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Effective Elementary Mathematics Teachers: A Cross-Cultural Perspective

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Abstract

The purpose of the research presented today is to report on my investigation of 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 processes would be documented across teachers in all schools. It was also hypothesized that processes might 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.

Introduction

The basis for this project comes from some important national trends and policies in the field of teacher education and teacher assessment. We have all been hearing more and more in the public and political sectors about how important teachers are for the success of students and how important it is to have a national curriculum to establish standards for learning and achievement for all students throughout the nation during their school years. At the present time our nation is in the process of implementing such a curriculum through the *Common Core State Standards for Mathematics* (CCSSM, 2010) which have been accepted by 47 states. In conjunction with these national standards are policies and procedures for evaluating the effectiveness of teachers based, in part, on student performance on uniform assessments of learning based on these common standards.

My personal interest in focusing research efforts on effective elementary mathematics teachers began in 2008, when the National Mathematics Advisory Panel Report published its

final report and in its response to that report, the National Council of Teachers of Mathematics (NCTM 2008) suggested that what is missing in these recommendations was 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.

At about the same time, Deborah Ball (2008) began to draw increasing attention to establishing parameters for identifying and defining what effective mathematics teachers needed to know not just about mathematics content, but about mathematics content in the context of pedagogy. As she pointed out then, we still did not know exactly what distinguished 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.

This interest in effective teaching, of course, did not just emerge spontaneously in 2008. Rather it has a 25 year long history stemming from the work of Lee Shulman (1987) who 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 25 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. In fact, the majority of the earlier 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., Beswick, Swabey, & Andrew, 2008; D'Agostino & Powers, 2009); Graeber, 2005; Jamar & Pitts, 2005; Morris, Hiebert, & Spitzer, 2009). More recent research has focused attention on mathematics content knowledge as it is related to teachers' pedagogical knowledge, but tends to be narrowly confined to very specific mathematics content topics (Ball & Forzani, 2009; Hill, Blunk, Charalambous, Lewis, Phelps, Sleep, & Ball, 2008). While all both kinds of research are important, they seem to be putting the cart a bit before the horse.

If we are to really understand and prepare mathematics teachers to be consistently effective practitioners **with all students**, then we need to first study in-depth those teachers who are most effective in teaching mathematics and study these effective teachers in a variety of schools, communities, and grade levels in the context of teaching in specific subject areas. We need to look not just at specific practices or curricular topics, but to examine what these teachers think about while they are planning and conducting mathematics instruction and assessment. We need to understand what motivates their behavior more than simply what behaviors they exhibit.

This presentation focuses on a study that examined the cognitive processes used by effective elementary mathematics teachers as gleaned from an analysis of pre-teaching lesson

planning interviews and on post-lesson reflection interviews with 4 elementary teachers, two in NJ and two in Israel. I was looking at common threads across the teachers regardless of school context as well as for indicators of differences among teachers across school contexts. I did not come to the research with any set notions about what effective teachers "should do" or what experts said effective teaching should embrace. Since I began collecting the data in 2009-2010, I have maintained this qualitative research stance and am now see some patterns emerging.

Research Questions

My research attempts to addresses the following questions:

1)What do effective elementary mathematics teachers think about in planning, implementing, and reflecting upon their teaching and students' learning?

2)To what extent do culture and context impact on what these teachers say they do and think about?

Research Methodology

The data reported on here are part of a larger study I conducted with 15 effective elementary school mathematics teachers in urban and suburban communities in four 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. As supervisors or principals, these school leaders all had opportunities to observe the teachers during lessons and were familiar with the teachers' records of student success based on standardized testing. All teachers identified were female with 3 or more years of teaching experience in grades 1 – 6. The study involved visiting schools where each teacher was individually interviewed in response to 12

specific "trigger" questions regarding her planning processes before her lesson was observed. See Figure 1

After the interview each teacher was observed doing the lesson discussed. 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 Figure 2. Thus, all interview data were based on structured yet flexible questioning, not unlike a clinical interviewing technique. Israeli teachers were asked questions in English and could answer in English or Hebrew. A Hebrew translator was present at all interviews in Israel. The interviews were audio-recorded and based on the mathematics lessons that lasted anywhere from 45 minutes to 1 ½ hours.

Subsequently, annotated transcripts of the interviews were made including translations of the Israeli teachers as needed. These transcripts were then coded.

Data Collection Techniques and Analyses

This paper highlights case studies of 4 of the 15 participating teachers based on their pre-lesson and post-lesson interviews. Two of the teachers were from northern New Jersey school districts and taught mathematics in Grades 1 and 2. Two of the teachers were from schools in Israel and taught mathematics in Grades 2 and 3. In each location, one of the teachers worked in a lower SES community and the other in a more affluent community. The interview transcripts of these participating teachers were examined for similarities and differences in their reported planning processes and reflective post-lesson reactions.

The interview transcripts were coded into pre-lesson and post-lesson categories using the interview questions as the source of categories. The codes were developed based on what the teachers actually said in response to those questions. The occurrence of these codes within

categories were then matched and compared for all four teachers across and between geographical location and SES conditions. For all data, consistencies and inconsistencies within and across teachers were noted.

Results from Pre- and Post-Lesson Interviews

The main finding for the interviews was that there were 7 common practices or self-reflections reported on by all 4 teachers in both regions and 12 additional practices or self-reflections that were reported by 3 of 4 participants, although not the same 3 teachers for each of these practices. These common reported statements grouped themselves into 4 main categories. As indicated in Figure 3, among the common practices were:

- **Sources of Lesson Ideas:** These teachers did not just work from the curriculum, but adapted lessons based on their past experiences in teaching the topics and used the Internet to obtain ideas for building their lessons.

  "I use the textbook, but put in my own adaptations."

  "I use past experience in teaching this lesson."

  "I used technology in planning and conducting my lesson."

- **Use of Formative Assessments**: All indicated that they regularly used formative assessment for adapting lessons as they went along by observing, questioning, and listening to students' oral comments during both whole group and small group or individual activities.

  "I pull aside individuals or small groups to review with me after whole group instruction."

  "I use observation and questioning during group and individual work."

  "I listen to students' oral comments and the way they explain their work."

"I conference with students during their independent work."

"I collect and examine their written work to plan for the next time."

- **Differentiating Instruction**: All also indicated that they differentiated instruction by using different instructional materials and/or providing different levels of learning goals for their students and then worked with individuals and small groups to review and relearn material after the whole group instruction took place.

  "I ask different types of questions to different types of students."

  "I set different learning goals for different students."

  "I use different materials for children during whole group and small group instruction."

- **Self-Reflections on Teaching**: Finally, they all said that although they thought the observed lesson went fairly well (i.e., that most students had achieved the desired learning outcomes and remained on task), there were areas of the lesson that did not go well and that they would change the lesson accordingly in the future.

  "I would hold off on writing and spend more time with manipulatives next time."

  "I would break down the lesson into more steps."

Speculations on the Data

Up to this point, based on my analysis of the interview data in detail, I have some generalizations about what I have been hearing that I can share with you. These generalizations are based not only on my sample of the 4 cases I highlighted here but included less informal reviewing of the interview data from my larger 15-teacher sample. Taken on a question-by-question basis, the following preliminary conclusions were drawn.

1)What do effective elementary mathematics teachers do and think about in planning and reflecting upon their teaching and students' learning? (Figure 4)

- Interestingly, the most common practices described could all be considered constructivist in orientation and indicated that regardless of region or school community, effective elementary mathematics teachers are student-centered, differentiate instruction, engage all students in active learning processes, and expect students to take responsibility for their own learning.
- 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 and would be considered proponents of constructivist models of learning and cognitive development.
- It may be that one key distinguishing characteristic of effective elementary mathematics teachers is that they feel a personal responsibility for their students learning, beyond the press of external pressures and teaching to the test school climates. This of course would be particularly critical for the teaching and learning of elementary mathematics.
- 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.

- 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 did sense, too, 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 said they 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 that 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. One of the Israeli teachers in the study actually commented that when her students failed, she saw this as her failing and blamed herself for presenting poorly.

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

How consistent are these practices and processes across all teachers in diverse communities and school cultures? See Figure 5.

All of the above findings were consistent across teachers in both NJ and Israel and also across teachers in schools in the higher and lower SES communities. However, there were three findings so far that seemed to distinguish between teachers in different contexts.

- It appeared that Israeli teachers were more active in determining the content of what they would teach compared to the American teachers who tended to follow a specific curriculum. Most of the Israeli teachers developed their lessons collaborative with grade level colleagues. This seemed to be the case only for two suburban more affluent teachers in the larger New Jersey sample.
- Only the New Jersey teachers in the more affluent settings focused on providing differentiated instruction and challenges for the above average students in their classes. The urban New Jersey
- teachers did not do this and the Israeli teachers did not seem to do this either – or at least did not mention it. The focus of the urban NJ and all Israeli teachers seemed to be on making sure that lower achieving students received simplified tasks for independent work.
- The Israeli teachers tended to rely more on classroom tests and quizzes for assessing learning compared to the New Jersey teachers. This applied across SES conditions in both settings.

Implications of Findings (See Figure 6)

The next step in my research on these data are to select comments made by teachers during the interview related to actual classroom practices and by studying the videotapes of their

lessons, determine the extent to which these professed practices actually appear in their teaching. I am also interested in the extent to which these observed practices are used by different teachers in different school contexts – New Jersey vs. Israel and lower SES vs. higher SES.

I also feel that perhaps by trying to reduce the responses of the teachers to a series of categories and codes, that I may be missing the point about what makes these teachers effective. My sense is that it is really the underlying cognitive processes used by these teachers that distinguishes them from other teachers who may actually be using the same kinds of externally observed teaching techniques and similar kinds of planning strategies. I believe that it is their ***underlying intrinsic motivation*** that drives them ***about the what and how it is that they really want their students to learn***. It is not just about knowledge of the mathematics content or choices of instructional methods. Rather I believe it is about the specific motivation behind each act of teaching and why teachers do what they do. I believe that such motivational patterns, may be inferred from careful reading of the videotaped lessons with a focus on sequences of behavior taken in the context of teachers' statements about their intentions during the interviews.

Figure 1. Trigger Questions for Interviews on Pre-Lesson Planning

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?

Figure 2. 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. Do you think the students understood your explanations? How were you able to know this?

9. What were you trying to do when you did……?

10. I noticed…….. What were you trying to do there?

Figure 3. <u>Four Categories of Common Practices Reported by All Four Teachers</u>

- <u>Sources of Lesson Ideas</u>: These teachers did not just work from the curriculum, but adapted lessons based on their past experiences in teaching the topics and used the Internet to obtain ideas for building their lessons.

  <u>Tal:</u> *The math coach gives us a lot of ideas. I also get ideas from the Internet and from myself. I'm creative that way. I can take something I use in one subject (like reading) and put it in another thing (like math) and just use it in my class.*

- <u>Use of Formative Assessments</u>: All indicated that they regularly used formative assessment for adapting lessons as they went along by observing, questioning, and listening to students' oral comments during both whole group and small group or individual activities.

  <u>Lauren:</u> *And then as I'm going through the whole group lesson, I try to give them a lot of opportunities to show their thinking, whether it be on like the communicator is one way or by coming up to the Smartboard. So I try to see if are they getting it. Do I need to spend more time on it? Or did I plan too much and I can just move from here…like they're ready. So I try to determine that while we're on the rug. And then as they're working independently….Really a lot has to do through observation. Like if I see that some of them are just flying through it without a problem, I'll either move them to something different or add on to it. You know, make it a little bit more challenging for them. Or are they flying through it and doing it so quickly, they're doing it wrong and they're not understanding it. Then I might have to go back and do a little more teaching.*

- <u>Differentiating Instruction:</u> All also indicated that they differentiated instruction by using different instructional materials and/or providing different levels of learning goals for their students and then worked with

individuals and small groups to review and relearn material after the whole group instruction took place.

Efrat: *Yes, the same time, the same subject. That's not all. When I take a look at the book, I decide to give this problem, but some children can't do this. So I will tell them not to do this one. I tell them you have to do this one. And when we work in the book, I tell them, I mark what they have to do.*

- Self-Reflections on Teaching:

  Finally, they all said that although they thought the observed lesson went fairly well (i.e., that most students had achieved the desired learning outcomes and remained on task), there were areas of the lesson that did not go well and that they would change the lesson accordingly in the future.

  Heather: *Well, I thought that it was good, but you know, I always focus on the things that I need to do better. So I don't really ever say that it's a wonderful lesson. I think a lot of it is that the kids still have to get used to managing the materials. I need to come up with some way to keep the pennies on the desk. I already started collecting things to make for next year so that it's better. Also I didn't think I was going to have to repeat the directions as many times as I had to. I could see their faces and the ways that they weren't getting it right away. Then when I went to the groups, I could see that there were still some questions, so I did add more repetitions. As for the order, I liked that they played with the tens frame first. I think if it was the other way, that it would have been confusing for them…to try to manage the pennies and see the relationships at the same time. So I think I would keep it the same.*

Figure 4. Preliminary Conclusions About Common Cognitive DecisionMaking

Practices of Effective Teachers

- Use student-centered, constructivist practices
- Committed to the importance of active learning for students
- Take personal responsibility for their students learning
- Draw upon past experience
- Go beyond the given curriculum
- Change their lessons based on what happens during the lessons themselves.
- Learn from their own mistakes
- Some disappointment in the way their lessons go
- Self-critical and reflect regularly on the impact of their lessons and what needs to be modified

  Heather: *I'm just always thinking about ways to make my lessons better in the shower, in the car…seriously, like, little things just I just kind of put a little light on like "Oh, I could use that," and I just try to keep track of these little ideas. I have a journal, and I that I keep track of, and when the lesson comes up I'll have put little post-it notes like, you know, "Remember to do this, or try this." So that every year I'm trying to…because I've been teaching first grade for four years now so it's like, I'm familiar with the curriculum and I feel comfortable kind of trying to take it to a different level with the kids.*

Figure 5. Impact of Culture and Context

- Israeli teachers were more active in determining the content of what they would teach compared to the American

Efrat: *We have curriculum and we are going to do all of the curriculum, but we are free to choose what we are doing. We have the books. We are going to do all the stuff in the books, but I prefer to think about the lesson first and use the books second.*

- Israeli teachers developed their lessons collaboratively with grade level colleagues more than the New Jersey teachers

- Only the New Jersey teachers in the more affluent settings focused on providing differentiated instruction and challenges for the above average students in their classes.

Lauren: *(for more advanced students) I plan something to keep them from being bored and that will challenge them at the same time…..created lesson like that for the grade level for every unit. Now because I modify some of the lessons, there are days that I want to keep them with me and there are days that they can go off on their own. They seem to handle that transition well.*

- The focus of the urban NJ and all Israeli teachers seemed to be on making sure that lower achieving students received simplified tasks for independent work.

Tal: *He understood….he didn't understand yet what I wanted all of them [to understand], but for me what he understood today is enough. Because tomorrow, another day, he will understand more. He is in a delay, so I know this. It will take time, for him.*

- Israeli teachers tended to rely more on classroom tests and quizzes for assessing learning compared to the New Jersey teachers.

Figure 6. Implications of Findings for Further Research

- For each teacher, relate interview comments to actual classroom practices
- Compare classroom practices across cultural contexts
- Consider underlying motivational factors involved in teachers' instructional choices and decisions (e.g., look for sequences and patterns of behaviors in videotaped lessons)

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