
Impediments, Supports, and Suggestions for Effective Teaching of Mathematics: What Urban Teachers and Principals S

Judith McVarish
St John's University
Margot Ely
New York University
Barbara Signer
St. John's University

This study rests on written statements made by New York City teachers and administrators. The study documents what a sample of urban teachers of mathematics and school principals in elementary, middle, and high schools state are: impediments of, as well as supports to, their productive teaching of mathematics, and their suggestions of what is needed to help promote the productive teaching of mathematics.

Introduction

This study of urban public and parochial teachers and administrators documents what a sample of teachers of mathematics and school principals in elementary, middle, and high schools report are supports, as well as impediments to the productive teaching of mathematics. They also provide suggestions on how better to promote effective teaching of mathematics. In an area of interest that has been extensively studied by quantitative methods, we believe the value of this qualitative research piece is in documenting the voices of urban teachers and principals across grades K-12 regarding the question of how to improve mathematics education for school children.

Discussion of the Literature

Since research shows that teacher beliefs strongly influence teacher instructional practice (Dougherty, 1990; Grant, 1984; Shroyer, 1978; Steinberg, Haymore, & Marks, 1985; Thompson, 1984), the results of this study provide information that might be used by all stake holders in mathematics education and buttress the argument for teachers, students, administrators, teacher educators, community representatives, and researchers to inform decision makers of what teachers identify as needed support.

Social teaching norms (Stigler & Hiebert, 1999) and the classroom situation (Raymond, 1997) are particularly strong influences on

mathematics teaching practices and contribute to inconsistencies between teacher beliefs and practice about effective mathematics teachings. Thompson (1984) suggests that such instructional barriers result in practice that is more traditional than the teachers' stated pedagogical beliefs. The classroom factors linked to these practices are time constraints, scarcity of resources, classroom management and standardized testing (Raymond, 1997). Briars (1999) also attributed the lack of ongoing staff development as an impediment to implementing reform-based mathematics teaching. Research also suggests that the most effective way to implement reform based mathematics instruction is to provide continuous professional development that focuses on changes in beliefs and practice (Ross, McDougall, & Hogaboam-Gray, 2002).

Methods

This study invited teachers and principals to respond to a qualitative instrument containing three open-ended questions: (a) What factors help teachers do a productive job teaching math? (b) What factors get in a teacher's way of teaching math productively? And (c) What do you suggest that would promote the productive teaching of math?

All written responses were transcribed and coded for source, position, and demographic variables. The qualitative analytical process (Riesman, 1993; Tesch, 1987; Wolcott, 1990; Ely, 1997) was then applied by studying statements, chunking, categorizing, re-categorizing, and grouping statements, in a search for themes, meta-themes, and unique cases. This resulting analytical system was further refined with the use of QualRus, a qualitative research program, that allowed us to disaggregate and illustrate the data by the demographic variables. The open-ended survey sampling included approximately 436 public and private school teachers and 26 public and private school principals. We sent the instrument to 18 New York City Public Schools that included six middle schools, and six high schools. In addition, we sampled eight private New York City Diocesan Schools of which three were K-8 s and five were high schools. The sample was randomly selected using free lunch statistics to obtain an equal distribution across three socio-economic groups. A total of 324 surveys were distributed in the New York City Public Schools and 138 surveys sent to private Diocesan Schools.

Findings

Forty teachers and 14 principals completed and returned the open-ended questionnaire. This was a return rate of over 61% for principals and over 9% for teachers. Our instrument required more time and effort than instruments such as forced choice and Likert scale surveys. Perhaps teachers had just too much on their plates. Perhaps they may have felt

their voices do not matter. Principals on the other hand may have felt it more professionally important to speak for themselves their entire faculty. The respondents were evenly distributed between public and parochial schools, approximately 47.5% versus 52.5%, respectively. Close to two thirds of the respondents were female. Total years of teaching experience varied widely, ranging from one to 35 years. The distribution of years teaching tended to be predominately new teacher with 1-5 years of teaching experience (41%). The group with the fewest respondents (7.7%) had 11-15 years experience.

Question 1: What factors help you as a teacher to do a productive job of teaching math?

Forty teachers wrote responses to this open-ended question. These responses provided a total of 111 items that fell into 6 broad factors that were considered helpful: pedagogy, administrative and system support, materials, teacher characteristics, teacher preparation and education, and students. Response distributions to this question can be found in Figure 1.

Fourteen principals wrote responses to the question: What factors help teachers do a productive job of teaching math? Their responses were chunked into 43 items that were placed into six categories (administrative and system support, ongoing professional development, materials, teacher characteristics, teacher preparation and education, and teacher's math understanding).

By far the greatest number of responses from the teachers (39%) were related to teaching methods or pedagogy. These consisted of relating math to students' lives, using manipulatives or visuals, and doing cooperative group work. Principals did not mention teacher pedagogy as a factor in teaching mathematics productively.

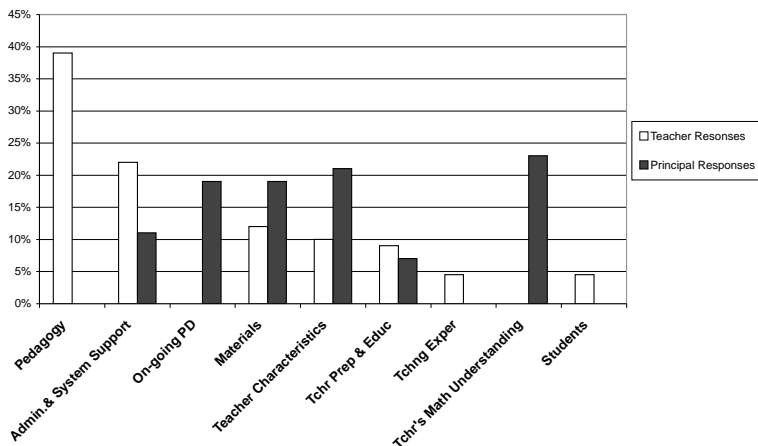
Twenty two percent of the items from the teachers' perspective fell into a category we called "Administration and System Support. These referred to support from other teachers and building administrators. Six percent of the principals responded with comments about giving teachers time and four percent of the principals specifically mentioned administrative and system mentor support. We put these sub categories into the category of administration and system support. While the teachers' comments referred specifically to support by other people, the principals' comments referred to such people support to a much lesser extent.

Ongoing teacher professional development was a reply given by principals (19%). Teachers did not cite ongoing professional development as a factor that helped them teach more productively.

FIGURE 1

What Factors Help?

Question 1: What Factors Help?



Twelve percent of the items given by teachers were about materials and resources such as use of manipulatives and technology. Principals also saw materials and resources as helpful for the teaching of mathematics (19%).

The category of "Teacher Characteristics" emerged in both teacher (10%) and principal (21%) responses. Comments referred to: (a) teacher interest in or love of mathematics, (b) organized or logical persons, and (c) belief in the value of drill.

There was a similar response distribution for the category, "Teacher Preparation and Education." Nine percent of the teachers and seven percent of the principals noted the importance of teacher preparation and education.

A few teachers also mentioned previous experience and students as contributing to their mathematics teaching success (4.5% each). Interestingly, only principals noted the importance of a teacher's mathematical understandings (23%) as an important factor in the productive teaching of mathematics. Their comments included teacher ability to understand concepts and misconceptions.

In comparing responses of teachers and principals to this question, teachers emphasized the importance of teaching strategies. Both groups cited materials, and teachers' characteristics, with principals giving more voice to teacher characteristics. The teachers described these characteristics as closely related to math strategies while the principals noted more person-related items. The teachers gave recognition to their peers in helping them to do a good job in math. The principals did not mention other teachers as a means of support. Nineteen percent of

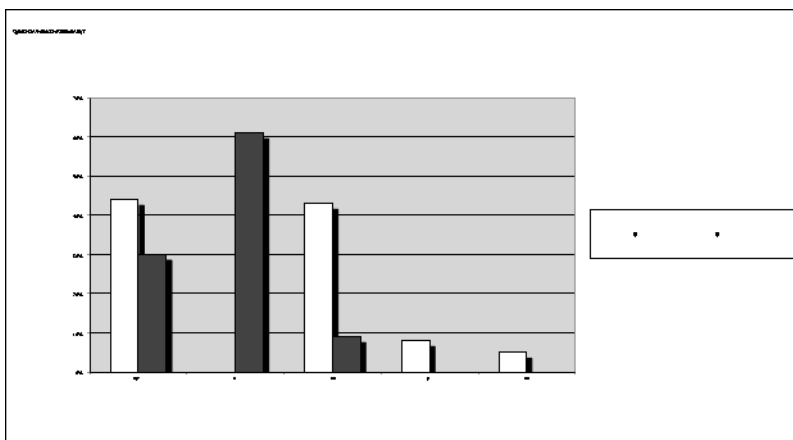
principal responses were about the value of ongoing teacher professional development. The teachers never mentioned this as a factor, nor did they report content knowledge and understanding, as stated above, as important.

Question 2: What gets in the way of you doing a productive job of teaching math?

The forty teachers responded by providing 74 items. These were grouped into three categories of the system, students, and teaching issues. The principals provided 33 replies to this question that also fell into three categories: teacher related, the system, and students. The distribution of responses for question 2 can be found in Figure 2.

The system getting in the way was reported by teachers in comments such as: “Given the demands of time and syllabus there is no chance of nurturing an appreciation of the beauty of math.” And, “Curriculum is designed very pragmatically to best prepare students to get high grades on standardized tests.” System-controlled factors such as: (a) time constraints, (b) being given clerical and non-teaching assignments, (c) curriculum constraints, (d) inadequate resources and texts, and (e) too many students were also noted by the teachers (44%). Principals reported system factors to a lesser extent (30%): (a) improper teacher placement, (b) interruptions, (c) time limits, (d) textbooks, (e) test scores, (f) repetition of curriculum, and (g) inadequate manipulatives and other materials.

FIGURE 2
What Factors Get in the Way?



Percentages of teachers who blamed the system by teacher characteristics of school system, years teaching, professional

development activities, gender, and grade level were also computed. 61% of the New York City and 70% of the Diocesan teacher respondents blamed the system. 75% of teachers with more than five years teaching and 46% of teacher with less than five hears blamed the sytem. 68% of teachers with some professional development compared to 40% of teachers with no reported professional development blamed the system. 62% of the female and 61% of the male teacher respondents blamed the system. When comparing grades taught, 71% of the K-2 teachers, 50% of the grade 3-5 teachers, and 60% of the 9-12 teachers blamed the system. Grade 6-8 teachers are not reported because in the public schools they are in a middle school setting and in the Diocese they are part of a K-8 school.

An inspection of these results reveals the system cited as a problem by all demographic variables. However, teachers with less than five years teaching experience were less likely to blame the system than more experienced teachers. Teacher frustration with the system over time may well be responsible for this difference. Also, teachers with no professional development were less likely to blame the system. It may be teachers with some professional development blamed the system because they could not implement practices learned during the professional development sessions. Early childhood teachers, perhaps because they are more child centered, were most likely to blame the system.

Teachers viewed students as a negative factor in the teaching of mathematics (43%) much more frequently than principals (9%). Teachers identified inappropriate behavior (19%) that was described as uncooperative, disruptive, lacking motivation, and poor attendance. They listed a plethora of negative student comments that included poor academic skills and attitudes such as: (a) not making connections; (b) inadequate study habits; (c) not understanding concepts, uses, or purposes of math; (d) being below grade level; (e) not doing homework; and (f) lacking skills they should have learned previously. Also included in the “students get in the way” category were statements about student makeup of classes, such as having four or five special needs students who struggle to follow the majority of the class, as well as having such a wide range of abilities in classes.

Similarly, percentages of teachers who blamed students disaggregated by the same teacher characteristics of school system, years teaching, professional development activities, gender, and grade level were computed and compared. 62% of the public school teachers and 55% of the Diocesan teachers blamed the students. 62% of teachers with more than five years teaching and 66% of teachers with five years or less of teaching experience identified student characteristics as a negative factor. 65% of teachers with some professional development and 60% of

teachers with no professional development identified student characteristics as a negative factor. 76% of male teacher respondents and 59% of the female teachers identified student characteristics as a negative factor. When comparing grades taught, 42% of the K-2 teacher respondents, 65% of the grades 3-5 teachers, and 69% of the 9-12 teachers blamed the students.

An inspection of these results also indicates that groups in all categorizations identified student characteristics as a negative factor. Public school teachers were more likely to identify student characteristics as a negative factor. This may be related to the higher incidences of disciplinary actions in public schools. Higher grade teachers were more likely to cite student characteristics as negative and this probably is due to the fact that older students are expected to have more advanced study habits, higher levels of mathematics knowledge, and more responsibilities. The higher percentage of male teachers sharing this view is probably due the fact that more males teach at the higher grade levels.

Responses of principals that referred to students were much more limited. Their descriptors were about students with poor math skill; students who cannot find help with homework; and students who do not complete their homework.

Eight percent of the teachers responded with teaching related issues. They stated problems such as not grouping by ability, teaching to the state tests, being too textbook dependent and the results of institutional pressures on students. One such comment appears below:

It is very unfortunate that even most of those competitive, goal oriented students who succeed by these criteria do not grow any fonder of the subject or develop an aesthetic sensibility for it. This is especially true because most students fear and/or loathe math to start with, and the rigors and pressures of test preparation only increase this effect. It's too bad.

The principals did not address teaching issues identified by the teachers. They did however, point to teachers as the biggest obstacle to teaching mathematics effectively (61%). Specifically they complained about the teachers' lack of skills in mathematics. One principal wrote: "An unskilled teacher is definitely the worst thing you can give a child." Other teacher shortcomings were being: (a) too dependent on the textbook; (b) a poor classroom manager; (c) unable to teach more than one level of math; (d) boring; (e) ill-prepared; (f) unfamiliar with alternative methods of problem solving; (g) unrealistic about expectations about students; (h) reluctant to implement innovative and new teaching techniques and skills to address individual needs; (i) weak in motivational skills; (j) poor lesson planners; (k) inadequately trained; (l) accustomed to doing too many activities of the same type

when it is evident students have the concept; (m) impatience with children who just don't get; and (n) fearful of math.

In their replies teachers did not emphasize the need to advance their own teaching strategies. While teachers mentioned students positively five times in replies to the first question about productive teaching of mathematics, they gave 32 negative mentions about students to the second question in which they targeted factors that impeded productive mathematics instruction.

In their replies to question 2 about impediments, principals overwhelmingly pointed to the teachers (61%) and the system (30%). They did not mention their own roles. Also, while principals did not cite reform based mathematics teaching as a factor that supports good mathematics teaching, they were vocal in saying that the lack of such reform based mathematics pedagogy in their schools was a factor that has hindered school mathematics instruction.

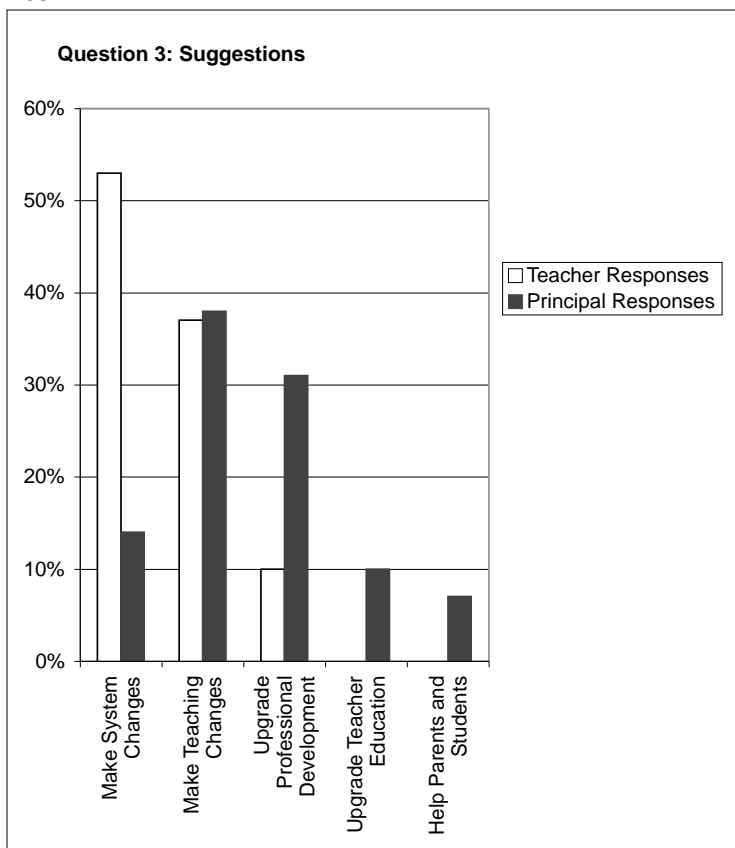
Percentages of principal responses were computed and compared by school system and years of experience. 88% of the Diocesan and 80% of the public school principals identified inadequate teacher skills and knowledge as a factor that inhibited effective mathematics teaching. 90% of principals with 10 years or more experience reported deficient teacher knowledge or skill inhibited good mathematics teaching. However, no principal with four year of experience or less reported this.

While both the public and parochial school principals made high percentages of negative statements about teachers, the Diocesan principals, may have based their opinions in part on the combined effects of the shortage of licensed mathematics teachers and the higher salaries in public schools. This often results in mathematics teachers working out of licensure. While more experienced principals overwhelmingly cited teacher knowledge and skills as a problem, new principals did not claim this. Perhaps being so new, they may still identify with the teachers' perspectives.

Question3: What ideas do you suggest to promote productive teaching of math?

Forty teachers provided 59 items in response to this question. These were grouped in the following way: Make Changes in the System (53%), Make Changes about Teaching (37%), and Upgrade Professional Development (10%). Principals responded to question three with 29 suggestions to promote productive teaching of math. These were grouped into the following categories: make Teaching Changes (38%), Upgrade Teacher Professional Development (31%), Make Changes in the System (14%), Upgrade Teacher Education (10%), and Help Parents and Students (7%). These findings can be found in Figure 3.

FIGURE 3.
Suggestions



Make Changes in the System

(Teachers 53%; Principals 14%). Teacher comments in this category included the need for: (a) smaller classes, (b) more time to teach math, (c) ability grouping, (d) more time to interact with colleagues, (e) less administrative work, (f) more qualified math teachers on lower levels, (g) tutoring for “at risk” students, (h) paraprofessionals in each class, (i) removing discipline problems, (j) eliminating interruptions and paper work, (k) assigning specialists on lower levels, (l) having more interaction between high school and middle school teachers, (m) finding better texts, (n) paying teachers to mentor other teachers, (o) hiring more math specialists, and (p) seeking corporate sponsorship of tuition assistance for math teachers. Principal suggestions included: (a) hire more teachers who were math majors, (b) upgrade materials, (c)

departmentalize lower grades, and (d) purchase necessary manipulatives and equipment.

Make Changes about Teaching (Teachers 37%; Principals 38%). The following are teaching recommendations offered by the teachers: (a) integrate math with subject areas, (b) make math meaningful, (c) have freedom to teach in your own style, (d) incorporate fun activities, (e) teach less to tests, (f) use manipulatives, (g) stress basic skills at the lower grades, (h) know your students and their learning styles, (i) stress fundamentals, (j) use technology, (k) take more field trips and group activities, and (l) help teachers boost their confidence. Principal recommendations called for teachers to develop: (a) well-designed lesson plans tailored to the ability levels of the class; (b) lessons that spiral the teaching of math; (c) ways to have more fun teaching math, relax and take chances; and (d) cross curricular approaches. They also wrote that teachers should include more (a) cooperative learning activities, (b) daily drill of basic facts, (c) focus on rules; (d) use manipulatives and (e) memorization of times tables.

Upgrade Professional Development (Teachers 10%; Principals 31%). Teacher professional education responses included needs to : (a) know more content knowledge, (b) integrate math in other subjects and real world, (c) create better learning environments, (d) better prepare primary teachers, and (e) have more ongoing professional development. Principals recommended that professional development include more: (a) constructivist, hands-on workshops; (b) more frequent teacher development activities; (c) use of trainers in buildings to reinforce workshop models; (d) teacher opportunities to take graduate courses free of charge, (e) information on good Internet sites; and (f) professional conferences. It is interesting to note that percentage wise, principals gave three times as many mentions for the need to upgrade professional development than did teachers.

Upgrade Teacher Education (Principals 10 %). The focus of the principals' comments was on having colleges (a) excite future teachers of math, (b) share research, and (c) provide more training in teaching math.

Help Parents and Students (Principals 7%). Here principal suggestions were to help parents change the attitude of "I can't do math...that's why my child can't do it" and to improve student attendance.

In providing ideas to promote productive teaching of mathematics the teachers focused heavily (53%) on making changes in the system, while principals provided a less weighty set of suggestions (14%) about changing the system. Both teachers and principals wrote of the need to change teaching (38% of the items to 37%, respectively). It is interesting to note that teachers suggested interactions with other teachers as a way

of improving mathematics instruction, but principals made no mention of teacher dialogue as recommendation.

Discussion

Our discussion centers on support for teaching strategies suggested by national mathematics standards, “the blaming syndrome,” and different perspectives of teachers and principals about professional development and peer collaboration.

National Mathematics Standards

Teachers and principals expressed the belief that teaching strategies were an important factor in the teaching of mathematics. Similarly, the use of manipulatives was strongly endorsed; a strategy that relies on both resources and pedagogy. Though some, teachers appear to support a constructivist philosophy of the teaching of mathematics that is aligned with the teaching strategies called for in the National Council of Teachers of Mathematics Principles and Standards for School Mathematics (NCTM, 2000), many still emphasized the need to drill basic facts.

The Blaming Syndrome

Nowhere in the three open-ended questions did we use the term “blame.” However, blame seems to be at the heart of many responses. When asked, teachers blamed the system and students equally (45 % & 43 %) for what gets in the way of their doing a productive job of teaching mathematics. Principals blamed the teachers (61%). Neither group pointed to their own responsibilities in replying to this question. There were no statements such as, (a) “I need to learn how to teach to different children’s needs,” (b) “I need to support my teachers more,” or (c) “more content knowledge or more effective teaching strategies would help me better meet the student’s learning needs.”

Professional Development and Peer Collaboration

Both teachers and principals acknowledged the need to provide further professional development for implementing practices advocated by reform based mathematics. This finding is consistent with Briars (1999) and Ross, McDougall & Hogaboan-Gray (2002). Teachers underscored the importance of cooperation and support of their peers, and guidance from administrators. This was not referenced by the principals. This study confirms Raymond’s (1997) and Thompson’s (1984) findings that teachers and principals reported time constraints, scarcity of resources, problems with classroom management, and standardized testing to hinder effective mathematics teaching.

Although the teachers and principals did not delve deeply into high stake testing, the lock step syndrome, skill and drill messages, and teacher development seen as a means to pass tests, all cast a pall on the promise of reform based mathematics. Imbedded in the blame syndrome were many stakeholders need to cast blame elsewhere and to protect themselves professionally.

Further Research

Though much of the response was expected, and while some of it was encouraging, it was disheartening to acknowledge what was not said. That is, there was no acceptance of one's own responsibility for improving mathematics teaching and learning. This needs further study. In the course of this work, we concluded that the voices of parents and students also needed to be sought, as well as those of rural teachers and principals, and the perspectives of newly graduated teachers.

Finally since there were such disparate findings between principals new to the job and those with more than ten years experience, we recommend longitudinal studies of principals over time. We reason that unless we make all stakeholders partners in mathematics reform discussions, all understanding about the state of mathematics education in urban schools will have little impact on the children in classrooms. Teachers and principals are the link, the all important resource that cannot be left out of the mathematics reform equation. A current strategy in teacher development is to empower teachers to work together in teacher support groups. Of interest to the researchers is, what happens over time when teachers are given the opportunity to collaborate on strategies to improve the teaching and learning of mathematics as exemplified by Jim Stigler's lesson study work? Had teachers been more actively involved in their own professional development, would their responses about factors that promote good mathematics teaching mention professional development more frequently? Also, how would teachers and principals respond in interviews that probed the same questions investigated in the current study? We recommend these questions be studied in future research as well as replication of the current study in other urban areas.

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