Math for All:

An Opportunity to Develop Our Civic Responsibility to Inclusion Students

PREPARED BY:

Ellen B. Meier, Ed.D.
Kathy Powell, Ed.D.
Fiona Hollands, Ph.D.
Caron M. Mineo
Teachers College, Columbia University

Babette Moeller, Ph.D.
Education Development Center

Barbara Dubitsky, Ed.D.
Bank Street College of Education

EDC Learning transforms lives.

Education Development Center
Learning and Teaching Divsion
Center for Children and Technology

Math For All: An Opportunity to Develop Our Civic Responsibility to Inclusion Students [1, 2]

Abstract

Inclusion students are now required to perform capably on high stakes tests. Teachers must be prepared therefore to meet the needs of students who come to school with a wide range of abilities and disabilities. Numerous studies have shown that elementary teachers are typically unprepared to implement standards-based mathematics in inclusion classrooms. This research reports on the findings from a four year National Science Foundation project, *Mathematics for All (MFA)*. Using multimedia case studies as the centerpiece of its professional development curriculum, the research demonstrates the effectiveness of this rich professional development program to help teachers develop a deeper understanding of teaching inclusion students in elementary mathematics.

A. Description of the problem and objectives

Teaching mathematics in elementary inclusion classrooms is challenging in the high stakes testing era of *No Child Left Behind* legislation (NCLB, 2001). There is increased pressure on schools to ensure that all children have the opportunity to reach proficiency on challenging achievement standards. Teachers of students with disabilities and a wide range of abilities are particularly challenged by these new mandates.

Evidence shows that elementary teachers in inclusion classrooms are often poorly prepared to implement standards-based mathematics education for students with disabilities. Moreover, teachers frequently receive only minimal preparation in understanding the strengths and needs of children with learning disabilities. In a nationally representative sample of public school teachers surveyed by the National Center for Education Statistics (2001), only 33% of the teachers who serve students with disabilities considered themselves well prepared to address the needs of their students.

Unfortunately, professional development programs are often superficial and brief: the focus is frequently on changing teachers' behavior rather than helping teachers deepen their content knowledge and better understand the needs of their students (Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). "A study of professional development in mathematics Birman et al. (2007) shows that few teachers receive intensive, sustained, and content-focused professional development in mathematics" (Yoon et al., 2007, p. 2).

In recognition of the need to better prepare elementary teachers to teach math in inclusion classroom, the National Science Foundation funded a four year project, *Mathematics for All (MFA),* to develop multimedia case studies and a curriculum to address the pressing

[1] Paper presented at the annual meeting of the American Educational Research Association, New York, NY, March 2008.

[2] The work reported in this report was supported by a grant from the National Science Foundation (Grant No. ESI-0243527). Any opinions, findings, conclusions, or recommendations expressed here are those of the authors and do not necessarily reflect the views of the National Science Foundation.

professional development concerns of K-5 elementary teachers of mathematics in inclusion classrooms. The project recently finished its fourth year.

This research describes the results of the project, developed through the collaborative effort between Bank Street College of Education and the Center for Children and Technology (CCT) of the Education Development Center (EDC). The researchers who evaluated the program are from the Center for Technology and School Change (CTSC) at Teachers College, Columbia University.

Over the four years of the grant, *Math for All* team members developed two sets of case materials, piloted and refined them. They embedded the case materials in five day-long workshops which were supported to extensive *MFA* work in teachers' classrooms. The focus of one set of case materials is on grades K-2 and the other on grades 3-5. These materials have been field-tested in four diverse sites representing different regions of the United States

In assessing the impact of these case materials use, researchers from the Center for Technology and School Change (CTSC) looked to see whether this MFA professional development approach impacted teachers' knowledge, skill, and classroom practice. Specifically, the research examined whether participation in the MFA professional development would: (1) Increase teachers' awareness of different students' strengths and needs; (2) Increase teachers' ability to observe students; and (3) Increase teachers' knowledge of and ability to create and use instructional strategies to address individual students' strengths and needs.

B. and C. Perspective(s) or theoretical framework and connection to the literature

The new math standards and the related high stakes tests present enormous teaching challenges for teachers. For teachers of inclusion classrooms, the challenges are even greater; teachers must address a broader range of learning requirements. Inclusion research has shown the importance of using instructional strategies to analyze students strengths and needs, and provide teachers with the skills to adapt curricula and design effective lessons. The challenge has been to bring this knowledge to teachers in ways that help them grow professionally.

Research on inclusion (e.g., Council for Exceptional Children, not dated; Karp, 2000; Pugach, 2005; Wade & Zone, 2000) has helped to identify key competencies that teachers need to help students with disabilities succeed in a general education setting. Among other things, teachers need to have subject matter knowledge and need to know how children with different kinds of disabilities develop and learn, and they need to be able to do the following:

- Analyze students' needs and strengths.
- Use a variety of instructional approaches (e.g., explicit strategy instruction, coaching, cooperative learning, inquiry based learning).
- Make decisions about and manage multiple instructional strategies.
- Adapt curricula and activities and design effective lessons.

- Identify, develop, and utilize appropriate resources and materials.
- Formally and informally assess student learning.
- Seek assistance and guidance from specialists and other resources.
- Work with specialists and families.

To develop these competencies, however, it is not sufficient for teachers to take one or more isolated courses or workshops on developmental variations and general teaching strategies that work for students with disabilities. As leaders in teacher education (e.g., Loucks-Horsley, 1998; Bransford, Brown, & Cocking, 1999; Shulman, 1987) have emphasized, teachers need to develop pedagogical content knowledge, i.e. knowledge about how to teach a discipline, and more specifically, knowledge about how to teach this discipline to a diverse group of students. Expert teachers not only know the structure of their discipline, but they are also sensitive to how different students will approach the discipline and which aspects might be especially difficult or easy for them to master. Learning about learner differences and effective strategies for supporting diverse learners to reach common learning goals thus is best embedded in learning about how to teach a particular content area. Therefore, for teachers to be well prepared to help students with disabilities achieve standards-based learning outcomes in mathematics, they need a good understanding of the specific needs and capabilities of these students in relation to standards-based mathematics content and they need to know how to create effective mathematics learning environments for them.

Project Description

Math for All is a professional development program to support teachers as they improve K-5, standards-based mathematics education for all students, including students with disabilities. Specifically, the *Math for All* program is designed to help teachers deepen their understanding of and skill in (a) how to analyze the demands of mathematical activities; (b) how to assess individual students' strengths and needs in mathematics; (c) teaching practices and instructional strategies for teaching mathematics to students with different strengths and needs; (d) how to plan accessible mathematics lessons.

The *Math for All* program consists of video-case based curriculum materials and learning activities that form the core of two workshop series for teachers who teach students in grades K-5. One workshop series focuses on grades K-2 and the other on grades 3-5. Each series consist of five day-long sessions and is intended to be implemented over time during the school-year, to make it possible for participants to complete assignments in their classrooms between workshop sessions. Each workshop series provides for 30 hours of class time, plus 10 hours devoted to workshop-related assignments that participants carry out in their classrooms, and 10 hours of follow-up meetings, for a total of 50 hours of professional development during the course of one school year. Ideally, participants in the workshop series are teams of general and special education teachers who serve the same students at their schools. Where applicable, these teams can also include paraprofessionals or instructional aides, math coaches, and instructional support specialist who work with the teachers.

Each workshop session is organized around one particular case lesson. Within each workshop series, there is one case lesson for each of the five NCTM content standards (number and operations, data analysis and probability, measurement, geometry, and algebra). The classrooms featured in the case studies are general education classrooms that include students with a range of different kinds of disabilities (e.g., learning, speech and language, developmental, and behavioral disabilities). Each case includes information about several children with different kinds of disabilities along with information about students without disabilities.

In each workshop session, learning activities are designed to deeply immerse participants in the mathematical activity of the case lesson, in analyzing the learning demands of this activity using a neuro-developmental framework, in observing a student engaged in the activity to assess the extent to which he or she does or does not meet the demands of the activity, and in analyzing teaching practices and instructional strategies that build on individual students' strengths and address their weaknesses. After in-depth analysis of each case lesson in this fashion, participants then connect what they have learned to their own classrooms. Working with the members of their team, they examine the mathematics of a lesson that they will be teaching in-between course sessions, analyze the demands of the core mathematics activity, discuss the strengths and weaknesses of one or more focal children in relation to that activity, and then plan adaptations for the lesson to support student learning. Workshop assignments require participants to implement their lessons plans, to observe their focal students within that lesson, and to reflect on and revise the adapted lesson. Participants also have reading assignments (they read Mel Levine's book A Mind at a Time) to familiarize themselves with a neuro-developmental framework of learning.

The instructional format of the workshops incorporates key components of constructivist pedagogy, including deep inquiry into children's thinking and behavior to provide guidance for responding differentially to each learner in the classroom; reflection on classroom events to examine beliefs and practices in relation to alternative approaches to particular situations and in relation to theoretical ideas; and learning in groups where teachers can collaboratively explore ideas, make plans, learn from analyzing what is and is not working, and revise plans.

D. Articulated mode of inquiry

A mixed methods approach was used for this research. Both quantitative and qualitative data were identified, gathered and analyzed during the course of this fourth year field site study.

A quasi-experimental research design was used to assess the impact of teacher participation in the MFA program in four diverse field-test sites representing different regions of the United States. It was possible to establish control groups in three of the sites; the control group represented comparable groups of teachers from the treatment districts.

Pre and post questionnaires and performance assessments were given to 88 teachers participating in the professional development (i.e., the treatment group) as well as a non-random comparison set of 22 teachers in a control group. Responses to the pre-post quantitative questionnaire data were captured in Likert scales of one to five, and analyzed using the Statistical Package for the Social Sciences (SPSS). A factor analysis of key questionnaire items identified two constructs. Each factor was tested for internal consistency and deemed reliable at an acceptable level of $\propto$>0.80. Since Levene's Test for Equality of Variances confirmed homogeneity between the control and treatment groups, an independent samples t-test was used to compare related pre-post differences in means on the established constructs.

Qualitative data was gathered in the form of pre-post workshop performance assessments, observations of a sample of teachers in the workshops and in their classrooms, interviews with a sample of participating teachers and interviews with the project staff. The qualitative data was analyzed in three stages following Miles and Huberman's classic Sourcebook on Qualitative Data Analysis : data reduction to identify themes, data display to organize the themes, and conclusion drawing and verification by identifying patterns, configurations and propositions (p. 10).

The purpose of the research was to test the hypotheses that participation in the MFA workshop series would:

1. Increase teachers' awareness of different students' strengths and needs
2. Increase teachers' ability to observe students
3. Increase teachers' knowledge of and ability to create and use instructional strategies to address individual students' strengths and needs
4. Improve the math performance of students with and without disabilities.

E. Selection and use of evidence to support conclusions

Data Sources

1) Questionnaires: Pre- and post- teacher questionnaires were given to both the treatment and control groups in 2006-2007 (see Appendices A and B). The purpose of the pre-/post questionnaires was to document participants' backgrounds and prior experiences, workshop expectations, and responses to the workshops. Questionnaire data also documented changes in participants' classroom and lesson planning practices, their awareness about key issues concerning the inclusion of students with disabilities, and the perceived impact of the workshops on their professional practice.

Pre-questionnaires were administered to the workshop participants (the treatment group) at each of the four field-test sites during the initial workshop session. The post-questionnaire was administered at the conclusion of the fifth workshop session.

A total of 88 teachers completed both a pre-/post questionnaire. These are the teachers included in the treatment group.

Pre-/post teacher questionnaires were administered to a control group in three of the four field-test sites (see Appendices C and D). The 22 control teachers completed the pre-/post- questionnaires online during two two-week periods, approximately 2-3 months apart.

2) Performance-Based Assessments: A performance-based assessment (Thinking About a Student in Your Classroom) was administered to the both the treatment and control groups (see Appendices E and F). The performance-based assessment documented changes in participants' understanding of and skill in observing students and matching instructional strategies to students' needs and strengths. For the treatment group, the pre-task was assigned to participants prior to the five-part workshop series and submitted at the first session. The post-task was completed during the final workshop session. The control group teachers completed the pre- and post performance-based assessments online in conjunction with the pre-/post questionnaires.

The pre-assessment asked teachers to:

1) Think about a student you teach who you have questions about relating to math. Please describe this child.
2) What are some instructional strategies and classroom structures that you might use to support the child you described above?

The post-assessment asked the teachers to review their comments on the pre-task and answer the following questions:

1) Now that you have nearly completed the *Math for All* workshops, how has your thinking about the student changed?
2) How has your thinking about instructional strategies and classroom structures for this child changed?

3) Workshop Feedback Forms: The workshop feedback forms were designed to assess what participants think they have learned; determine which aspects of the individual workshop sessions participants liked; describe how what they learned will contribute to their classroom and professional practice; and gather suggestions for improving the upcoming workshop sessions.

4) Document Analysis: Meeting notes and handouts were analyzed.

5) Workshop Observations: Researchers observed the implementation of the five-part workshop series at the local field-test site, in New York City, to document the activities provided.

6) Classroom Observations and Post-Observation Interviews: The goal of the classroom observations was to gather data about the impact of the MFA workshop series on participants' professional practice. The external evaluators conducted classroom observations in six New York City classrooms. Participating teachers volunteered for observations and researchers visited their classrooms one time to observe for 40-60

minutes. The observations were scheduled for three weeks following the final workshop session. Teachers were interviewed following the classroom observation. Six classrooms were observed, two classrooms of which had two teachers working together (i.e., collaborative classroom team). Of the eight teachers observed; three were interviewed independently, four teachers were interviewed in teams of two, and one teacher was not available to be interviewed due to a scheduling conflict.

Researchers observed one math lesson selected by the participants. Demographic data about the class was gathered prior to the observation. Teachers identified their focal student to the researcher prior to the observation. When two researchers were present, each researcher focused their observation on one member of the collaborative classroom team.

7) Faculty Interviews: Interviews were conducted with three of the key Bank Street faculty who developed and implemented the case study materials. Questions addressed faculty learning as a result of their participation in the development of the case study materials; current and proposed use of the case study materials in graduate courses; and the impact of the materials and development process on faculty's professional practice.

Subjects

Four pilot locations were identified on the basis of geographical distribution, a commitment to inclusion and to teaching standards-based mathematics to students with disabilities, and expressed interest by district-level or state-level administrators. One of the districts is in a rural area in the Midwest, the second is a large Northeast urban district, the third, is a predominantly rural school district in the Midwest, and the fourth is an affluent small town in the Northeast (Table 1).

Primary data sources for this research include the elementary classroom teachers who teach math in inclusion classrooms, special education teachers, instructional aides, and others, such as coaches and instructional support specialists (Table 2).

Table 1. Regional Descriptive Data: Matched Pre-Post Pairs

Site	State	Region	SES	N
1	Southeast	Predominantly Rural	Lower Middle	19
2	Midwest	Rural	Middle Class	40
3	Northeast	Urban	Lower Middle	11
4	Northeast	Suburban	Upper Middle	18

Table 2. *Positions reported by treatment group*

	Positions reported by treatment group						
Site	*General Education Teacher*	*Special Education Teacher*	*Instructional Aide*	*Math Coach*	*Instructional Support Specialist*	*Other*	*N*
Arkansas	7	5	0	2	1	4	19
North Dakota	13	12	13	1	0	1	40
New York, NY	3	3	0	3	1	1	11
Connecticut	10	1	0	2	1	4	18
Combined	33	21	13	8	3	10	**88**

Table 3. *Positions reported by control group*

	Positions reported by control group						
Site	*General Education Teacher*	*Special Education Teacher*	*Instructional Aide*	*Math Coach*	*Instructional Support Specialist*	*Other*	*N*
Arkansas	*	*	*	*	*	*	*
North Dakota	8	4	3	0	1	0	16
New York, NY	1	0	0	0	0	0	1
Connecticut	5	0	0	0	0	0	5
Combined	14	4	3	0	1	0	**22**

* Control data was not been collected.

The focus of the case-based materials was PK-2 and grades 3-5 (see Table 1), however in many schools teachers often teach a variety of grade levels as indicated in Table 4.

Table 4. *Participant Grade Levels*

		Percentage of participants reporting working with the following grade levels:					
Site	*N*	*PK-2*	*3-6*	*PK-6*	*7-12*	*K-12*	*Other*
Arkansas	19	5.3%	47.4%	15.8%	5.3%	26.3%	0.0%
North Dakota	40	40.0%	7.5%	47.5%	0.0%	2.5%	2.5%
New York, NY	11	54.5%	0.0%	27.3%	0.0%	18.2%	0.0%
Connecticut	18	0.0%	72.2%	27.8%	0.0%	0.0%	0.0%
Combined	88	26.1%	28.4%	34.1%	1.1%	9.1%	1.1%

* Data was obtained from a pre-survey of participating teachers.

The sites selected for inclusion in this MFA grant were chosen, in part, because they were using a standards based curricula. This controlled for some of the additional variation which would have been included in the data if we had used sites that did not follow standards based curricula. See Table 5 below for data on which curriculum teachers reported using.

Table 5. *Math curriculum currently used by MFA participants*

		*Reported Curriculum**		
Site	*N*	*Investigations in Number, Data and Space*	*Everyday Mathematics*	*Other*
Arkansas	19	57.9%	5.3%	47.4%
North Dakota	40	77.5%	12.5%	12.5%
New York, NY	11	9.1%	100.0%	9.1%
Connecticut	18	100.0%	0.0%	11.1%
Combined	88	69.3%	19.3%	19.3%

* Note: The total percentage per site may not equal 100.0%, as participants were asked to identify all that apply.
**Data was obtained from a pre-survey of participating teachers.

The vast majority of teachers participating in the MFA professional development reported prior experience working with children with disabilities. 97.7% currently or previously have worked with children with disabilities. See Table 6.

Table 6. *Participants' professional interaction with children with disabilities*

			Circumstances under which participants have worked with students with disabilities			
Position	*N*	*Percentage of participants reporting having worked with children with disabilities*	*General education inclusion classroom*	*Self-contained special education classroom*	*Resource room*	*Other*
General Education Teachers*	33	96.9%	93.8%	3.1%	6.3%	6.3%
Special Education Teachers*	21	100.0%	66.7%	42.9%	76.2%	19.0%
Instructional Aides*	13	100.0%	100.0%	15.4%	7.7%	0.0%
Math Coaches*	8	100.0%	62.5%	12.5%	50.0%	62.5%
Combined**	88	97.7%	85.1%	19.5%	32.2%	13.8%

* Note: The total percentage per site may not equal 100.0%, as participants were asked to identify all that apply.
** Note: Combined statistics includes data from positions reported as "other" and "instructional specialist," which are not included in this table.
*** Data was obtained from a pre-survey of participating teachers.

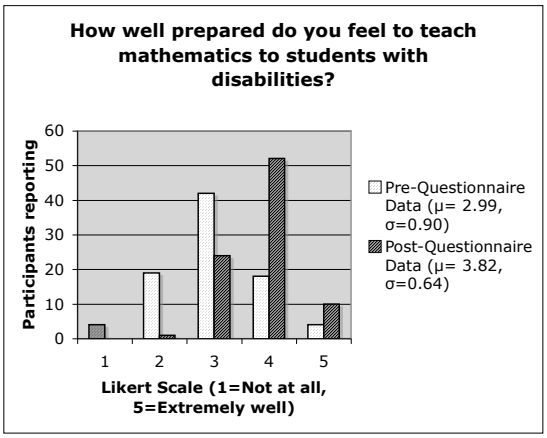
Analysis

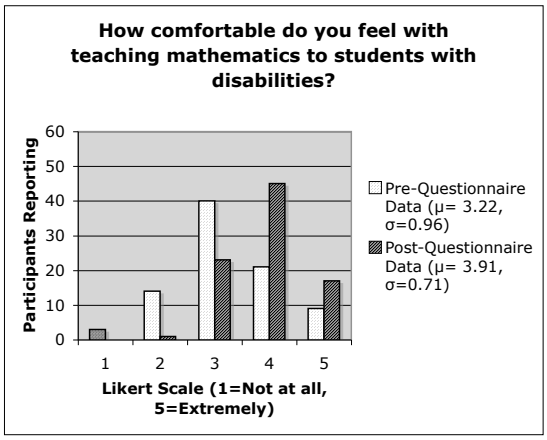
All of the data gathered, the pre-post teacher questionnaires, pre-post performance based assessments, workshop observations, teacher interviews, and classroom observation summaries were analyzed. For the quantitative data, analyses were run on appropriate sections to determine statistical differences (if any) between 1) pre-post data from the treatment group, 2) pre-post data from the treatment and control groups. The qualitative data was coded and analyzed to identify relevant themes related to differences between pre-post data and treatment and control group data.

Pre-/Post Questionnaire Results

(Please see Appendices K and L for pre- and post- descriptive data)
A number of impacts were reported by teachers participating in the MFA workshops. Using a Wilcoxon Signed Ranks Test to analyze participants' pre and post response to categorical items, seven primary impacts were found to be statistically significant. Of those seven significant items, two related to the teaching of students with disabilities. The first was the significant change in how well prepared teachers feel in teaching mathematics to students with disabilities ($Z=-6.743$, $p<.001$). The second was the significant change in how comfortable participating teachers feel in teaching mathematics to students with disabilities ($Z=-5.669$, $p<.001$). In both cases the mean changed significantly in a positive direction, thus with significantly less teachers feeling unprepared or uncomfortable teaching mathematics to students with disabilities. See Figure 1.

Figure 1. *Pre-Post Questionnaire Results: Participant preparedness and comfort in teaching students with disabilities*





The five other primary impacts which showed statistical significance were all related to comfort across the following aspects of planning mathematics lessons: helping teachers observe individual student strengths and weaknesses ($Z=-3.629$, $p<.001$), analyzing the demands of the mathematical task ($Z=-4.014$, $p<.001$), considering the learning goals of the lesson ($Z=-4.456$, $p<.001$), selecting a variety of instructional strategies and materials to support students with diverse strengths and needs ($Z=-4.209$, $p<.001$), and writing lesson plans ($Z=-3.567$, $p<.001$). The complex intellectual task of synthesizing these five elements to determine what and how to teach mathematics to unique, individual students is the ultimate goal of this grant. The pre-post questionnaire comparison shows a positive correlation between teachers taking the MFA workshops and gaining in their ratings of ability on each of these tasks. Later in this report, other methodological approaches look to see whether teachers showed evidence of increased ability to successfully integrate these elements.

A strong focus of both the workshops and the teacher reports of changes were in observing student strengths and needs and relating that information to the instructional strategies they selected. Participants from the four field-test sites reported the following

as the ways in which they most frequently identified student's strengths and needs prior to the MFA workshops: (1) the use of in class assessments such as teacher made tests or quizzes, worksheets, or homework (53.5%) and (2) the use of observation (51.2%). At the same time, participants reported that they most often select instructional strategies for a particular mathematics lesson based on: (1) the academic needs of students (68.0%); and (2) the guidelines of the adopted curriculum (40.0%). (See Table 7 for responses by position-type).

Table 7. *Participants' selection of instructional strategies in math prior to the workshop series*

How do you select instructional strategies for a particular mathematics lesson? *This open-ended item yielded the following codes:*	By Position				
	General Education Teacher n=33	Special Education Teacher n=21	Instructional Aide n=13	Math Coach n=8	Overall* n=88
Based on the academic needs of students	72.7%	72.2%	0.0%	100.0%	68.0%
Based on the guidelines of the adopted curriculum	48.5%	50.0%	0.0%	28.6%	40.0%
With assistance from additional teacher resources beyond the adopted curriculum	27.3%	11.1%	0.0%	0.0%	16.0%
With assistance from colleagues	12.1%	5.6%	100.0%	0.0%	16.0%
To promote student engagement	6.1%	5.6%	0.0%	14.3%	6.7%
Based on available classroom resources	6.1%	0.0%	0.0%	14.3%	4.0%
Based on school and/or district expectations	6.1%	0.0%	0.0%	0.0%	2.7%
To support content and process standards	0.0%	5.6%	0.0%	0.0%	2.7%

* Note: Overall descriptive data includes information from positions reported as "other" and "instructional specialist," which are not included in this table.

** Data was obtained from a pre-survey of participating teachers.

In post-questionnaire responses, 92% reported that the workshops taught them new ideas about how to adapt or modify lessons based on individual students' strengths and needs thus providing participants with a way to respond to student needs. Table 8 (below) lists the specific changes in understanding reported by the teachers.

Table 8. *Participants' reported change in understanding due to the workshop*

	Percentage reporting "Yes"				
	By Position				
Related Item	General Education Teacher n=33	Special Education Teacher n=21	Instructional Aide n=13	Math Coach n=8	Overall* n=88
Have these workshops taught you any new strategies for finding out what a student's strength and weaknesses are?	97.0%	90.5%	100.0%	100.0%	96.6%
Have these workshops taught you anything new about how to adapt or modify lessons based on individual students' strengths and needs?	100.0%	76.2%	92.3%	87.5%	92.0%

* Note: Overall descriptive data includes information from positions reported as "other" and "instructional specialist," which are not included in this table.

** Data was obtained from a post-survey of participating teachers.

Professional Knowledge

On a five point Likert rating scale (5=A lot and 1=Not at all) participants reported how the workshop series contributed to their professional knowledge in post-questionnaire responses. The highest ranked option was: The workshop series helped me to enhance my understanding of individual students' needs (see Table 9 below).

Table 9. *Math for All's contribution to participants' professional knowledge*

The workshop series helped me to enhance my understanding of…	1-Not at all	2-Not much	3-Some	4-Quite a bit	5-A lot	**Average**	**Standard Deviation**
…individual students' needs.	0.0%	1.1%	14.9%	47.1%	36.8%	**4.20**	**.73**
…individual students' strengths.	0.0%	2.3%	14.8%	52.3%	30.7%	**4.11**	**.73**
…how to adopt or modify math lessons to help students with diverse strengths and needs meet a given learning goal.	0.0%	3.4%	29.5%	40.9%	26.1%	**3.90**	**.83**
…alternative instructional practices and materials that can be used to pursue a given learning goal.	0.0%	2.3%	37.5%	38.6%	21.6%	**3.80**	**.81**
…the mathematics of specific lessons.	0.0%	4.7%	31.8%	44.7%	18.8%	**3.78**	**.80**

* Data was obtained from a post-survey of participating teachers.

Professional Skills

Reported gains from participants on the post- questionnaires mirrored goals they held for the workshops indicated above on the pre-questionnaires. A total of 96.6 % reported on the post-questionnaire that the workshops had taught them new strategies for finding out what a student's strengths and weaknesses are. Additionally, 92% reported that they felt these workshops had given them new information about how to adapt or modify lessons

based on individual students' strengths and needs. Thus participating teachers found a strong congruence between what they hoped to learn and their perceived focus of the actual workshops.

The post-questionnaire asked participants what the most important lesson they learned from these series of workshops. Open-ended responses were coded by researchers and the top four lessons reported by participants were: (1) understanding how students learn i.e. Neuro-developmental Framework (42.0%) (2) understanding the strengths and needs of students (34.1%), learning how to adapt lessons, generally to meet the strengths and needs of students (34.1%), and understanding my role in helping all students succeed i.e. reach a collective goal (20.5%).

Overall, 95.5% of *Math for All* participants reported on the post questionnaire that their professional practice would change as a result of the workshops. On the same questionnaire, participants reported that the program had most strongly contributed to their professional skills in the following areas: (1) observing individual students; (2) analyzing the demands of mathematical tasks; and (3) collaborating with colleagues in planning math lessons. See Table 10.

Table 10. *Math for All's contribution to participants' professional skills*

To what extent did the workshop series contribute to your professional skills in the following areas? ***The workshop series contributed to my professional skills in…***	1-Not at all	2-Not much	3-Some	4-Quite a bit	5-A lot	**Average**	**Standard Deviation**
…observing individual students.	0.0%	0.0%	18.2%	46.6%	35.2%	**4.17**	**.72**
…analyzing the demands of mathematical tasks.	0.0%	0.0%	15.9%	54.5%	29.5%	**4.14**	**.66**
…making decisions about how to adapt or modify math lessons to support students with diverse strengths and needs meet the learning goals.	0.0%	00%	31.8%	37.5%	29.5%	**3.98**	**.79**
…collaborating with my colleagues in planning math lessons.	0.0%	3.4%	21.8%	36.8%	37.9%	**4.09**	**.86**

* Data was obtained from a post-survey of participating teachers.

Math for All Workshops

On a five point Likert rating scale with 5=excellent and 1=poor, the majority of participants at each of the field-test sites gave the MFA workshop series favorable ratings (Average=4.05, SD=.74), with 91.9% of participants across the field-test sites reported that they would recommend the MFA workshop series to a colleague.

Table 11. *Participants' top rated workshop components*

The overall goal of the *Math for All* Workshop series is to help teachers (and staff developers who work with them) be better prepared to teach students with diverse strengths and needs in standards-based math classrooms. For each component of the workshops, please rate how useful you found it for accomplishing the workshop's goals.	1 (Not useful at all)	2	3	4	5 (Extremely Useful)	**Average**	**Standard Deviation**
Using video to observe students	0.0%	0.0%	9.1%	34.1%	56.8%	**4.48**	**.66**
Using video to observe teaching practice	0.0%	0.0%	11.4%	35.2%	53.4%	**4.42**	**.69**
Applying what I have learned in the workshop in my own classroom (e.g., observation of a child)	0.0%	2.3%	20.7%	49.4%	27.6%	**4.36**	**.75**
Hands-on exploration of math activities	1.1%	1.1%	11.4%	37.5%	48.9%	**4.32**	**.81**

* Data was obtained from a post-survey of participating teachers.

Factor Analysis

A factor analysis of key questionnaire items identified two constructs (Table 12). Each factor was tested for internal consistency and deemed reliable at an acceptable level of $\propto$>0.80 (Table 13).

Table 12. *Factor analysis of key questionnaire items*

Scale Item		Factor Loading
Factor 1: Assessing student needs in relation to the demands of the math lessons		
	Comfortable considering the learning goals of the lesson	0.924
	Comfortable thinking about how the math of the lesson connects to the math students have studied in the past and will study in the future	0.867
	Comfortable analyzing the demands of the mathematical task	0.862
	Comfortable thinking about individual student's strengths and needs	0.790
	Comfortable selecting a variety of instructional strategies and materials to support students with diverse strengths and needs	0.689
Factor 2: Preparedness to teach students with disabilities		
	Comfortable Teaching students with disabilities	0.919
	Prepared to teach students with disabilities	0.918

Table 13. *Reliability Analysis*

Factor	Number of Items	N	Cronbach's Alpha
Factor 1: Planning Mathematics Lessons	5	102	0.9151*
Factor 2: Teaching Students with Disabilities	2	109	0.8997*
Overall	7	102	0.9020*

*Acceptable at $\alpha > 0.80$.

Analysis of Control Data

Levene's Test for Equality of Variances confirmed homogeneity between the control and treatment groups before an independent samples t-test and a one-way analysis of variance was used to compare related pre-post differences in means on the established constructs. Analyses were performed on gain scores in an effort to remove initial differences between the control and treatment groups. See Tables 14-17 below

Table 14. *Group Statistics by Factor*

Factor	Group	N	Mean	Standard Deviation	Standard Error Mean
Factor 1: Assessing student needs in relation to the demands of the math lessons	Treatment	78	2.423[a]	4.517	0.511
	Control	20	1.200[a]	4.742	1.060
Factor 2: Preparedness to teach students with disabilities	Treatment	85	1.506[a]	1.556	0.169
	Control	22	0.318[a]	1.492	0.318

[a]Mean can be interpreted as the average difference between pre and post scores (i.e., average gain score)

Table 15. *Independent Samples Test: Significance of Differences between pre-post gain scores of treatment and control teachers*

	Levene's Test for Equality of Variances		t-test for Equality of Means			
Factor	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Factor 1: Assessing student needs in relation to the demands of the math lessons	.090[a]	0.765	1.070	96	0.287	1.223
Factor 2: Preparedness to teach students with disabilities	.239[a]	0.626	3.218	105	0.002**	1.189

* Significant at p<.05 ** Significant at p<.01 *** Significant at p<.001

[a]Assumption of equal variances can be assumed.

Table 16. *One-Way Analysis of Variance (Factor 1): Significance of Differences between pre-post gain scores of treatment and control teachers*

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	23.813	1	23.813	1.144	.287
Within Groups	1998.238	96	20.815		
Total	2022.051	97			

* Significant at p<.05 ** Significant at p<.01 *** Significant at p<.001

Table 17. *One-Way Analysis of Variance (Factor 2): Significance of Differences between pre-post gain scores of treatment and control teachers*

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	24.653	1	24.653	10.353	.002**
Within Groups	250.020	105	2.381		
Total	274.673	106			

* Significant at p<.05 ** Significant at p<.01 *** Significant at p<.001

Performance-Based Assessments

The pre-/post performance based assessments support the findings from the questionnaire data and provide additional evidence, in addition to the beyond self-reports, of the impact of the MFA workshops on the treatment group.

The majority of the treatment group showed changes in their pre-/post descriptions of their focal students and the instructional strategies and classroom structures they would use to accommodate the student's needs. Changes in the post performance-based descriptions included the following: (1) use of the neuro-developmental framework to observe and characterize the focal student; (2) inclusion of focal student's strengths and needs; (3) use of a broader range of instructional strategies and classroom structures and (4) alignment of instructional strategies and classroom structures with the strengths and needs of their focal students.

- Treatment and control teachers used similar language to describe their focal students in the pre performance-based assessments. Teachers from both groups selected students who were struggling academically and they specifically described some of the problems these focal students encountered in math. The teachers then described a variety of instructional strategies that they have tried to accommodate the needs of their focal students.

- The post performance-based assessments show evidence that the majority of treatment teachers shifted in the language that they used to describe their focal students. In most instances, the treatment group aligned their instructional strategies and classroom structures with the descriptions of their focal students.

- In the post performance-based assessments, the treatment group used the Mel Levine's neuro-developmental framework to guide both their observation and description of their focal student. They referred to psycho social, language, memory, attention, and sequential ordering constructs in their descriptions.

- In the post performance-based assessments, the treatment group referred to a broader range of instructional strategies and classroom structures in their post performance-based descriptions. They also described the variety of ways they modified their lessons to illustrate the instructional strategies and classroom structures they are currently using to support their focal students.

- In the post performance-based assessments, the treatment group referenced many of the instructional strategies included in the MFA case-based materials.

- In some of the post performance-based assessments, treatment teachers included instructional strategies for supporting "higher end" students.

- In the post performance-based assessments, the treatment group teachers changed their description to focus on their focal student's strengths.

Classroom Observations

The classroom observations and post-interviews provide evidence beyond participants' self report data (i.e., workshop feedback forms and questionnaires) of the degree of change in participants' knowledge, skill and classroom practice. The classroom observations and post-interviews demonstrate that workshop participants are observing individual students, modifying math lessons to accommodate the needs of the students, and incorporating a range of instructional strategies into their classroom practice.

Faculty Interviews

Three faculty members from Bank Street College (BSC) were interviewed at the end of the MFA project development process. They were each asked 14 questions in individual, hour-long interviews. The findings reflect their perspectives on a variety of topics including: expectations for the MFA project; the impact of the MFA project on BSC graduate students; the impact of the MFA project on their professional practice as teacher educators; their current vision of teaching in inclusive K-8 settings and the preparation necessary to support students with a range of abilities and disabilities; their current and planned use of the case studies in graduate courses; the unique features of the MFA case study approach; their reflections on participating in the project development process.

The broad goal, the creation of video cases, was the same for each of the faculty. However, individual responses to what each hoped to accomplish was shaped by their respective use of the materials over the four-year development process. Faculty described how the project, and the video cases, present a rich set of opportunities for teaching and learning. For example:

> We accomplished what we started out to do. We wanted to develop a set of [video] studies that provided a pathway for studying and asking questions around [teaching] practice and how children learn. Much of the video [referring to cases that were shot] are rich enough that they allow for conversation around teaching and learning at a variety of levels. They allow [viewers] to look at the math, to look at children, to look at teaching practice and to ask a lot of questions. The [teaching] practice [in the video cases] provided enough content to start a good conversation around practice. (Faculty Interview, 2007)

Faculty members expressed a number of ways that their expectations changed over the course of the project including: a facility with the Mel Levine neuro-developmental framework, a preference for using the case study materials with in-service versus pre-service teachers; the ability of BSC students to gather "evidence" from the video cases as they considered issues relevant to math teaching and learning. One faculty member had originally hoped that the complete body of video cases would include a diverse range of teachers.

F. Conclusions

The findings from both the quantitative and qualitative data indicate that the program was effective in enhancing the preparation of teachers who work with students with disabilities. The following bullets capture key conclusions:

- A factor analysis of the pre-post questionnaire data indicated that the MFA professional development approach was effective in enhancing the preparation and comfort of teachers working with students with a range of abilities and disabilities.

- Workshop participants reported in post-questionnaire data that one significant aspect of the workshop series was learning how to adapt and modify lessons based on individual students' strengths and needs thus enabling them to be responsive to student needs.

- Participants reported in post-questionnaire data that the workshop series contributed to their professional knowledge, enhancing their understanding of individual students' needs.

- Participants reported that the workshops contributed to their professional skills in the following areas: (1) observing individual students; analyzing the demands of mathematical tasks; and (3) collaborating with colleagues in planning math lessons.

- Changes in pre-post performance based descriptions of focal students provided further evidence of the impact of the MFA workshops. Changes in post performance-based descriptions included the following: (1) use of the neuro-developmental framework to observe and characterize the focal student; (2) inclusion of the focal student's strengths and needs; (3) use of a broader range of

instructional strategies and classroom structures and (4) alignment of instructional strategies and classroom structures with the strengths and needs of their focal students.

- The classroom observations and post-observation interviews demonstrate the workshop participants are observing individual students, modifying math lessons to accommodate the needs of the students, and incorporating a range of instructional strategies into their classroom practice.

The MFA project also had a broader impact, as Bank Street Math and Special Education faculty who participated in the development of the MFA video cases and implemented the case study materials into their graduate courses. Faculty members described how the development and implementation of the materials deepened their own thinking around issues of inclusion and the teaching of math in K-8 inclusion classrooms. They reported that the materials had an impact upon graduate students who were able to view and use the video cases as "evidence" as they engaged in conversations around teaching and learning.

G. Significance of the findings

Regardless of their experience level, for most teachers, the prospect of teaching mathematics in inclusion classrooms is daunting. Earlier focus group research associated with this project found that teachers do not feel prepared to assess the strengths and weaknesses of a range of students, and they do not feel fluent enough with the math content itself at different grade levels to modify specific activities to accommodate a range of learners.

While prior research has identified the key competencies that teachers need in order to work successfully in inclusion classrooms, there is limited professional development available for teachers. *Math for All* is a unique multimedia case-based project, developed to help teachers assess the needs of inclusion students and design successful instructional strategies in elementary mathematics. The research presented above shows that teachers are receptive to this approach and that the project succeeds in creating new understandings of inclusion students and strategies.

If policymakers and the public are genuinely committed to inclusion classrooms, they must also commit themselves to providing better preparation and support for these teachers. The emerging research from this NSF project provides data demonstrating the effectiveness of using case-based materials to prepare elementary teachers to help all students achieve a high quality education in mathematics.

References

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32-42.

Giangreco, M. F., Cloninger, C., & Iverson, V. S. (1998). *Choosing outcomes and accomodations for children: A guide for educational planning for students with disabilities (2nd ed.)*. Baltimore: Paul H. Brooks.

Hall, G., & Hord, S. (2001). *Implementing change: Patterns, principles, and potholes*. Boston: Allyn and Bacon.

Karp, K. (2000). *Weaving lessons: Strategies for teaching mathematics and science in inclusive settings.* In S. E. Wade (Ed.), Inclusive education. Mahwah, NJ: Lawrence Erlbaum Associates.

Kinzer, C., & Risko, V. (1998). *Multimedia and enhanced learning: Transforming preservice education*. In D. Reinking, M. C. McKenna, L. D. Labbo & R. D. Kieffer (Eds.), Handbook of literacy and technology. Mahwah, NJ: Erlbaum.

Levine, M. (2002). *A mind at a time*. New York City: Simon & Schuster.

Lewis, C. C. (2000). *Lesson study: The core of Japanese professional development.* Paper presented at the American Educational Research Association, New Orleans, LA.

Mastropieri, M. A., & Scruggs, T. E. (1992). Science for students with disabilities. *Review of Educational Research*, *62*, 377-411.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook (2nd ed.)*. Thousand Oaks: Sage.

National Center for Educational Statistics. (1999). *Teacher quality: A report on the preparation and qualifications of public school teachers*. Washington, D.C.: U.S. Department of Education.

National Center for Education Statistics. (2001). *Teacher preparation and professional development: 2000* (No. NCES 2001-088). Washington, D.C.: U.S. Department of Education, Office of Educational Research and Improvement.

Putnam, R., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning. *Educational Researcher*, *29*(1), 4-15.

Wade, S. E., & Zone, J. (2000). Creating inclusive classrooms: an overview. In S. E. Wade (Ed.), *Inclusive education*. Mahwah, NJ: Lawrence Erlbaum Associates.

Wilson, B. (1995). *Situated instructional design: Blurring the distinctions between theory and practice, design and implementation, curriculum and instruction*.

Yoon, K. S., Duncan, T., Lee, S. W., Scarloss, B., & Shapley, K. (2007). *Reviewing the evidence on how teacher professional development affects student achievement* (No. 33): Institute of Education Science: National Center for Education Evaluation and Regional Assistance.