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*An Investigation of the Strategies and Decision-Making Processes Used By Effective Elementary Mathematics Teachers*

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**Purpose of Study**

The purpose of this research is to investigate the behavioral and cognitive decision-making processes used by effective elementary mathematics teachers working in a variety of cultural, language, and socio-economic settings. It was hypothesized that several behaviors and processes would be documented across teachers in all schools. It was also hypothesized that effective behaviors and processes would differ depending upon the type of school and students involved. My long range interest is in finding out what makes elementary mathematics teachers effective in order to add to the body of knowledge in this field and use the findings of this study in the service of better elementary mathematics teacher preparation, enhancement, and selection.

**Theoretical Framework and Literature Review**

The basis for this project comes from some important national trends and policies in the field of teacher education and specifically in the field of mathematics teacher education. In March 2008, the National Mathematics Advisory Panel released its final report. This panel was charged with making recommendations to advance the teaching and learning of mathematics in grades PK-8 based on a synthesis of scientifically based research. The National Council of Teachers of Mathematics (NCTM) has responded to this report and has participated in follow-up panel discussions about the findings of the report. At these panel follow-up discussions held in October 2008, it was suggested that what is missing in these recommendations is information about teachers' knowledge, skills, and dispositions other than mathematical content knowledge. It was also indicated that what we need to know is how more effective teachers differ from less

effective ones and how to measure this. The current move toward a national curriculum further demonstrates the need to develop a standard for professional development of teachers who will be able to implement this curriculum equitably for all students. Particularly at the present time, when teachers are being held responsible for failing students, we need to devote particular attention to the qualities of successful teachers rather than focus on punishing less successful ones. My research addresses these needs.

The majority of studies on what makes mathematics teachers effective tends to focus on the kinds of professional development experiences teachers need to have in order to become consistent producers of successful students (e.g., Bewwick, Swabey, & Andrew, 2008; D’Agostino & Powers, 2009); Graeber, 2005; Hill, et al., 2008; Jamar & Pitts, 2005; Morris, Hiebert, & Spitzer, 2009) . While this is important, it seems to be putting the cart a bit before the horse. As far back as 1987, Lee Shulman (Shulman, 1987) wrote a seminal paper about the kinds of knowledge and behaviors that teachers needed to possess and use in order to be effective practitioners who approached teaching with “educational reform” values that emphasized comprehension, reasoning, and reflection. In this paper he observed that up to that point research on effective teaching had focused on generic relationships – that is, teacher behaviors that were associated with student success regardless of subject matter. This led to generalizations about best teaching practices that were more closely connected to classroom management rather than to differences in pedagogy related to content knowledge. He called for research that was based on actual observations in the context of specific teaching and learning situations of novice and expert teachers.

Following this seminal paper, research conducted over the next 20 years on effective teaching, however, did not seek so much to learn from effective teachers as it did to “prove” a

theory that certain kinds of pedagogy or certain kinds of content knowledge were essential to student success. As Deborah Ball (2008) points out, we still do not know exactly what distinguishes effective teachers from less effective teachers based on empirical evidence-based investigations of teachers themselves. Rather we rely on assumptions about how “experts” think mathematics should be taught, as recommended in national standards documents and reports of task groups, and then infer what must be the effective teaching practices leading to student success. If we are to really understand and prepare teachers to be consistently effective practitioners **with all students**, then we need to study the teachers who are most effective and study these effective teachers in a variety of schools and communities in the context of specific subject areas.

### **Research Questions and Methods**

My research investigates the behavioral and cognitive decision-making processes used by effective elementary mathematics teachers working in a variety of cultural, language, and socio-economic settings. It was hypothesized that several behaviors and processes would be documented across teachers in all schools. It was also hypothesized that effective behaviors and processes might differ depending upon the type of school and students involved.

The research questions my study addresses are:

- 1)What do effective elementary mathematics teachers do and think about in planning, implementing, and reflecting upon their teaching?
- 2)How consistent are the practices and decision-making strategies across all effective elementary mathematics teachers?
- 3)To what extent are effective elementary mathematics teachers unique or different in their approaches to planning, implementing, and reflecting on their practices.

4) To what extent do culture and context impact on what these teachers do and think?

5) How can the findings of this study be used in the professional development of other teachers in order to enable them to be more effective elementary mathematics educators?

To begin to answer these questions I conducted observations and interviews with 15 effective elementary school mathematics teachers in urban and suburban communities in New Jersey public schools and in four public schools in Israel. The teachers were identified as effective by either their supervisors, principals, or their mathematics coaches based on their perceptions of the teachers as being able to promote successful student learning. All teachers were female and all but one had 5 or more years of teaching experience in grades 2 – 6. The study involved visiting schools to interview the teachers about their planning and assessment of one lesson which I observed. The interviews were audio-recorded and the classroom observations were videotaped. The lessons lasted anywhere from 45 minutes to 1 ½ hours. No children were directly involved in the study and all information regarding individual teachers and schools was anonymous. The interviews were done before and after the lessons took place.

### **Data Sources**

Each teacher was individually interviewed in response to 12 specific “trigger” questions regarding her planning processes before her lesson was observed (see Table 1). After the interview each teacher was observed doing the lesson previously described. Following the observation, each teacher was interviewed again in response to 10 other specific “trigger” questions regarding their perceptions and reflections on how the lesson went in terms of the plan and the children’s learning (see Table 2). Additional questions were also asked based on teachers’ responses to the trigger questions and on the specific behaviors observed by the

researcher. Israeli teachers were asked questions in English and could answer in English or Hebrew. A Hebrew translator was present at all interviews.

Subsequently, annotated transcripts of the interviews and observations were made, including translations of the Israeli teachers as needed. I am now almost finished with the transcripts and am in the process of developing observational categories and codes for the videotaped lessons and the interview data. The transcripts will be coded in terms of how the teachers made their instructional decisions during planning, what they did and said during implementation, and what their post-implementation reflections were of their mathematics instruction. The working document of categories currently being considered appears in Table 3.

## **Results**

I have completed the “demographic” data analysis, but my full data analysis of the interviews and observations is underway. I am dividing the results of my study into four major sections.

The first section will deal with the backgrounds of the teachers in terms of their preparation in mathematics and pedagogy as well as year so of experience teaching.

The second section will deal with structures and formats of the teachers’ planned and implemented lessons.

The third section will deal with the coding of transcriptions of the teachers’ verbal responses to the pre-lesson and post-lesson interview questions. These codes are being developed within clusters of questions that were used in during the interviews (see Tables 1 & 2).

The fourth section will deal with the categories that are being derived from the teachers’ behaviors during the lessons and these are being developed based on repeated viewings of the classroom videotapes of the New Jersey teachers and viewing of the classroom videotapes along

with transcripts of the videotapes for the Israeli teachers. After those categories are completed, each teacher will be coded on the various elements of the categories which are yet to be determined (see Table 3).

After the data are formally categorized and coded, I will make some comparisons of responses across teachers and locations as well as compared the planned vs. the actual lessons implemented by the teachers.

Based on a preliminary review of the data, I can see certain patterns emerging. First, the teachers' backgrounds and lesson structure data indicate several salient trends. All but one of the teachers had a minimum of 5 years of teaching experience and most had more. We find also that 9 of the 15 teacher participants had some advanced training specifically in mathematics education and were highly qualified in that subject area. This finding is consistent with Ball (2008), Hill (2008), and others who have highlighted the importance of content knowledge in effective teaching of mathematics. However, I also found that for the 6 teachers who lacked any training in mathematics or mathematics pedagogy, they were able to transfer knowledge gained in other disciplines to their teaching of mathematics. This may mean that for elementary mathematics teachers, this advanced training may not be necessary in order to be effective, but that effective teachers are able to translate what they have learned in other areas (language arts, technology, early childhood) to the teaching of mathematics. This conjecture is consistent with Hill's later findings indicating that the mathematics leaders in her sample did not necessarily possess very sophisticated mathematics knowledge (Hill, 2010).

Second, in terms of planned lesson structures, all of the teachers indicated that they planned for substantial amounts of student-initiated activity, mostly small group work, but some individual activity during the lesson. We could tentatively say, then, that at least in terms of

planning, effective elementary mathematics teachers are committed to the importance of active learning for students and philosophically, would be considered proponents of constructivist models of learning and cognitive development.

Third, in terms of my preliminary and informal review of the interview and observational data, the most outstanding observation is that there is no universal approach to teaching that is common to all effective teachers. In fact, I would say that there is no single way that effective teachers conduct themselves in the classroom that would apply to their teaching all the time. I generated this latter hypothesis initially from my observation of the performance of one teacher whom I observed teaching two very different levels of classes. She was like two different people in those classes. In her lower functioning class with very inattentive students, she was a bit like a drill sergeant. Her tone and facial expression were serious and a bit stern when addressing the group as a whole, yet she was soft-spoken and warmly affectionate when she addressed individuals in the class who needed help. Whether “tough” or “tender,” she was consistently directive in this lower class. On the other hand, when I observed her with an enrichment class for talented students, she was anything but directive. She allowed the students to do the thinking and she was much more relaxed, smiled often, was offered lots of praise for their verbalizations – which were very lengthy and thoughtful. In this class, she asked challenging questions and provided students with opportunities to think for themselves. This was in sharp contrast to her directive approach with the lower functioning class.

From this comparison, I began to think about the possibility that effective teachers vary their demeanors and modes of presentations as a function of their expectations for their students based on realistic assessments of their prior achievements. I would suggest then that one important characteristic of effective elementary mathematics teaching is being able to adjust

one's own language, demeanor, pacing, directions, and feedback approaches to the abilities and behaviors of the students in a class. This would suggest that effective teachers are so tuned in to individuals in the class that they monitor their pacing, voice quality, questions, answers, noticeably within a given class. I have to conduct a much more detailed and systematic examination of the data, though, before reaching this conclusion. I feel confident at this point, though to say, that probably effective teachers understand the overall quality of their students and adjust their behaviors accordingly in managing whole class instruction and providing differentiated homework and seatwork to students.

Fourth, in the same vein, my observations also suggest that effective teachers are great listeners, and in fact seem to listen with the "third ear" of clinicians. They respond to the unsaid. They anticipate what will happen before it happens and are ready to address it before it occurs (as in lots of repetition of phrases where needed in some classes and the use of open-ended questions in another). They are ready to circumvent or short circuit undesirable behavior before it occurs as well (as in removing distracting elements and students in a seamless way as they proceed with their lesson content). Classroom management is integrated into the lesson without pauses and breaks in the flow of thinking for both the teachers and the students. Effective teachers orchestrate and conduct like seasoned musicians.

Fifth, in my interviews with the teachers about their planning, I noted that beyond the given curriculum, effective teachers drew upon their experience from past years and from their professional development and graduate work, for planning lessons, whether that work was done in mathematics or other subject areas. They claimed to adapt what they learned to the unique classroom situations and students whom they are teaching. In fact, most of the teachers indicated that in planning, they relied more on their own prior teaching experience, workshops attended,

grade-level team planning, and ideas from the Internet, than on the school's curriculum materials. My informal preliminary findings, too, suggest that Israeli teachers were more active in determining the content of what they would teach compared to the American teachers who, often of necessity and because of school policy, tended to follow a specific curriculum.

Sixth, in terms of reflecting upon and learning from their own experiences, all teachers indicated that they changed their lessons based on what happened during the lessons themselves. This response came from teachers who had been working with the same grades and curriculum for a few years, but also from teachers who were using new curricular materials. All the teachers said they were able to borrow from past experience and bring in relevant activities and approaches from prior years or from the older curriculum as needed. They said that they learned from their own mistakes. I do have to say, though, that these findings are not based on my classroom observations, because I had no way of knowing this, but based on what they claimed to be so during their interviews before and after the lessons.

This brings me to my seventh point, one that may seem less flattering to effective teachers, but also one that may be critical for effective teaching. At least in this very short-term single classroom observation method, I can say that almost all the teachers did not follow their stated plans. Mostly they ran out of time too soon because of a) difficulties with technology that didn't work, b) the length of time it takes to allow students to work at their own pace in groups or even individually, c) unexpected interferences came up like fire drills or assemblies for the whole school, and d) very large class size – up to 35 – which made the planned active learning experiences hard to monitor and complete.

I did sense, though, that these effective teachers wanted to do a lot more and knew they should be doing a lot more than the amount of time in which they were expected to do it. In post-

lesson interviews, almost all the teachers expressed disappointment in the way their lessons had gone and complained about not having enough time to complete the lessons. Most had to continue with the same lesson on the following day or had to use homework to complete what was supposed to be done in class. So I would say as my final point, effective teachers are extremely self-critical and reflect regularly on the impact of their lessons and what needs to be modified the next day, the next week, or even the next year in order to make the lesson more “perfect” by eliminating confusing directions or problems, by modifying the sequence or structure of the lesson, and most important, by extending the time for different activities so that students have time to complete their independent work – whether in groups or individually. Several of the teachers in the study actually commented that when their students failed, they saw this as their failing and blamed themselves for presenting poorly. They communicated this to their students as well.

My plans for the future regarding the rich data I have collected for this study include the following:

- Code the behaviors and statements of videotaped lessons and interview transcripts
- Organize data into categories that can then be used to compare findings within and across the different schools in the study
- Complete all statistical analyses and summarize results
- Adapt instruction using findings on effective teacher strategies for two of my graduate courses for elementary teachers
- And of course, come back to NERA next year to present my full results.

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### **Table 1. Interview for Planning Lessons**

1. What is your lesson about?
2. Where did you get your ideas for this lesson?
3. How do you select your problems and materials?
4. What do you expect the students to learn from this lesson?
5. How will you begin the lesson?
6. How do you know where to begin the instruction?
7. What arrangements, if any, will you be making for different levels and styles of learners in your class?
8. What kinds of activities will the students engage in?
9. How will you end the lesson?
10. What will be the follow-up for this lesson?
11. How will you check for learning?
12. How will you know if your lesson was successful?

Table 2. 10 Trigger Questions for Post-Lesson Interviews

1. What did you think of the lesson right after you finished teaching it?
2. What did you do after the lesson in terms of assessing its effectiveness?
3. How do you think this lesson went compared to your plan for the lesson?
4. What techniques did you use that you thought worked particularly well?
5. Were there any parts of the lesson that surprised you? What were these?
6. How might you alter your plan for this lesson when you teach it again next year?
7. In terms of your assessment of the learning goals for this lesson, do you think all the students achieved them?  
If not, why not? If so, why do you think it worked so well?
8. What were you trying to do when you did.....?
9. Do you think the students understood your explanations? How were you able to know this?
10. I noticed..... What were you trying to do there?

Table 3. Categories to be considered for coding Interviews and Observations

Interviews

Content of lesson - pre  
Source and selection of ideas and material for lesson - pre  
Expectations for student learning outcomes - pre  
Structure of lesson and role of teacher – pre  
Student activities during and after lesson-pre  
Differentiation of instruction – pre/post  
Assessment of students planned - pre  
Teacher’s evaluation of lesson after it occurred - post  
Highlights of lesson - post  
Comparison to plan –pre/post  
Surprises - post  
Meeting of student learning outcomes- post  
Changes in lesson for future- post

Observations

Use of voice  
Modeling or think alouds  
Use of familiar routines  
Classroom management  
Structure of lesson and role of teacher  
Student activities during lesson  
Clarity and structure of teachers’ questions and statements  
Student participation  
Differentiation of instruction  
Assessment of students  
Comparison to plan