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SELF-PORTRAIT : A TOOL FOR UNDERSTANDING OF TEACHING MATHEMATICS.

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Abstract: In a course labeled as 'math methods' for preservice elementary school teachers, the focus is on constructivist philosophy and a description of teaching as synonymous with research. The participants consciously view themselves as teacher-learners by continuously looking at their perception of self in a set of write-ups: "Self-portrait as a Teacher". Three such self-reflections are collected over ten weeks. The data show that the initial stage is a general, often vague, perception and description of a math teacher, reflecting the media portrayal of the necessity of math in schools, followed by confusion and frustration of not knowing math deep enough to explain it to others. The final portrait some resolution of conflict and self-discovery in 'doing' mathematics. In all, the practice of self-regulation becomes progressively more evident. Although teaching is acknowledged as a reflective practice, preservice teacher's process of self reflection is not well known. The self-portraits bring out the profile of a learner, which is helpful in providing the preparation appropriate for individuals and the group and helps in building a learning community of teachers.

Introduction:

The purpose of this paper is to share with you the findings of a research on inservice teacher thinking of their role and practice of mathematics teaching during their preparation at an institution of tertiary learning. Although the research on teacher thinking in mathematics is vast and useful (see Brown & Borko, 1992 for an excellent review), the focus here will be on the adoption of the reflective practitioner perspective (Schon, 1983) and embedding aspects of metacognition to amplify teacher thinking of self-as-a math teacher. The data reported here are drawn from a study-in-progress on teacher preparation for the elementary schools in a state institution.

Theoretical Considerations:

The status of mathematics education, particularly in the U.S. is going through major shifts and challenges. Since the publication of the Curriculum and Evaluation Standards for School Mathematics by the National Council of Teachers of Mathematics in 1989, there has been lively interest resulting in considerable discussion effort in changing the nature and practice of mathematics instruction in schools. The institutions of higher education responsible for preservice and inservice teacher training have taken an active role in this reform effort (Jacobson in *The Chronicle of Higher Education*, March 3, 1993, p. A17). The "vision" put forward by the NCTM constitutes of the recommendations for curriculum reform with change in content emphasis, teaching style, and teaching material involved, as well as, changes in assessment and evaluation practices. Evidently education does not exist in isolation from the society at large in terms of the philosophy and principles of instruction, the curriculum followed and the method of evaluation adopted. Hence, the nature of educational practice in

schools is closely connected to the society and contributes to the distribution of economic, cultural and political power of the society. At the core of the "idealist" view of the quality of mathematics education recommended by the Standards is the notion of "excellence" defined and described in terms of ideas such as "mathematical power", equity and access for all. We learn that mathematical power denotes "an individual's ability to explore, conjecture and reason logically, as well as the ability to use a variety of mathematical methods effectively to solve non-routine problems. . . In addition, for each individual, mathematical power involves the development of personal confidence" (NCTM, 1989, p.5) in the use of mathematical methods. These recommendations were loudly applauded because they were not geared towards the curriculum content alone. Simply put, in the light of the Standards, one sees mathematics as an engaging process, neither as a mastery over a set of specific content and concepts nor as a simplified prescriptive approach to a successful procedure leading to the desired response. The recommendations of the Curriculum and Evaluation Standards are accepted and viewed positively by scholars from various expertise and backgrounds-- Michael Apple (Apple, 1992) and Alan Bishop (Bishop, 1990) are just a few to be mentioned. In a review of two major reports on the status of mathematics education (Everybody Counts: A Report on the Future of Mathematics Education and Curriculum and Evaluation Standards for School Mathematics), Bishop, a preeminent mathematics educator from the U.K. (now in Australia) notes that "A mathematical education must not only encourage mathematical activity, but also offer the experiences of reflecting *on* mathematics and reflecting *about* mathematics. Also, while a mathematical training can certainly benefit those who succeed, what *educationally* does it offer those who don't? Those who will not become professional mathematicians do not need mathematical training but they do need mathematical education which will, in a democracy, empower them to understand and ultimately evaluate the activities of practicing mathematicians. . . Competence without a reflective practice is no education" (Bishop, 1990, p. 362-363).

The notion of "reflection" in education is not new. In an inquiry-oriented model of learning, reflection of thought and action plays a major role. Moreover, since the mid-eighties, the works of Donald Schon (The reflective practitioner: How professionals think in action, 1983, and Educating the reflective practitioner: Toward a new design for teaching and learning in the profession, 1987) had a sizeable impact on the ways of looking at teacher thinking and subsequent teacher-training. Grimmett points out that Dewey characterized "reflection as a specialized form of thinking" (Grimmett & Erickson, 1988, p. 6). Taking Dewey's perspective he explains how one draws inference from past experience and from the suggestions arising from

experience out of a situation. In his elaboration, he further says, "reflection involves looking back as well as looking ahead" ((p. 7) and "closer the process of reflection moves towards a resolution of the felt problem, the more critical it becomes to examine the past events and experience" (p. 7). In looking at the knowledge-in-action for professionals, Schon points out that the actions taken by the professionals in their own setting reveal their thinking and reflection on and in such actions. In other words, he argues that the relevant knowledge does not constitute a particular kind of theoretical thinking or 'technical rationality" (Schon, 1983, p. 21). According to Schon, a professional in the field, searches for meaning and understanding in the setting or context to compose an epistemologic formulation of practice; thus "implicit in the artistic, intuitive processes which some practitioners do bring to situations of uncertainty, instability, uniqueness, and the value conflict" (p. 49), is the "messy" nature of the practitioner's knowledge. Schon further points out that knowledge so constructed by practitioners is through *reflection-in-action* -- generated vis-a-vis acting and testing and experimenting on the spot, and *reflection-on-action* -- based on planning through consideration and discussion of post-hoc actions. Both types of reflections are thus necessary to involve the practitioner in some form of a conversation or dialogue with self. In this dialogue the individual as a practitioner identifies and recognizes a problem-setting and tackles the problem from a sense-making, problem-solving approach. To the individual, the 'problem' is viewed and framed in terms of prior knowledge and experience; certain relevant features are singled out perhaps as a core of the cause of uncertainty; following that the actions necessary are generated through a series of conversation with self within the setting, and eventually tested to continue the on-going dialogue. The cyclical nature of communication, that is, *talking to* and *talking back* with self and the setting constitute the reflective conversation of a practitioner which in turn generates new understanding and relevance of the practice. This is a very brief sketch of Schon's idea which has a powerful and broad implication for training teachers for a reflective practice.

The study of reflective practices within teacher education focuses on how an educator (beginning as well as experienced) makes sense of the very complex nature of the learning process in school settings. The nature of interaction in a classroom is a vastly intricate design of a social fabric and is often perceived as an entanglement of cultures and values of its members. Because teaching involves a sense-making for the teacher in such a complex setting, by studying the teacher carefully over a period of time one is able to document and describe the acquisition of such "wisdom of practice" (Lieberman and Miller, 1984 in Grimmett & Erickson, 1988, p.11).

From a very different way of looking at human participation in a social context, similar elaborations on the nature of participation of authentic members are provided by Lave and Wenger in their model of social practice theory of learning (Lave and Wenger, 1991). Learning, they say, is not merely situated in practice but is "an integral part of the generative social practice in the lived-in world." (p.35). An individual actor's participation is designated as *legitimate peripheral participation*. According to them, it serves as a "descriptor of engagement in social practice that entails learning as an integral constituent" (p. 35). The notion of "peripherality", which often generates confusion, denotes the spatial and temporal locators, thus describing the nature of learning trajectories which also relate to the identity and membership concerns. After Lave and Wenger, a theory of social practice is essentially a model of relational interdependency between the "agent and world, activity, meaning, cognition, learning and knowing" (p. 50). This view claims also that "learning, thinking, and knowing are relations among people in activity in,with, and arising from the socially and culturally structured world. . . Learning is . . . the historical production,transformation, and change of persons" (p. 51). Learning, for them, is not "a condition for membership" (p. 53) but is marked as an "evolving form of membership" (p. 53). Participation of an individual accordingly is viewed as "situated negotiation" and "renegotiation of the meaning" by means of which "identity, knowing,and social membership entail one another" (p. 53). Although they describe the distinction between the *talking about* and *talking within* a practice (p. 109) and the necessity of comprehending the distinction within the community of practice, they also point out that for a newcomer "the purpose is not to learn *from* talk as a substitute for legitimate peripheral participation; it is to learn *to* talk as a key to legitimate peripheral participation" (p. 109).

Although both perspectives described above characterize and discuss in detail the necessity of authentic, engaging participation in a setting or a community of practice, there is a major difference in the way one describes knowing and learning. For Schon, a significant part of knowing arises out of self-discovery, which, through informed deliberation leads to a richer, newer knowledge. Social practice theory (Lave and Wenger, 1991), on the other hand, makes no specific mention of self-reflection as a process of acquiring the knowledge of practice. For legitimate peripheral participation, self-reflection, if any, is implicit by nature and comes along with the ongoing monitoring of engagement of the actor and the agent in the context of the practice.

Methodological Considerations:

The theoretical frameworks mentioned in the section above will be useful later to describe and analyze the premise of this research.

Setting :

This investigation grew out of an intense interest in action research and the constructivist framework of the teacher as a researcher (Duckworth, 1987). A course titled "Mathematics in Elementary School" (dubbed as 'math methods') is a requirement for the students in their second quarter of training in the elementary school teacher preparation program in a large state university in the U.S. Designed as a field-based program, the enrolled prospective teachers spend half-a day in an elementary school as their field placement while attending the university for necessary and relevant course work. Concurrent with this course, they are also enrolled in a class designed on pedagogy of teaching language arts to elementary school children. The class met once a week for a period of two and a half hour over an academic term of ten weeks.

Participants:

Thirty prospective elementary school teachers (twenty four female, six male; all white Caucasians except two members from two different minority groups) were enrolled in this course on teaching mathematics to children in elementary schools. The members of this class represented the typical clientele for this teacher preparation program.

Methods:

In philosophy of the course evolved from the constructivist premise.

The philosophy of the course is described in a handout in the form of the *general goal of instruction* for "Mathematics in Elementary School" is distributed to the students on the first day of class. The handout also contains information on texts and reading material (two resource books and a mini-subscription to *Arithmetic Teacher*), evaluation criteria¹, description of the expected projects and a calendar with important dates regarding the projects for the course. The

¹ Emphasis is on constant self-assessment: no tests and quizzes are given. Strong commitment in class participation is expected. End of the term course grade is assigned on the basis of the following:- two individual large projects, other individual and group projects, and class participation (also includes journal writing).

content of the general goal is given below (Table: 1). The main project, called the *Teaching Experience*, is essentially teaching any math topic to a single child for about twenty minutes and analyzing the results of the teaching from two different perspectives: (1) the *student profile*, or, what happened to the child because of the teaching ? and, (2) the *teacher profile*, or, what happened to you because of the teaching experience ? The Teaching Experience has to be audio-taped, transcribed and submitted with the analysis as a part of the project. Students present their results of Teaching Experience orally in class and are expected to critique each other's Teaching Experience. Two Teaching Experiences are required for the course.

 Insert Table 1 about here

All along the course a very strong emphasis is placed on looking at tools, material and cognitive, and on tool-use highlighting the possible extensions and limitations. Using the NCTM Standards as a guideline, each class is based on various hands-on activities rooted in everyday life, followed by discussions and suggested links to other content areas.

Table 1: Description of the philosophy for the course "Mathematics in Elementary School"

<p>This course stresses mathematics learning and teaching as a higher-order thinking skill. Mathematics is not a set of symbols or reliance on recall of formulas: it is an approach of problem solving that enhances the development of logic and reasoning.</p> <ul style="list-style-type: none"> ◦ The main intent of this course is examination of the learning and teaching of elementary school mathematics in the light of recent theoretical and pedagogical developments. ◦ This course is designed to assist you in preparing yourself as a successful mathematics teacher, who will stimulate and promote interest in mathematics in children and establish a link for them to understand the powerful ways in which <i>mathematics</i> is embedded in our <i>everyday</i> life. ◦ This course is based on ways that children learn mathematics. We, the participants of the class, the instructor and the students, will work together to explore and experiment on learning of mathematics. We will strongly <i>emphasize</i> children's understanding and knowledge of mathematics and discuss their patterns of learning mathematics both in school and out of school. This course will, thus, <i>help</i> us to become aware of <i>how children learn mathematics in their everyday lives</i> and prepare us, the classroom teachers, to better design, monitor and guide the learning environment for children. Our <i>role</i> as a teacher is to facilitate children's construction of their own mathematical knowledge. ◦ This course will, during this academic quarter (ten formal meetings, each two and a half hour long), through examples (concrete and abstract) and involved discussions, provide us

with *ideas* (not recipes) on basic instructional decision making for elementary math classrooms.

Purpose:

Guided by the constructivist principles that knowledge must be constructed by an individual and that the new knowledge must be assimilated to make sense, this course on pedagogy of mathematics in elementary schools relies on the knowledge of mathematics that gradually develops into pedagogy of mathematical thinking. The students, treated as teachers participating in the class, are not lectured to but are put in contact with the real-world ideas and examples and encouraged to look for the various embedded mathematical concepts and principles that they have studied earlier. By engaging the participants in this approach of investigation and inquiry, one helps them to see what is of personal interest and challenge: thus, gradually a process of sense-making evolves for themselves. They continue to think and wonder about their queries. Instead of explaining to these queries, the instructor allows for and encourages continuous discussion among the participants. The students try to explain and discuss the sense they are making. In short, this approach generates and emphasizes the interdependency of inquiry and sense-making and respects the notion of knowledge-construction of an individual as sense making through social negotiation. In addition to their university classes, the students as newcomers begin their participation in teaching contexts with their internships in schools, where they usually spend their time by occasional teaching of small groups and/or whole class, observing and helping the teachers. Their involvement in becoming a teacher is expressed in terms of their cumulative experience and evolving membership in the community of practitioners of elementary school teaching. The process of gradual transformation of identity, self and knowledge contribute to their awareness and knowledge of self as a teacher. For a newcomer, this process of unfolding to a newer, developing role of a teacher involves mutual intentionality, implying actions, behaviors and responses of *all* the actors and the world around them. Participation in terms of continuous negotiation, validation and renegotiation legitimizes the role of a practitioner in the field-- this implicit separation of self as a learner-participator arising out of the duality of doer and knower is crucial for a practitioner. In the university, the course encourages and requires the students to keep a journal²

² A journal is a free format, free writing experience for the students where no constraints are imposed. No class time is allocated for journal writing and a high degree of freedom is maintained in recording personal thoughts. Journals are used as a means of communication between the students and their instructor.

as a personal notebook regarding their thoughts and emotion on mathematics and issues relating to learning in school and out. The assumption is that, past the initial barrier or resistance to surprise, novelty and discomfort of "writing about math", one has a better opportunity of capturing self-growth by documenting the process of reflective dialogue.

Self-portrait as a cognitive tool:

Self-portrait, a very ancient art form (Lucie-Smith, 1987), is a narration and representation of self-study. Often realistic in style and detailed in description, it is a static capturing of a dynamic thought profile, a process that encourages one to introduce the inner self to the world outside. In order to recognize the value of reflection and a deeper appreciation of thought about self-as-a-learner, the self-portrait is a powerful cognitive artifact. As such, it is a close approximation to self-assessment, a metacognitive exercise, that benefits both the student (the writer) and the teacher (Kenney & Silver, 1993; Clarke, Clarke & Lovitt, 1990).

On the first day of class the students were given a written hand-out and an oral explanation about the goal of the class and the rationale for monitoring self-growth. The students were asked to write an "honest and objective" self-evaluation, or a self-portrait, expressed as a "sketch of your own profile. . . in the process of becoming a math teacher for the elementary grades". The self-portraits were written three times during the academic quarter on every fourth week. By definition writing a self-portrait has to be open-ended and cannot be pre-structured; however, a few pointers were suggested for elaboration, if necessary (Table 2).

Insert Table 2 about here

The self-portraits were retained by the instructor. They were occasionally used, maintaining anonymity, in conjunction with journal entries, for addressing issues and concerns in class. When necessary, they were also used for one-to-one meetings with the students. The three self-portraits written by each student thus created a profile of a newcomer, or, teacher-in-the-making.

Of the thirty students representing a variety of intellectual and emotional commitments and backgrounds, only one withdrew from the program for personal reasons, leaving a handwritten note to the instructor with a request to *still* read her self-portrait, for she brought in "the

During the academic quarter, every journal is read three times, with occasional comments as necessary from the instructor.

perspective of a student returning [to school] after a long absence." The rest provided a rich data base to draw upon the mental models of beginning elementary school math teachers.

By looking at the data, some of the initial reactions and questions that arise are :

- (1) what happens to the students when they are required to draw a self-portrait as a teacher as often as on every fourth week during a very busy academic quarter ?
- (2) what happens to the instructor who assigns such a novel task in an already hectic time frame ? In other words, how does the instructor utilize "appropriately"³ the information generated ?

The contents of the self-portraits were analyzed by looking for recurring themes or patterns that could be useful to draw an inference on the nature of the *reflective* practice for teachers-in-the-making. Some of the observations will be reported in the following section.

Table 2: A few suggestions on elaboration of a Self-portrait

- What defines and describes a "good" elementary school math teacher in your mind ?
- What, according to you, are the strongest area(s) of growth so far ?
- What, according to you, are the area(s) where you need to pay more attention ?
- What aspects of the learning process (in this class and its application in the field) has been exciting/challenging to you so that you feel great about yourself ?
- What aspects of the learning process has not been exciting and you were often bored ?
- Do you think that mathematics in elementary school will have much more relevance if it is integrated with other subject areas ? If so, what aspects of math can be integrated with other subject areas ? Describe your effort in this process of integration.
- Describe your thoughts and analyses of math classes that you see. *You are encouraged to see as many different math classes as possible.*
- Describe how do you plan a lesson if you have been teaching in your placement. What type of pre- and post-assessment do you conduct ?
- What math content do you think you need to know more ?
- What are your main worries and doubts about becoming a math teacher?
- What is your level of in-class participation ? Are you satisfied with your in-class participation ? Justify. What do you recommend to increase participation ?

³ During the academic quarter, the instructor keeps a journal for the purpose of documentation.

Feel free to write about *other* issues and concerns that are important to you.

Analysis and interpretation of data:

As mentioned earlier, the self-portrait of the pre-service elementary school teachers were collected three times at an interval of three weeks over a period of ten-week long academic term. For writing the self-portrait no format was provided except a set of pointers or guidelines for elaboration was suggested (Table 2).

The descriptions of self as a math teacher revealed certain categories, which could be viewed in terms of conditions of human mind, such as, perception, belief, feelings, desire, intention and resolution. These categories are also used in describing folk or cultural models (D'Andrade, 1987). Drawing upon the analysis of cognitive anthropology, folk or cultural models can be viewed as "a cognitive schema that is intersubjectively shared by a social group. . . typically consisting of a small number of conceptual objects and their relations to each other" (D'Andrade, 1987, p. 112). Because of constraints of the human mind, cognitive schema tends to hold a small number of objects or ideas, which exist in hierarchical organization. One has to remember at this point that "these objects may themselves be complex schemas" (p. 112). The schema of a math teacher is the intersubjectively shared within the group when there is a sense of sharing or common understanding of the process of becoming a "math teacher". As a result of this process, interpretations within the folk model ("math teacher") often occur as "obvious facts" and need not be made explicit.

To view the developmental trend in self-awareness, the data will be described as the "first", the "second", and the "third" snapshots.

The "first" snapshot:

The "first" or the initial attempt to describe self is perhaps a naive, under-edited or unedited representation and an overwhelming task for many. Written on the first week of school, their views of self-as-a-math teacher included mostly personal attitudes and feelings towards mathematics, followed by a general, often vague and distant perception of a math teacher with desires and wishes echoing the media-portrayal of the necessity of math in schools.

A large number of students (70%) admitted openly and clearly of their *feelings* of fear and anxiety in teaching math. Expressing math as a "riddle hard to decipher" (Kevin), many of them described situations and incidents in detail which contributed to their "not so pleasant memories" of math. Here are a few examples of their thoughts:

- I can't help but feel at a loss for words when I ask myself the question:"How do I see myself as a math teacher ?" I studied math until about the fall of my senior year in high school and would consider myself as one who has "mathophobia". (Betty)

- Math was always high pressure and you had to come up with the right answer or you got bad grades. (Cathy)

- I feel very math illiterate and incompetent overall. (Molly)

- The one area I avoid and fail to think of as I am preparing to be a professional teacher is math. I am ashamed to say such a thing in this context, but it is the honest truth.

(Nancy)

- Math sucks! That, my dear friends, is the unfortunate premise form which I am currently operating. (Ursula)

- I didn't really understand how to apply mathematical concepts to my everyday life.

(Virginia)

- It is very scary for me to think of myself as a math teacher because it is very scary for me to think of math! (Connie)

Current review of research on teacher's beliefs on mathematics (Thompson, 1992), on teacher's knowledge of mathematics (Fennema & Franke, 1992) and on teacher preparation in mathematics (Brown & Borko, 1992) also have indicated similar observations.

However, a few of them did not hesitate to express their *feelings* of interest and enthusiasm that they see in a "good" math teacher. They wrote

- I love math and I love excitement of discovery. It is these two primary qualities that I look forward to bringing to the elementary classroom--and outside the classroom, too. . . it is critical to get out to see that math is, indeed, all around us, and to find out how to use it, change it and make it work for us in a variety of settings. (Sam)

Their *feelings*, often strongly negative, were followed by their *desires* to change. The *desires* took the form of lists, such as,

- I do not want my students to experience the dread that I did when it was time for math class. . . I know that I am going to force myself to re-learn math, change my way of thinking. . . I want to learn more about math, more about how to teach it effectively. For most of my life math has been the subject that I have purposely avoided, I know that it is time to jump in head first. (Wilma)

- My goal is to gain confidence [to teach math]. I am not comfortable. . . I don't think I had any great model math teachers growing up. (Roberta)

- I want to encourage creativity in problem solving. (Ilene)

- My idealistic goal . . . is to create the opposite environment of the one to which I was subjected. (Nancy)

- I want to be able to truly integrate math with other areas of what I teach. True integration of concepts, not simply having a math unit on regrouping where our problems have characters from the desert (our science unit). (Anne)

Borasi and Rose (1989), Marwine (1989), Powell & Ramnauth (1992) have noted that writing about mathematics is an engaging process which often have a therapeutic effect on the students.

The "second" snapshot:

The "second" or the intermediate self-description arrived right in the middle of the term, after completion of the first project on Teaching Experience. The stress generated for the lack of time was apparent, as Anne mentioned:

- Personal assessment is the most important but also the most difficult, particularly true and honest assessment. The last four weeks have flown by and I find myself more often than not simply trying to keep my head above water.

There was less explicit mention of negative feelings towards math and towards math teaching. The comments revealed an effort and desire to view teaching of mathematics differently. They read as:

- I decided to go through my journal for signs that the fear [of math] might be fading. Unfortunately, I am still a little apprehensive about the discipline and the thought of teaching mathematics. I probably didn't need to read my journal entries to come to this conclusion; however, the process was very worthwhile. . .

In going through my journal I realized that while I may still be intimidated by the idea of teaching math, I have learned a great deal about myself, the learning process, and (hopefully) some things to remember when I am teaching. (Connie)

- I will not say I am completely over this phobia, but I am more aware about mathematics. With this awareness I have become more comfortable with the subject and been able to work through many of my fears and apprehensions. (Cathy)

- I realized that not much had changed. A few of my views towards the teaching of mathematics have changed, but not as many as I would have expected. I think that this lack of growth has happened due to a couple of reasons. First of all, I am still not seeing math in my field placement. . .playing with manipulatives has been entertaining, but I still don't feel that I have a good understanding of how to use them in my own math lessons.

(Karen)

- Well, I do feel that I have changed since the last time I wrote this. I feel one significant change leads to several worries. I feel that I am more confident that I can teach math to my students. I feel that it can be fun and interesting and stimulating for not only them but me. I am not afraid of math as I was before, although some things do still scare me. I think that I am beginning to realize that the desire to teach something well is half of the journey.

(Fran)

- This time around, I'm not feeling quite so scared of becoming a math teacher, or being forced to teach math. (Virginia)

- It is simply amazing how much my self-image as a teacher has changed in the past few weeks. It has been more of an evolution towards more honest and dare I say "raw" self-image. Through my experience in my school and at the university I am realizing more and more how much I have to learn. These days are incredibly formative, and in order to properly evolve into a professional educator, I have to accept my inexperience and open myself up for learning. It is hard to maintain this receptive humility being that I am constantly asked to serve as an authoritarian and role model in the classroom. . . over the past 3 - 4 weeks, my strongest area of growth has been in my increased self-awareness and shift in perspectives. I cannot say that I have acquired any strong, practical skills, units, or methods. I have simply thrown out many of my earlier philosophies and replaced them with dynamic confusion that will hopefully settle into a sense of professionalism and competence. Hopefully. (Tom)

Also noticeable was the fact that, after four weeks of intense participation at the university and the field classes, many of the students began to slowly move away from their emotional response to a different mental level of clarifying their needs, desires and possible intentions as a teacher. In contrast to the earlier version of the self-portraits, which relied strongly on personal feelings only, the second set showed a shift in trend: because of the expectations and demands on newcomers in the field, signs of dissociation on practice related concerns and re-definition of personal goals started showing up.

Here are a few examples:

- One of my greatest areas of growth has been "letting learning happen." My instinct was, when a child played with a geoboard or pattern blocks during free time, to constantly question them about what they had made, why, what it reminded them of etc. The value of play. Good play just like good talk. Recognizing when students are engaging in good play and good talk. I am more conscious of how their play and talk can and does contribute to learning. As a teacher when to step back and "let it happen" and when it is necessary to intervene, to get a student on task, ask a probing question. (Anne)

- My strongest area of growth thus far includes allowing the students to discuss their ideas and difficulties. When I began teaching math in my field classroom, I felt threatened by my students' questions and verbal, out-loud discussions. I felt as if I constantly needed to know the "correct" way to solve a problem or teach a concept. I now realize that the students should and are readily able to discuss, teach themselves, and understand mathematics. . . I am trying to allow them to figure out much more on their own before we even begin analyzing a topic through a large class lesson. While all of the above that I have stated is well and fine, and I do try to follow it, I still transmit at times and do not allow my students to freely experiment as much as they could. However, I am working very hard at it every time I teach.

(Olga)

- . . . I shall redefine my ideas of what constitutes a good mathematics teacher. I believe the # 1 characteristic that a mathematics teacher must possess, is a strong ability to listen. . . must provide the students with the time and opportunities to formulate their own conclusions regarding mathematics.

(Tom)

- My views of a good teacher has not changed. What has changed is the width of the discrepancy between my aspirations and my reality. I no longer fear mathematics. . . I now experience mathematics in a new paradigm, a paradigm in which math is life.

(Ursula)

There were more intentional focus on instructional strategies, such as, concerns and discussions on the ways of posing problems. For example:

- I realize that I do way too much talking, and don't ask enough open-ended questions.

(Karen)

- My first and foremost goal is to learn to appreciate the silence. . . the big goal. (Ruth)

- Asking lots of questions and really listening to their responses is key.

(Claudia)

- Questioning is so important in teaching math. The way I worded some of my questions had a major effect on the direction or misdirection of his [student] thinking. (Wilma)

- I believe that exploring different approaches, and really questioning the "right" or "best" solutions is a large part of math. Being able to back up from a problem, and approach it from a new angle, questioning why and how prescribed solutions work as opposed to gospel truth, is an important step in math. (Helen)

- . . . my concerns. The first and the largest is, of course, HOW DO I DO THIS RIGHT???? What if I mess up? What if they don't understand? . . . Also, how do I control the urge to tell. . . I know if I learn the patience, I will see the results. . . desire is half the journey. I guess I am half way there.

(Fran)

More importantly, there had been reappraisal of one's knowledge and understanding of mathematics. Often one heard:

- A couple of things kind of jump out. First, I need to re-think my understanding of math. I need to relearn it, so to speak. I say this because I need to know how I understand what I understand. The process of learning math is just as important as knowing the right answer. Being conscious of this process and the problems that may arise will better equip me to be a math teacher. (George)

- I was disillusioned by the belief that math would be the easiest subject to teach, as it has always been one of my favorite...an area in which my content knowledge is strong. . . It was not until I attempted to teach my fourth grade class math that I clearly understood the frustration many people have regarding math. It was then that I realized the reason so many people hate math is because they do not understand it. (Helen)

- Another goal pertains to my rigidity. A good teacher comes to class prepared but is flexible enough to work with changes. . . Related to this goal is to unlearn the way I learned math, to become a new student of math with background knowledge. I need to strive to understand math. (Ruth)

- I knew that math will be a major hurdle for me in becoming a math teacher. I know it will take time, but I feel good about the fact that I am approaching it with a much more open mind. At times I feel like I have to learn math all over again,, but I know that my efforts will pay off in the end - for myself and my students. (Wilma)

Finally, there was a general agreement that active participation at the field placement was seen as "very helpful." Their experience in the reality of an elementary classroom where they could see "math happen" added impetus to their thinking about math and teaching of math.

- I am seeing 4th and 5th graders completely engrossed in what they voted as their "favorite subject", math. . . I am involved in doing the "math warm-up" every morning with the class. . . I am now correcting the math handouts every other day . . . so I really get a chance to see how each student is doing to others in the classroom. I found this, correcting and looking over of papers, very helpful. (Betty)

- I am able to learn techniques and philosophies that can be experimented with and can be applied immediately in my teaching. For me, the best learning come when I can apply what I am learning as I am learning it. (Larry)

- . . . I am not seeing math in my field placement. This is very disappointing and frustrating. I am not able to apply what I am reading or what I am seeing in my class. It is difficult for me to think "Ah-ha! I would have taught the lesson differently. (Karen)

- My self-portrait has also changed due to frustrations experienced due to my being "a guest" in my classroom. I have many ideas that I would like to implement in our math program, and I feel that it is not in my power to revolutionize my cooperating teacher's techniques. (Tom)

- . . . I believe at least some of my students have been inspired to think more about math because of my confidence and interest in it, and I think this is a great achievement. (Sam)

The quotes above are the examples of how the *self-portrait as a math teacher* acted as a cognitive tool for the students to view themselves as a part of the complex process of teaching mathematics in the elementary school.

The "third" snapshot:

The "third" or the final snapshot was collected on the last week of school, three days before the final project⁴ was due. For many, the self-descriptions echoed Cathy's opening sentence: "Time has just flown by." In contrast to the "first" snapshot, many of the participants in the class reported "good feelings" in teaching mathematics and thinking about mathematics in particular. In a similar fashion they talked at length about their feelings. Here are a few examples:

- This quarter has been very interesting for me. . . I learned that as a teacher my every word is held accountable while it is acceptable for me to say, "I don't know, let's find out together." . . . I learned firsthand, the importance of being flexible in a first grade classroom setting! . . . as far as math, I have very mixed feelings. . . I feel excited about several experiences I have had and several conclusions I have come to through those experiences. At the same time, I feel like I have just reached the tip of the ice-berg. . . so much more to learn! Probably the greatest change I have noticed in myself is that I am no longer terrified of mathematics! (Connie)

- First of all, I have learned that teaching math is not an easy task. There is no set formula or step by step guide to teach me how to teach math. Whatever mathematical knowledge my students take with them from my class, will be learnt because I have successfully set it

⁴ The final project is a portfolio in preparation for a possible employment in future. It is a collection of the following:

- (1) The "best" effort project;
- (2) at least one entry from each of the following categories: individual work, group work, and journal entry.
- (3) Each entry has to be appropriately dated and submitted with a reflection on selection criteria.
- (4) A table of contents.
- (5) A letter of application to a principal explaining why you are the best candidate for the teaching job.

up. . . I still have a lot of work to do. . . although I have come a long way, I need to be completely comfortable with the subject. (Cathy)

- I feel that in many ways my understanding has increased. One very important area of growth for me . . . was becoming aware of how many different ways math can be looked at. . . I now realize that math can be taught creatively, and that it can be looked at from many different perspectives. (Karen)

- I am one of many who has suffered from what may be called "math-phobia." And when I started the class I know I feared passing this attitude on to my innocent students. Now, there is a level of comfort as well as the attitude that math can even be fun! What this means to me is that I must make the efforts to create lessons that I think are fun, so that I can provide a positive model in the area of math. (Nancy)

- I know that my personal attitude has changed quite a bit - not that I'm ready to jump up and down proclaiming my love for math, but I can honestly say that some interest has been sparked. The 'block' I remember so vividly only 10 weeks ago, is beginning to break down. I find that I am becoming more aware of the math that takes place all around me each day, and it makes me curious to know more - to understand more. (Wilma)

- I think that as far as my feelings about teaching math, I am still unsure of myself. I feel like I can teach. I know that I can teach, but I am still personally uncomfortable with some mathematical concepts. Maybe I have to invest some more time in learning math again. . . If I can facilitate discovery by the children and myself, I can teach. I feel I can do this.

(Fran)

The immense usefulness of field experience, teaching children in particular, was reported in detail with enthusiasm. Tom wrote, "I feel as though I myself established a working schemata based upon the meaning of education. I have begun to draw important connections between what I teach and why I am teaching it. . . I often wonder why am I teaching various skills and concepts. This constant self-awareness has helped me to be a stronger and a more conscious educator." To Larry, "I had the fortunate opportunity to take while concurrently teaching math in my placement class. This opportunity helped to broaden my awareness and understanding to what math is to me and how I can present it to students."

Stronger resolution towards integrating math with the other subjects was another observation. Earlier, in the 'first' snapshot, the issues on integrating math sounded rather superficial and untested. In describing her unit on multiculturalism, Cathy stressed that "By including mathematical knowledge in areas that are not normally thought of as mathematical, I can reinforce the fact that math is not an isolated textbook subject." Sam's advocacy was, ". . . help guide students from their algorithms to a new understanding and appreciation of the

dramatic discoveries of mathematics in everything from flowers to flags, from wheels to water, and from primers to primates. I can do that, so can the students."

A remarkable observation was that with increased self-awareness in the students new goals, their views on teaching mathematics to children, were evolving. Olga, for example, mentioned emphatically that, "The most important aspect I have gained is feeling. . . While I am still not fully comfortable with teaching math to all students at all times, I am so much more confident in my personal ability to develop, implement, and personally assess a math lesson. I am hoping this is the first step to becoming a "good" math teacher."

Anne, on the other hand, wrote, ". . . much has changed in my reaction to the stimulation. I am better able to process information now, as I am getting more adept at reflecting on my learnings rather than simply becoming overwhelmed by them. . . I am approaching [tasks] with a "learning" attitude rather than a "doing" attitude. This change has come through the ability to dialogue with myself, to do self-reflection and analysis without the constant need for "approval" from another source. . . this quarter has helped me tremendously in getting focussed and introspective, why I am teaching a certain way or content."

Discussion:

In the light of the above analysis the questions originally raised could be summed up as follows.

The first question looks at the results of writing a self-portrait thrice on student behavior. It appeals to the effect of the "happenings", cognitive and emotional, to a newcomer as an inservice teacher in the field of teaching children mathematics. In agreement with Schon's perspective, the activity of writing the self-portrait of a math teacher as frequently as three times in a ten-week long training on understanding the nature of mathematics teaching encouraged and helped the students reflect on their practice of learning to teach. Beginning with high anxiety many of the participants could express nothing but their feelings of fear and apprehension about not knowing "enough math". Eventually they could resolve many of their emotional conflicts and started viewing themselves as confident and comfortable enough to carry through a mathematical investigation interesting and appropriate for the children they would teach. This change in belief in self-as-a-teacher triggered self-trust and resulted in an attitude of the teacher-as-a-researcher (Duckworth, 1987) when they started paying closer attention to childrens' behavior. They began to view themselves as active legitimately participating members, and became gradually more aware of their changing roles in the context of teaching children. This conscious recognition of their own on-going adaptation to their

participation in a teaching context contributed to their change in goals. Consequently, their desires and intentions generated newer plans and goals for future teaching.

In a recent paper, Clarke, Frid and Barnett (n.d.) have suggested a triadic categorization structure fundamental to cognitive sophistication employed in mathematics education in particular. From empirical evidence they propose three levels or structures differentiated by the "sources of conviction" (p. 3): collectors, technicians and connectors. In their analysis, (p.6) a teacher-as-a-collector, level 1, relies on the teacher/text as the exclusive authority, treating the learning goal as reception and retention. According to this scheme, in level 2, the teacher-as-a-technician, allows for some student voice but still relies on the teacher/text as authority. The learning goal shifts to understanding and making connections. In level 3, the teacher-as-a-connector moves to giving authority to students, where critical analysis and construction of knowledge defines the learning goals. A similar pattern seems to exist in the self-portrait-as-a-math teacher data. The growing excitement of the students in the above study came from their realization that they themselves as newcomers could move beyond the implicit collector-level to a different plane of operation, namely, that of sense-making and seeing a connection: "I can see how little pieces fit into a bigger piece" (Edward).

Self-reflection is a metacognitive process, a means of actively monitoring the repertoire of one's own knowledge, process, attitude and beliefs. This effort of consciously assessing or taking stock of self-as-a-learner, in terms of what one knows, can do, believes and feels about, contributes towards one's self-awareness. In the field of mathematics education, particularly in problem-solving research, a strong emphasis is placed on metacognitive efforts for successful problem solving (Silver, 1985; Schoenfeld, 1987). A self-portrait, as a cognitive tool embedded in the practice of learning and teaching, is a form of self-assessment, which helps the students to not only link the practice at the schools and the university training but also clearly delineate his/her role as a contributing member of the community of educators.

The second question (what happens to the instructor who assigns such a novel task in an already hectic time frame ?) generates a parallel situation to the Teaching Experience project for the students. It also appeals to the effect of the same "happenings", cognitive and emotional, to the teachers in the field, teaching children mathematics and to the teacher-of-the-teacher, teaching at the university. It evidently creates two sets of profiles, that of the students writing the self-portraits and that of an instructor's reaction and response to these self-portraits, generating her own self-portrait. Basically, to the instructor, the activity of writing a self-

portrait of a math teacher served as a cognitive tool for communication, recognizing participation patterns and understanding other peoples' understanding.

To the instructor, the individual student profiles were immensely valuable for providing one more link of communication in the given short time frame. The totality of the individual student profiles effectively created a general student profile through a fusion of the responses, which in turn served as a base-line information that helped in making changes in instructional plans and decisions for the course.

The student profiles served another purpose for the instructor: they themselves acted as the tools for her ongoing self-appraisal, a process that is absolutely necessary even in teaching at the tertiary level! Besides its intellectual advantages, its emotional impact was strong enough to strengthen human relationships and establish a closer sense of community among the newcomer teachers in the elementary school and at the university.

Methodologically, the self-portrait as a tool for data source is powerful and novel. A tool is an artifact of human construction; in turn, it influences human behavior and thinking patterns. Evolution of a tool is a long and dynamic process of interaction between human mind and its environment. Like every design issue, the self-portrait as a tool needs serious evaluation and retooling to suit and adapt to the context of teaching and learning mathematics for children.

Adopting writing a self-portrait as a part of instructional practice has other methodological as well as pedagogical advantages. Within a very limited time frame this context-specific view point of developing an academic course on teaching mathematics to elementary school children emphasizes the *emic* approach i.e., reliance on the native meaning system from within. The participants (the students and the instructor) in this ongoing study started looking at their participation patterns *within* their community of practices, where the self-as-an-actor served as the unit of analysis. From this research it is clear that writing the self-portrait as a cognitive tool serves to actively amplify the mental processes of self-assessment. At the same time, it provides us with alternative assessment information for students at teacher preparation programs.

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