers. Although three student teachers were not observed by me, I included their questionnaire and interview responses in the analysis of the data.

Analysis

Erickson (1986) suggests that to analyze data from qualitative studies is to "generate empirical assertions, largely through induction" and to "establish an evidentiary warrant" for these assertions through a systematic search for confirming (or disconfirming) data. To aid in completing this task, four primary stages of analysis were adopted. Based on the recommendations of Wolcott (1993), Strauss (1987), and Spradley (1979), processes of "cooking" the data, "coding" the data, creating domain analyses, and writing memos were implemented. These four stages, as described below, were used to make sense of the data and address each of the four previously mentioned research questions.

Table 1

Number of student teachers observed, questionnaires returned, and total observations

	students observed	questionnaires returned	total observations
Fall 1993	9	8	36
Spring 1994	11	14	38
Fall 1994	8	7	29
Spring 1995	12	na[1]	24[2]
Totals	40	29	127

[1] Questionnaires for the Spring 1995 cohort will be given in May, 1995.

[2] To date, 24 classroom observations have been made for the Spring 1995 cohort.

Cooking the data

Spradley (1979a) discusses the importance of "cooking" data immediately upon completion of any type of field work. Following his suggestions, as soon after each observation as possible, noted taken during the lesson and interview were cooked-- i.e., reworked, filled-in, or completed-- to retain a more accurate description of the field experience for later analysis. It was common for me to make brief notes during interviews, and then complete my notes shortly thereafter.

Coding the data

Strauss (1987) recommends a "coding" process as the second step in analyzing qualitative data. This entails systematic fracturing of the data which leads to generative questions, and ultimately, a discovery of core categories or themes consistent in the data. The cooked notes were coded in this fashion and, where appropriate, the data was categorized in reference to the four research questions. For example, any instances in which issues of "pressure" (research question 1) were evidenced were marked accordingly. Later, all of the evidence of "pressure" was aggregated in one file, where the coding procedures were again applied to further identify sub-themes. This process was completed for each research question.

Domain analysis

Following these coding procedures, Spradley (1979a) recommends a domain analysis be constructed to help understand the relationships between primary themes that emerge through the coding process. In an often tedious process, data was organized into classes (Schatzman & Strauss, 1973), and relationships were drawn, where possible, between these classes. Again, these domain analyses were completed for each of the research questions.

Memoing

The fourth stage of analysis was one that was engaged in repeatedly throughout each of the previously described stages. Strauss (1987) suggests that a "memoing" process be included throughout the analysis for the purpose of capturing insights, questions and understandings as they occur to the researcher while immersed in the project. Following this recommendation, I kept a separate file for any random thoughts, insights, ideas or interpretations that came to me throughout the study. While many of these "memos" had little bearing on the final analysis, several did became significant in my efforts to understand the beliefs, thinking, and practice of the student teachers.

Throughout the analysis, this iterative process of summarizing, coding, and categorizing was conducted to make sense of both the interview and questionnaire data. As the investigation evolved into the second year, I found few original themes, codes, or domain analyses in the new data. As this occurred, I was comforted by Graue's (1994) suggestion that a researcher is beginning to get handle on the data when all of the newly generated codes and themes simply mirror those discovered earlier.

Results

The analysis of data led to four empirical assertions in response to the previously stated research questions. These four assertions are as follows:

Assertion 1: While student teachers perceive notable pressure from the university program to implement the *Standards*, they feel almost no pressure to do so in the school environment, particularly from cooperating teachers.

Assertion 2: Despite acknowledging a number of constraints on their preferred teaching style, student teachers suggest their own teaching parallels the *Standards*.

Assertion 3: Classroom observations did not support Assertion 2; i.e., although the student teachers said their teaching mirrored the *Standards*, there was little evidence to support this assertion.

Assertion 4: Although they often fail to embody the values espoused by the education program, cooperating teachers are the most significant influence on the developing philosophies and practices of student teachers.

As a means of establishing for the reader the validity of these assertions, excerpts from the data-- survey results, quotations, descriptions of lesson observations, extracts of lesson plans-- will be woven together in the tradition of ethnographic work (Wolcott, 1993). Evidence supporting each of the four assertions will be presented separately, followed by a discussion of the implications of these findings, when viewed together, for mathematics teacher education practices.

Assertion 1: Pressure for the *Standards*

As the influence and acceptance of the NCTM *Standards* continues to grow, so also grow the expectations held of teachers. It is no longer acceptable merely to recognize the vision of the *Standards* documents. Rather, a growing number of mathematics educators and researchers now expect teachers to act upon them; to continue making changes in their own practices to more closely follow goals articulated in the *Standards* (Brown and Borko, 1992). For many teachers, this is a daunting task. It is one thing to understand the goals of a reformed curriculum; it is entirely another to implement those goals in a classroom. Confounding this challenge for student teachers is subtle pressure they perceive from the university education program to adopt teaching practices consistent with the *Standards* during the field experience.

The conflict between university and school expectations surfaced immediately in my first interactions with the student teachers. Parenthetical notes on lesson plans were often written to alert me that I would "not be seeing much of the *Standards* today." A number of reasons for this were often given. For example, one student teacher noted that, "She [cooperating teacher] sees the *Standards* as too time consuming in practice, and that too much stuff needs to be covered right now." Another student, after five weeks of teaching, referred to curricular constraints: "I think the *Standards* are great ways of teaching, but I can't do them now. The material isn't at a point yet where I can do anything."

Noteworthy about these comments is the underlying assumption held by the students that I, as the university supervisor, expected to see the *Standards* enacted. When questioned further in interviews about this perception, students hinted at the difficulty of trying to implement the *Standards*-- a validation of their education-- while at the same time respecting the norms of their collaborating teacher. "Everyday," said one, "I feel that I am not doing what my education has taught me to do in the classroom." Another student, expressing sentiments similar to those of many of his peers, addressed the pressure of responding to both the education program objectives and the cooperating teacher concurrently:

> *Once you actually get into the schools, it takes a monumental amount of assertiveness and enthusiasm to make changes away from traditional teaching methods. That type of teaching [traditional] is just what the schools want. But, the university wants the opposite. It is so hard-- kind or a rock-and-a-hard-place type of thing.*

As a final example, one student spoke firmly and directly to the pressure applied by the university program to apply the *Standards*:

> *I agree strongly with most of the Standards, both for curriculum and teaching practices. I think the university is right to emphasize the Standards in its courses and field experiences. However, I think the university gives the impression that any student who does not meet the Standards by graduation will not be a decent teacher. I believe they hold us to unrealistic expectations. I want to aim for the Standards, but I don't expect to reach them in my first semester in a classroom. This, in my view, is the problem with the university's education program.*

Illustrated in table two below, questionnaire results confirmed this tension. When asked about the pressure applied by the university to teach like the *Standards* documents recommend, only one student teacher indicated "little" pressure. All others reported at least "some" pressure, with 70% indicating a "good amount" or "great deal" of pressure.

In contrast, it is interesting to note that student teachers report very little pressure to implement the *Standards* from cooperating teachers. Markedly different from the figures above, 81% of student teachers indicated "little" or "very little" pressure from cooperating teachers to teach like the *Standards* documents recommend. Further, students regularly responded that they discussed the *Standards* little, if at all, with their teachers. As one such example:

> *I agree with the Standards... [however], I have <u>never</u> heard the teachers at my school talk about the Standards or how the department should follow them. It is dishonest to portray mathematics teachers as a unified front on the issues of the Standards.*

While few of the student teachers reported that their cooperating teachers vehemently opposed the *Standards*, only one student was forthright in recognizing his cooperating teacher as overtly supportive of the *Standards*. Interestingly, this particular teacher is a former graduate of the same teacher education program.

These data suggest that student teachers feel the pressure to teach consistently with the *Standards* much more from the education program than from their cooperating teachers. Zeichner (1993) describes this phenomenon of university-driven pressure by suggesting that "student teachers are assessed primarily according to how well they measure up to some external standard of excellence derived from academic course work, either standards from the academic disciplines or from educational research on teaching and learning" (p. 14). Mathematics education appears to be dangerously close to falling into this assessment paradigm. As Borko and Brown (1992) indicate, the *Standards* has lived up to its name in the sense that it now serves as a yardstick -- a measure of quality by which teachers are often compared. As Zeichner (1993) goes on to suggest, using external gages such as the *Standards* as an evaluation tool has the potential to be damaging to student teachers who are still struggling to develop rudimentary pedagogical and management skills.

Table 2

Perceived pressure*

Question 1: **"How much pressure did you feel from the university program (supervisors, professors, classes, etc.) to teach like the *Standards* recommend?"**

Answer options:	very little, if at all	a little	some	a good amount	a great deal
teacher responses:	0	1	5	11	4

Question 2: **"How much pressure did you feel from your cooperating teacher to teach like the *Standards* recommend?"**

Answer responses:	very little, if at all	a little	some	a good amount	a great deal
teacher responses:	10	7	3	1	0

* Note: The first cohort of students (n = 8) did not receive these two questions.

Assertion 2: Teaching practices and the *Standards*

The second assertion drawn from the analysis of data is that, despite the number of reasons student teachers give for not enacting the *Standards* more often in their classes, they still think their own teaching parallels the *Standards*. This sentiment became clear through both the questionnaire results and interview data.

Student teachers hold the *Standards* in high esteem. Although I heard a number of times that "a lot of the *Standards* are not practical to do in a real classroom," there is almost uniform agreement that the vision of the *Standards* is laudable. The most ringing endorsement came from a student who worked diligently to incorporate the *Standards* into his teaching practices: "The *Standards* are the Bible. I really believe they represent all that is good and valuable in math education."

The lavish praise given the *Standards* was often tempered with explanations as to why the *Standards*, though highly respected, were not implemented as regularly as would be desired. In addition to those examples presented in the previous section, some students noted that the *Standards* were "not as practical as they were made out to be, especially in dealing with the structure of most schools-- short periods, no collaboration, no team teaching." Others pinned the problems on their cooperating teachers, rigid textbooks, departmental policies, and student ability (or lack thereof).

Paradoxically, despite the numerous explanations I received from student teachers as to why they did *not* implement the *Standards* more readily, they nevertheless reported that their teaching mirrored the *Standards* to a noteworthy degree. Some made bold statements they would have been hard pressed to support: "I consciously implement the *Standards* daily." Others were more reserved, though still positive. "I do the *Standards* as much as possible, especially in General Math. I became a little intimidated in Advanced Algebra, though, and have found myself doing some retreating." Particular aspects of the *Standards* were often cited as fundamental elements in their teaching: "I try to get my students to communicate in mathematical terms much more than other [teachers] I have seen, since I find this is really important." Another reported his commitment to "particular aspects of problem solving, communication and group work." Still others reported regular use of graphing technologies and computer labs as specific evidence of the *Standards*.

Analysis of the questionnaire data also suggested that student teachers felt their teaching paralleled the *Standards*. As Table 3 indicates below, when asked how closely their teaching embodied the recommendations and challenges of the *Standards*, (i.e., "How much did you teach like the *Standards* recommend?"), 89% of the student teachers indicated their teaching mirrored the *Standards* at least "some", and nearly fifty percent in particular noted a "good" or "great deal" of likeness between the *Standards* and their teaching. Similarly, when asked about the overall value of the *Standards*, (i.e. "Of how much value are the *Standards* documents to you in your practice of teaching mathematics?), 96% of the students indicated at least "some" value, with again almost 50% of the students suggesting a "good" or "great deal" of value.

Through both survey questions and countless conversations, the themes and philosophy of the *Standards* appear to receive enthusiastic support from the student teachers. Yet, as described in the following section, I found an alarming degree of disparity between these responses and what I observed regularly in school classrooms.

Table 3

Student teachers' self perceptions

Question 1: **"How closely did your teaching embody the recommendations and challenges of the *Standards*? (i.e., How much did you actually teach like the *Standards* recommend?"**

Answer options:	very little, if at all	a little	some	a good amount	a great deal
teacher responses:	0	3	12	12	2

Question 2: **"As a whole, of how much value are the Standards documents to you in your practice of teaching mathematics?"**

Answer options:	very little, if at all	a little	some	a good amount	a great deal
teacher responses:	0	1	14	11	3

Assertion 3: The (mis)match between students' perceptions and their practice

The data gathered during the 127 classroom observations suggest a different reality than the data that surfaced through the interviews and surveys. In every lesson I observed, I recorded the events of the period. There was enough similarity in how these student teachers were utilizing the class period that I was able to categorize the lessons observed into one of four categories.

The first category was labeled the "traditional expositional format". The procedures in this type of class consisted of an opening review of the prior homework assignment, a teacher-directed, ten to fifteen minute exposition of new or review material, followed by time to work the next set of homework problems. This procedure was similar to the description of mathematics classrooms given by NSF researchers nearly two decades ago:

> *In all math classes that I visited, the sequence of activities was the same. First, answers were given for the previous day's assignment. The more difficult problems were worked on by the teacher or the students at the chalkboard. A brief explanation, sometimes none at all, was given of the new material, and the problems assigned for the next day. The remainder of the class was devoted to working on the homework while the teacher moved around the room answering questions. The most noticeable thing about math classes was the repetition of this routine (Welch, 1978).*

The second type of lesson I labeled the "traditional-plus format." This type of lesson was modeled after the traditional expositional format, only it included some variety along the way. For example, perhaps the teacher required the students to work on the homework problems in a group. Or, perhaps the teacher chose to open class with an entry activity. Occasionally a teacher would include a relevant activity to accompany the lesson.

The third category, into which only a handful of lessons fell, was given the title of "innovative." These types of lessons included what I considered creative, interactive, and progressive elements that were implemented with respect to the *Standards*. The criteria for this judgment were based on specific definitions taken directly from the *Standards* (see Appendix D for detailed definitions used to categorize the lesson types).

The few lessons I observed which did not fit one of these categories, computer science classes, for example, were labeled "unclassifiable." The rest fell into the previously defined categories without exception, and are illustrated below in Table 4.

I should add briefly that, although I made every effort to develop and follow objective criteria for evaluating lessons, my own interpretation of the *Standards* inevitably affected my decisions. Those that have read the *Standards* in some detail would probably agree that they can be somewhat vague at times, and open for interpretation. I made every effort to maintain consistency in my observations, but nevertheless recognize my decisions and evaluations were, in part, products of my own biases and interpretations.

The primary finding of the observations when aggregated across the four semesters was that the classification of lessons into the four lesson categories did not parallel the way that student teachers perceived their own teaching. Recall that nearly ninety percent of the students replied that their teaching mirrored the recommendations of the *Standards*. Yet, only 13 of 127 lessons (10.24%) were categorized as "innovative" class periods. And, interestingly, seven of the thirteen innovative lessons were completed by the same three student teachers, clearly exceptions among their peers.

Table 4

Types of lessons observed

	traditional	traditional plus	innovative	unclassifiable	total
Fall 1993	18	10	5	3	36
Spring 1994	29	6	3	-	38
Fall 1994	15	10	3	1	29
Spring 1995	14	8	2	-	24
Totals	76	34	13	4	127

In contrast, the majority of the lessons I observed contained few, if any, elements of the *Standards*, and rarely provided meaningful ways for students to construct their own understandings and solution strategies for the mathematics they where studying. Seventy-six of the 127 lessons (59.8%) followed the traditional model. Given the emphasis of the *Standards* in the mathematics education program objectives, as well as students' self-professed commitment to the *Standards*, these results are disturbing.

I do not mean to imply that nearly sixty percent of the lessons, because they were traditional, were poor efforts. Many of those classes were effective, and implemented very well by their respective teachers. The mathematical presentation was regularly sound, and students participated constructively. In fact, by contrast, most of the "innovative" lessons had some significant glitches, and therefore may have appeared less effective than their counterpart traditional lessons. What I do mean to suggest by these results is that the type of planning and implementation of lessons I saw were inconsistent with both the emphases of the students' preparation for teaching mathematics as well as the perceptions student teachers held of their own teaching.

Also, in fairness to the student teachers, constraining elements do inherently exist in the student teaching experience. Many student teachers cited frustrations consistent with Lacey's (1977) thesis of "strategic compliance"-- of situations in which students feel compelled to conform to existing conventions and practices even though doing so is inconsistent with personal beliefs and values. Some of the constraints mentioned earlier by students were legitimate.

For example, some students had little freedom to deviate from the style of their cooperating teachers. Many felt constrained by planning deadlines established by the cooperating teacher or the mathematics department in which they were teaching. Many were rigidly bound to textbook-driven courses which allowed little flexibility. Also, it should be noted that these students were placed in a wide variety of classes, from precalculus to general remedial math. The variety of students, curricula, goals and objectives in these classes might have played a part in what strategies were implemented. The proliferation of traditional practices should be attributed in part to these factors. Yet, that recognition aside, further exploration is necessary to determine why these student teachers failed to teach in ways they claim to value highly. One plausible explanation is examined in the following section.

Assertion 4: The influence of cooperating teachers

The literature on teacher socialization attests to the significance of the cooperating teacher on the development of student teachers (see Zeichner and Gore, 1990). This literature provides a possible explanation for why student teachers' professed beliefs about their teaching and about the *Standards* are so different from the way they actually teach.

When asked about the primary influences upon their teaching, a large percentage of the student teachers point to their cooperating teachers. One reason for this is the natural tendency to model teaching practices after examples of cooperating teachers. A number of the student teachers commented on the fact that they had very few teaching models to emulate. As a means of negotiating the challenges of student teaching, many simply adopt practices of their cooperating teachers.

> *In thinking back on my training at the university it is clear that I had no modeling of how to actually teach a math class. The only teacher I got to see in action was my cooperating teacher, and that was for the five days prior to being put in front of a class. A student can reach his/her student teaching experience with basically no idea of what to do.*

This dependence on the cooperating teacher for the development of teaching practices and philosophies was evidenced through survey data. As Table 5 illustrates, 19 of the 29 teachers, roughly two-thirds, indicate that their teaching mirrored that of their cooperating teacher either a "good amount" or a "great deal." These findings are not surprising as they are consistent with other work on teacher socialization. What makes them significant for this investigation, and in particular for reform in mathematics education, is one other piece of information that student teachers almost uniformly agree on: cooperating teachers do not make the *Standards* an integral part of their teaching routines.

Table 5

Cooperating teachers and the *Standards*

Question 1: **"How closely did your own teaching style and/or philosophy mirror the teaching style/philosophy of your cooperating teacher?"**

Answer options:	very little, if at all	a little	some	a good amount	a great deal
teacher responses:	2	4	4	15	4

Question 2: **"Which of the following influences affected the development of your teaching philosophy during your student teaching the most?"**

Answer options:	education program	cooperating teachers	university professors	supervisors	other
teacher responses:	4	18	1	2	4

Question 3:* **"How often do you discuss the *Standards* with your cooperating teacher?**

Answer options:	very little, if at all	a little	some	a good amount	a great deal
teacher responses:	12	5	1	2	1

Question 4:* **"Did you pay more attention to the *Standards* than your cooperating teacher did?"**

Answer options:	yes	no
teacher responses:	16	5

* Note: The first cohort of students (n = 8) did not receive questions 3 and 4.

As suggested in an earlier section of this paper, only one student teacher indicated that he had frequent conversations with his cooperating teacher about the *Standards*. "When we discuss things at length, we do discuss the Standards. [My cooperating teacher] is knowledgeable and supportive of them." Conversely, interview data revealed that the rest of the student teachers noted little if any conversation about the *Standards*. One student indicated that, "very seldom do we talk specifically of the *Standards*," while many others said they had *never* talked with their cooperating teachers about the *Standards*. Such results are disturbing, if not problematic. If student teachers emulate their cooperating teachers and cite them as the primary influence on their teaching (see

Table 5 above), and yet cooperating teachers lack commitment to reformed mathematics instruction, then the difficulties pre-service teachers experience in implementing reformed practices for should come as no surprise.

Discussion

Each of the previously presented assertions are central issues in debates on teacher education in mathematics. Though these findings may not be surprising in and of themselves,-- indeed, perhaps they would even be expected -- when taken together, they provide a startling picture of the difficulties facing teacher preparation in mathematics. When the previous assertions are linked together, they suggest that the preparation of student teachers should not be overlooked in this time of reform in mathematics education.

A summary of the findings leads to the following chain of reasoning. First, student teachers feel pressure from the teacher education program, not cooperating teachers, to teach like the *Standards* documents recommend. This pressure has encouraged student teachers to profess commitment and affirmation for the *Standards*. Further, they perceive themselves to be teachers who implement the *Standards* regularly. Lesson observations, however, do not confirm the perceptions of student teachers that they teach like the *Standards* recommend. Rather, their practices are largely in opposition to reform-based ideals. As to the development of their teaching and thinking about mathematics instruction, student teachers report that their cooperating teachers are the most significant influence on the development of their teaching. Yet, contrary to the objectives of the university program, cooperating teachers spend little time modeling and/or discussing the *Standards* with their student teachers.

In short, although the student teachers espoused the reform movement, their teaching practices as a whole did not reflect the changes recommended by the *Standards*. Two conceivable explanations exist. Either the student teachers have already learned how to talk convincingly in attempts to appease the "right people", or they truly do not have the know-how, experience, or confidence to teach in innovative ways. Both cases are problematic. In the first case, it would appear that we continue to produce teachers who will rarely deviate too far from the strongly socialized group of teachers mistrustful of change and reform in mathematics. In the second case, students not yet capable of this new type of teaching suggest that teacher education efforts are remiss in preparing teachers to face the demands of the classroom. In the former case, it is of course difficult to envision how the teacher education program might change the attitudes of its pupils. If the latter case is true, however, it is clear the teacher education program needs restructuring.

One might argue that these teachers do in fact possess enough knowledge and understanding to teach innovatively, only lacking the confidence and experience to do so. With time, the argument continues, these teachers will begin to gain the confidence, comfort and know-how to teach a reformed curriculum. This is a plausible argument and, given the right circumstances, some teachers probably take just such a path. Many teachers improve in their efficiency and effectiveness in the classroom. However, simply becoming more efficient is not enough to fulfill the goals of reform in mathematics education. Because a teacher is polished, composed and confident does not necessarily mean he or she is able to structure appropriate learning opportunities in mathematics for students.

Further, there is a body of literature on teacher change which suggests that teachers, once initiated into a particular teaching style and philosophy, are not inclined to change later in their careers. Dewey (1904) recognized this many years ago in suggesting that, although teachers may improve in the mechanical aspects of managing a school classroom, they will not necessarily continue to grow in depth and insight as a teacher. Hence, it appears that teacher education programs as well as current supervision structures should be given close examination to insure that students begin to cultivate reform practices from the very beginning of their careers.

Recommendations

To renovate teacher education programs, however, is no easy task. There are many factors to consider in teacher preparation ranging from the quality of students interested in teaching mathematics to the quality of cooperating teachers in the schools. There are limitations in the amount of supervision student teachers receive, as well as the amount of time they can spend in actual classrooms before their student teaching. Despite these concerns, there are some steps that might be taken to improve the preparation of pre-service teachers. Several of these were suggested by the student teachers, and are discussed below.

Status of teacher education

First, the status of teacher training must be improved. Thompson (1992) suggests that researchers "should not take lightly the task of helping teachers change their practices and conceptions" (p. 143). It does not go unnoticed by student teachers that they are often taught and supervised by adjunct faculty and/or graduate students. Several students spoke to the lack of attention teacher training receives in a research institution, and see the inconsistencies in such a system. Zeichner (1993) supports the student teachers in this regard by suggesting that, "For a variety of reasons that have a lot to do with the low status and prestige associated with practicum and the labor intensive nature of practicum supervision, college and university teacher educators throughout the world have abandoned responsibility for trying to ensure that the practicum experience is an educative one for student teachers" (pg. 10).

Reconciling this dilemma is no simple matter, either. On one hand, the research on the learning and teaching of mathematics is extremely vital and significant work. On the other, so long as the information remains only in the domains of the researchers, there is little practical value in it. The student teachers I have worked with see the problems related to this issue clearly, yet nevertheless feel disappointed that they do not have greater access to distinguished and knowledgeable members of the mathematics community

Structure of teacher education

The premise for the second recommendation is that the current structure of teacher education programs is insufficient for proper development. Student teachers do not receive the guidance they need from the program at the most crucial time. It is one thing to discuss curriculum issues in the safety of the university classroom. It is another to try to implement them. As students begin their field experience-- the time during which they need the most supervision, guidance, and assurance-- the preparation program has been much to quick to relegate almost full responsibility to the collaborating teacher.

Though every effort is made to place student teachers in positive, progressive environments, there is clearly disparity in the quality of the placements. Some collaborating teachers are excellent, and espouse reform practices. Others, however, are much less receptive to reform agendas, and therefore potentially stunt the growth of these teachers at their most critical time of development. "Consequently, we often have a situation with the apprenticeship, where the lessons of experience for student teachers are determined by the luck of the draw and not as a planned part of the curriculum" (Zeichner, 1993, p. 12).

Zeichner (1993) elaborates on the placement process by noting that:

> *One major problem is that the placement of student teachers into particular classrooms and schools has often been made on the basis of administrative convenience and political advantage rather than on the basis of which settings can provide the best learning experience for student teachers (Zimpher, 1990). Student teachers throughout the world are frequently placed in classrooms where the teaching they are exposed to often contradicts what they are taught in the colleges. I should also add that practices in the teacher education colleges and universities often contradict these same theories (p. 10-11).*

It will not be enough, however, to simply improve the placement process. Rather, the structure of the program also must be changed to include the cooperating teachers in the design, planning and teaching of the methodology and curriculum courses. It appears from the responses of students (see for example, Table 5) that either cooperating teachers are unaware of program objectives and goals, or that they do not value them enough to include them in their teaching. There could be few other explanations as to why they spend so little time discussing the *Standards* with their student teachers.

If student teachers are expected to use the field experience to apply the knowledge they obtained in their coursework, then either of the two previous cases pose problems. Cooperating teachers must be allowed greater access and input to the education program in order to create more consistent learning environments and opportunities for student teachers. This would alleviate some of the pressure student teachers currently feel as they often attempt to reconcile the varying philosophical approaches taken by the education program and cooperating teachers.

Supervision

There must also be a concentrated effort on the part of the training program to incorporate more supervision into the student teaching experience. Currently, supervisors usually make four observations for each student as mandated by state requirements. Spread out over the course of the semester, this is not sufficient to provide the continuity and impact needed to be beneficial. As noted in Table 5, student teachers give little emphasis to the influence of supervisors on the development of their teaching. To be effective, weekly visitations should be the minimum in order to overcome problems inherent in the use of external supervisors "such as the lack of accessibility, the lack of trust, and the lack of influence" (Zeichner, 1993; p. 32).

Reformed practices modeled

The other primary concern expressed by the student teachers is the disparity between the way they are instructed to teach, and the way they received such instruction during their education. It is no secret that innovative teaching is difficult-- even more so if one has never seen it modeled. Not only should the content and methodology courses reflect the *Standards* by including opportunities for problem solving, interaction, discovery, connections, etc., the required mathematics courses they take should also be modeled after reformed practices. I often hear student teachers say they feel the pressure to teach in innovative ways, and yet rarely see such teaching modeled for them in both university and school classrooms. In the quotation cited previously, Zeichner (1993) makes reference to this very issue, suggesting that teacher educators are often remiss at practicing models of teaching that are consistent with the very theories they so vigorously promote. Although there has been some recent progress in this area, education programs as a whole must take the initiative to model teaching based on constructivist theories of learning.

Conclusion

According to Schoenfeld (1985), "Belief systems shape cognition, even when one is not consciously aware of holding those beliefs" (p. 35). That assumption, together with the notion that cognition precedes action, should be recognized as vital to the reform movement in mathematics. It would seem unlikely that a beginning teacher who did not have knowledge of the *Standards*, who did not value constructivist theories of learning, or who had not seen reformed teaching practices in action would incorporate teaching routines and practices consistent with the *Standards*. Even if the knowledge and beliefs of the *Standards* were in place, the evidence presented earlier suggests that it still might not be enough to cause reformed classroom practices.

These arguments place a burden on the mathematics education community. That burden, specifically, is to broaden, and in many cases challenge, the belief and knowledge structures of many current and future mathematics teachers. If reform i.. school classrooms is to occur, it is necessary that teachers come to greater understanding of the constructivist theories underpinning documents such as the *Standards* (NCTM, 1991).

This task, demanding though it may be, must be addressed if current reform movements are to be successful.

A natural place to begin this education process, it would seem, is in pre-service teacher preparation programs. Yet, there has been scant research investigating the effects of the reform movements in mathematics on the process of learning to teach. As Thompson (1992) suggests, "attempts to increase teachers' knowledge by demonstrating and presenting information about pedagogical techniques have not produced the desired results" (p. 143). Simply presenting students with the contents of the *Standards* is not adequate. We must, therefore, expand the goals of pre-service programs, as well as the experiences and supervision pre-service teachers receive. Brown and Borko (1992) and Thompson (1992), suggest the need for further research examining the beliefs and practices of teachers, particularly at the secondary level, to illuminate "how teachers learn from their experiences in the classroom as they interact with the students and the subject matter, how they might assimilate new information about mathematics, its teaching, and its learning, and how that information is internalized" (Thompson, 1992; p. 143).

These and other issues must be addressed before education programs will become as successful as we would like them to be. It is a critical time for educators in general, and particularly in the mathematics community. There continues to be widespread debate about the direction mathematics education should take, about the way mathematics is best learned, and how it should be taught. It would be a significant step if issues of pre-service training were also brought to the table to benefit from such detailed discussion. Until the preparation of teachers of mathematics receives this type of attention, we must accept that the true training of teachers will take place on the job-- in faculty rooms, department meetings, and in the classroom. Given that reform movements have been initiated in part to change what happens *in* these school settings, it would be unwise to continue the present path in mathematics education without devoting greater attention to the preparation of our future teachers.

Appendix A: Questionnaire

Post Student Teaching Questionnaire
June, 1994

Please use the following scale to respond to questions 1 - 11:

1: very little, if at all
2: a little
3: some
4: a good amount
5: a great deal

ans:______ 1. How closely did your teaching embody the recommendations and challenges of the *Standards*? (i.e., How much did you actually teach like the *Standards* recommends?)

ans:______ 2. How closely did your own teaching style and/or philosophy mirror the teaching style/philosophy of your cooperating teacher?

ans:______ 3. How conscious of the *Standards* were you as you planned for your lessons? (i.e., Did what you know about the *Standards* affect how and what you planned for your classes?)

ans:______ 4. As a whole, of how much value is the *Standards* document to you in your practice of teaching mathematics?

ans:______ 5. As a whole, how much practicality do you see in the *Standards*? (i.e., How feasible and practical is it to teach in a real classroom according to those recommendations?)

ans:______ 6. How much time (relative to the other things you tried to do) throughout the semester did you devote to having your students communicate either verbally, or in writing, about what they were learning?

ans:______ 7. How much time (relative to the other things you tried to do) throughout the semester did you devote to having your students connect the math they were studying to other subjects in school, or other areas of their lives?

ans:______ 8. How much time (relative to the other things you tried to do) throughout the semester did you devote to having your students develop problem solving skills that could be applied to a variety of non-routine problems?

ans:______ 9. How much did your cooperating teacher follow the guidelines and recommendations of the *Standards* ?

ans:______ 10. How much <u>practical</u> **training and experience** (aimed at implementing a teaching style consistent with the *Standards*) do you feel you received at UW-Madison?

ans:______ 11. How much indoctrination to the theory, philosophy, and recommendations of the *Standards* did you receive at UW-Madison?

ans:______ 12. How much pressure did you feel from the whole UW program (supervisor, professors, classes, etc.) to teach like the *Standards* recommend?

ans:______ 13. How much pressure did you feel from your cooperating teacher to teach like the *Standards* recommend?

ans:______ 14. Did you pay more attention to the *Standards* than your cooperating teacher did?

ans:______ 15. How often did you discuss the *Standards* with your cooperating teacher?

ans:______ 16. How much help do you feel you got (in developing your teaching) from your cooperating teacher?

ans:______ 17. How much help do you feel you got (in developing your teaching) from your supervisor?

ans:______ 18. How helpful were your professors and the training you received in developing your teaching?

ans:______ 19. Which of the following influences affected the development of your teaching philosophy during your student teaching the most?

1) your training at UW-Madison
2) your practicum experience
3) your cooperating teacher (either practicum or student teaching or both)
4) your professor(s)
5) your supervisor
6) other influence (if any) ______________________________

20. If possible, please rank the previous factors from "greatest influence" (#1) to "least significant influence" (#6). (You can rank them by their corresponding numbers from above.)

#1 _____ #4 _____

#2 _____ #5 _____

#3 _____ #6 _____

21. Do you see yourself involved in a career as a math teacher 5 years from now?
(please circle): YES NO DON'T KNOW

ans:______ 22. If you had to describe your teaching style as one of the following, which would be the closest resemblance to you? (Obviously, these are just rough sketches of styles. They won't be a perfect match. Just circle the closest one.)

a) expositional format (ex: correct yesterdays homework, lecture on new material, assign homework, give remaining time in class for a start on the next set of problems)

b) expositional format **plus** (same as above, but every once in a while incorporate occasional hands-on activities, work in groups, etc. A little variation every so often.)

c) project method (very little text book use; learning through projects and hands-on activities; groups; etc.)

e) student directed method (much like #3 above, but students get to help choose topics to be studied; lesson designed around student interests)

f) other (please explain)

ans:______23. Please rank your cooperating teacher using the same criterion.

ans:______24. If you had to give a score for the training and preparation you received in mathematics education at UW-Madison, what would it be? (1 = low, 10 = high)

25. What was/were the most valuable piece(s) of training you received at UW-Madison?

26. What were the least valuable pieces of training you received?

27. If you could make a suggestion about what should be done differently in your training, what would it be?

28. Any final comments or suggestions?

Appendix B: Teaching Observation Form

Student Teacher: ______________________ Date: ______________
Observer: ______________________ Time: ______________
School: ______________________ Class: ______________
Cooperating Teacher: ______________________

I. Evidence of *Standards*

Comments

Activity	present	not present
group interaction		
pair interaction		
cooperative learning		
communication: verbal		
communication: written		
problem solving		
connections: other math		
connections: real world		
high level reasoning		
technology		
assessment: grade hw		
assessment: other		

II. Time Allocation

Event	begin	end	begin	end	begin	end	total time
interactive presentation							
lecture/exposition							
guided practice							
tcher works problems							
stdnts work problems							
correct homework							
entry activity							
work on h.w. assgnmnt							
pair work/activity							
group work/activity							
quiz							
test							
free time							

III. Lesson Classification

Traditional Expositional	
Expositional Plus	
Innovative	
Unclassifiable	

Appendix C: *Standards* Definitions

Glossary of terms for observation form

group interaction: any occasion in which three or more students are engaged in conversation/effort relating to the lesson/activity; e.g., students working together on homework.

pair interaction: any occasion in which two students are engaged in conversation/effort relating to the lesson/activity; e.g., students discussing the solution to a problem.

cooperative learning: group interaction including components of cooperative learning; i.e., individual accountability, social skills, positive interdependence, etc.

verbal communication: any **structured** occasion in which two or more students are grouped with the specific intent (as directed by the teacher) to engage in dialogue regarding the mathematical content of the lesson; this does not include informal discussions by students such as described in "pair interaction".

written communication: any **structured** occasion in which students communicate about mathematical concepts in written form.

problem solving: non-routine problems or situations in which students have opportunity to apply integrated mathematical problem-solving strategies, apply mathematical modeling to real-world problem situations, or investigate in depth problems from within or outside mathematics.

math connections: opportunities to use, explore and value connections among mathematical topics.

world connections: opportunities to use, explore, value connections between mathematics and other disciplines.

high level reasoning: experiences/questions that reinforce and extend logical reasoning skills such as conjecturing, formulating counterexamples, formulating logical arguments, proofs, mathematical induction, and general in-depth analysis.

technology: the use of technology such as computers or graphing utilities to enhance/develop mathematical understanding.

assessment (h.w.):	the grading of homework assignments.
assessment (other):	assessment of activities/work in forms other than the grading of problems with correct/incorrect answers.

II. Time Allocation

interactive	teacher directed lecture which allows for some student input, usually presentation: in the form of answered questions.
lecture/exposition:	teacher directed lecture with no student interaction.
guided practice:	practice problems worked by students and teacher in which the teacher indicates correct procedures and solution strategies, modeling them for the class.
teacher worked problem:	problems worked publicly by the teacher.
student worked problem:	problems worked by students, either publicly or privately.
correct homework:	homework problems corrected (using any format).
entry activity:	any activity used to start the class (must be within the first minute of class).
work on h.w. assignment;	students have opportunity in class to work homework problems.
pair work/activity:	any activity in which students work in pairs.
group work/activity:	any activity in which students work in a group of three or more.
quiz:	quiz (usually less than 20 minutes) over given material.
test:	test (at least 20 minutes) over given material.
free time:	unstructured time in which students may do whatever they choose.

III. Lesson Classification

Traditional Expositional: The procedures in this classification consist of an opening review of prior homework, a teacher-directed lecture, followed by time to work the next set of homework problems.

Expositional Plus: The procedures in this classification are modelled after the traditional expositional format, only it also includes some variety along the way. For example, teachers may require students to work in groups on the homework, or perhaps an entry activity is provided prior to the lecture.

Innovative: These lessons contain creative, interactive, and authentic elements which are designed and implemented in the flavor of the *Standards*.

Unclassifiable: Lessons which do not fit one of the above classifications; e.g., computer science lessons, exams which take the whole period, etc.

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