Advisory Board Progress Report

ME.ET: The Mathematical Education of Elementary Teachers Project

January 4, 2009

The ME.ET project started in May 2005 with two strands of work: textbook analysis and identification of sites for survey research and fieldwork. We are now in the fourth full year of project work and completed our last data collection in December 2008. This report will provide an overview of what we have done in these three years and where we plan to go from here. The report is organized in the following sections:

Textbook Analysis
Selection of Sites
Instrument Development
Fieldwork
Data collection
Data Analysis
Graduate Student Development
Publications and Presentations
Plan for the January 4, 2009, Meeting

Textbook Analysis

There are currently 14 textbooks published for undergraduate mathematics classes for elementary teachers. In 2003, when we first started looking at these books, there were 21 such textbooks. Since then, two completely new textbooks have been published while nine have gone out of print. In some cases, the out-of-print books dated back to the seventies with multiple editions, still reflecting the influence of the "new math".

We are currently completing two new and more systematic analyses, based on comments from reviewers of a paper about our earlier work (McCrory, Siedel & Stylianides, in revision). In these analyses, we developed a map of the domain of fractions based on research, and used it to create a coding scheme to code the fractions sections of each textbook. The textbook team has completed initial coding and worked on interrater reliability and we are now in the process of final coding.

In the initial analyses, one characteristic of textbooks that stood out was something that I called mode of presentation. Some textbooks present the content in discrete bits, linearly, and without explicit connections across sections. Others present the content as a narrative about mathematics, telling more of a connected story. A third type of book is problem-based with neither a discrete collection or topics nor an interwoven story line. This description is qualitative, but the differences are apparent. In the new round of analyses, I hoped to find a quantitative basis for this qualitative difference, and in the fractions sections, it appears that there is one. We coded the type of representation used in each block of text, where a "block" is an author-defined segment of text (e.g., text between headings or within a delineated box), and type of representation corresponds to the six major conceptualizations of fractions (part/whole; measure; ratio; quotient; operator; or number). In preliminary analysis of the numbers, narrative books have a higher density of representation (#/page) than books in the other modes of presentation.

The second analysis is of problems in the fraction sections of the books. Using research on problem types, one of the graduate students is doing a detailed analysis of every fraction problem, including worked-out examples and exercises. She has developed a coding dictionary explaining all the categories with examples from the text, and we completed a reliability study at the end of August. We expect that her work will give us additional evidence of, and ways of talking about, how these books are similar and different across the body of work.

Selection of Sites

We considered many states as sites for this research, aiming to find states that varied with respect to teacher quality policies and NAEP results in mathematics for K-12 students. Access was also an issue. We chose Michigan, South Carolina, and New York City as our sites, and recently added a single institution in Georgia as explained below.

Michigan represents a middle level of NAEP achievement, very close to the national average for many years for 4th grade mathematics. It is a state with low scores on teacher quality improvement (as measured by Ed Week's *Quality Counts (Education Week, 2005)*). South Carolina has historically been quite low on NAEP achievement, but in recent years has shown great improvement both in average scores and in closing the achievement gap. SC scores high on the teacher quality improvement measures. New York City was chosen because of other research (the Pathways Project) that offered the possibility of synergy. That project studied teacher education and induction in NYC, and it seemed possible that my project could add detail about mathematics education. Problems with access, however, resulted in very limited data from NYC in this project.

Access was a problem in all three chosen sites. In spite of obtaining IRB approval from Michigan State University, many institutions – including all the City University of New York (CUNY) branches – expected separate IRB approval with varying requirements (such as having a local faculty member involved in the research). One university in SC even charged a large fee ($1500) to apply. In the end, the CUNY requirements were so burdensome that we abandoned the effort to collect student data except at one institution – City College – where we got our first CUNY approval.

Within the three sites, we identified 62 institutions that certify elementary teachers in an undergraduate program. Of these, we were able to interview 57 mathematics department chairs or their representatives. We further identified 30 institutions from which we planned to collect additional data. These 30 institutions were chosen to reflect a mix of large and small, public and private, and to include a majority of the students certified in the state annually. The department interviews led us to 136 instructors who were expected to teach a mathematics class for elementary teachers in the fall 2006 or spring 2007 semester. We contacted all 136 instructors at the institutions selected at which we had IRB permission to proceed. Appendix B Table 2 summarizes response rates for the instructor survey.

We also identified 7 instructors whom we asked to observe during their teaching of fractions. These instructors were selected based on our knowledge of how they were teaching and what their qualifications were. In this sample, we have 2 graduate instructors teaching mathematics courses in a mathematics department, 3 mathematics professors teaching courses that are listed as mathematics, and 2 mathematics professors teaching integrated math/methods courses. These sites are distributed across 5 institutions.

In 2008, we added one site in another state because of the nature of the course being offered: it is a single section of 100 students in the first of a sequence of three mathematics courses required for certification. This is by far the largest section in our sample and we were quite interested in both the results on the mathematics test, and in the instructor's teaching methods. At this site, we have collected student pre/post-test data, instructor survey data, and video and observation data.

Instrument Development

Instrumentation for the project includes:

- Textbook analysis codes
  - Problem coding
  - Narrative coding
  - Fractions

- Multiplication
- Reasoning and proof

Department interview protocol
- Course content information
- Instructor information

Instructor survey
- Attitudes and beliefs measures
- Opportunity to learn measures
- Textbook use measures
- Demographics
- Course implementation and methods

Student pre- and post-tests
- Mathematics
- Attitudes and beliefs measures
- Demographics
- Prior knowledge

Fieldwork observation protocol

All instruments are available on our Web site. Below, I briefly discuss the instructor and student instruments.

Instructor Survey

Whenever possible, we used items from existing surveys or changed them as little as possible to adapt them for our needs. There were many categories of interest, however, that were different from anything we could find that had been done previously. This included details about how the course was designed and taught, how the textbook was used, and how instructors collaborated with others.

For attitudes and beliefs on both student and instructor instruments, we used items from Schoenfeld (Schoenfeld, 1989) and from TEDS (Teacher Education Development Study, Schmidt, et al., 2008) at MSU. For opportunity to learn, we developed items similar to those used by TIMSS and TEDS. An annotated copy of the instructor survey showing the origin of each item is available at our Web site.

Student Pre- and Post-Tests

We used items from University of Michigan's Learning Mathematics for Teaching (LMT) project (Hill, Schilling, & Ball, 2004) for the student mathematics assessment, choosing items that focused on number and operations. We piloted items during 2005-6, and developed our final forms for Fall 2006. We measured prior knowledge (in addition to giving a pretest at the start of the class) with questions about their SAT or ACT score and about their high school and college mathematics classes.

After analyzing pilot data, we finalized pre- and post-test forms using a crossed design so that every student took every item either pre or post, but took no item twice. The pretest forms (E & F) included 6 common items for equating purposes, and also included demographics and attitudes and beliefs questions; the posttests (G & H) were identical to E & F respectively, but without the common items, demographics, or attitudes and beliefs. Students took E + H or F + G.

We also analyzed attitudes and beliefs items after the pilot, and reduced the number of items on the final forms. The analyses (correlations and exploratory factor analysis) suggested that the items overall are not very good measures of students' attitudes toward mathematics or mathematics teaching and learning, but we included the best set we could identify.

Data collection

We started data collection in fall 2005 with pilot instruments administered at MSU. During summer 2006, we contacted all department chairs and completed those interviews. In most cases, they provided us with names of the instructors who would be teaching the classes, and we contacted instructors in late summer 2006 for participation in student pre- and post-tests.

Appendix B is a summary of all data collected through December 2008, when final data were collected. In most cases, the instructor administered the tests using a script. We know, however, that administration was not uniform. For example, in some cases, the instructor essentially required students to take the test even if they were not willing to participate in the study, while in other classes, the instructor allowed students to do something else (or even leave the class) if they chose not to participate. We also learned that the time allocation (25 minutes for the pretest, 20 minutes for the post-test) was not strictly observed in some sections. Unfortunately, we have found no way to account for these differences in data analysis.

In late fall 2006, we mailed instructor surveys to all 136 instructors identified by the department, including both those who participated in the student data collection and others who did not collect student data but who taught one of these classes in the fall 2006 semester. From these, 56 forms were returned, after follow-up as outlined in our IRB application. Over the next 2 years, we sent forms to 10 additional instructors, followed up with original instructors and eventually received 78 completed forms.

Data collection (student pre-post tests) continued at a reduced scale in spring 2007, fall 2007, spring 2008, and fall 2008 semesters. In some cases, we were collecting data from instructors who initially agreed to participate, but could not do so during the initial semester. In other cases, instructors agreed to collect data from additional sections of their class. And in one case, we added a new instructor as explained above.

Data Analysis

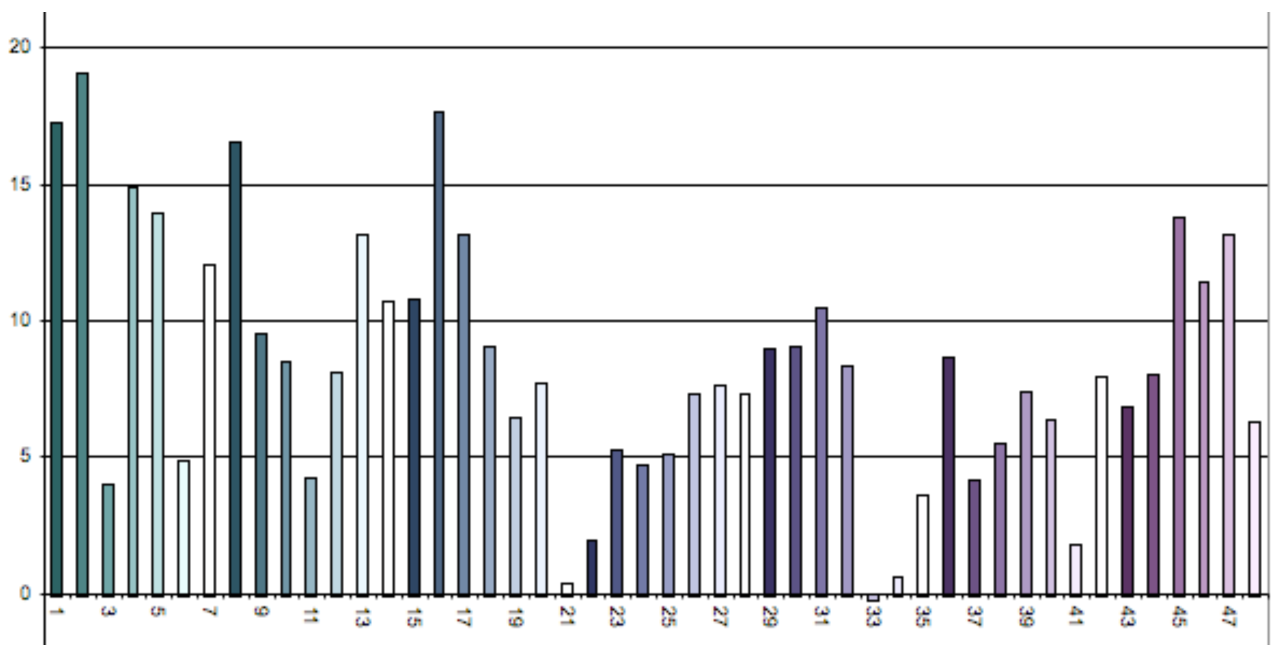
Analysis has been underway since the pilot data were collected. In that phase of the work, we analyzed attitudes and beliefs data, calculated IRT parameters and compared them to

LMT data, and selected items for the final instruments. We have also run descriptive statistics on the department interview and instructor survey data.

At this point, we are doing two kinds of analyses: developing multilevel models using data from student and instructor surveys; and working with the qualitative data (video tapes and field notes) to write case studies and develop analytic frames for further analysis.

Explaining differences in student achievement

We see significant differences in student achievement across instructors, in terms of both absolute achievement (posttest score) and gain score. Table 1 shows the gain scores across sections for all instructors who administered the pre/posttest. Some instructors had multiple sections, for a total of 48 sections of 41 instructors.



We started our analysis with a number of theories about what might explain differences in achievement, including some fairly obvious hypotheses. At the student level, explanatory factors included:

Pretest Score
SAT/ACT
Attitude toward math
Socio-economic Status
College mathematics classes
Year in college

At the instructor level, our hypotheses included factors related to:

Instructional methods
Attitude toward teaching the course
Goals
Knowledge of math ed policy and standards documents
Experience
Rank
Control
Time on task

Also at the instructor level, but related to the context rather than to particular characteristics of the instructor, we identified these factors:

Instructional materials
What textbook is used (if any)
How textbook is used (how much, for what purposes)
Class size
School quality
Average SAT/ACT overall
Average SAT/ACT reported by the class

Tables 4, 5, & 6 in Appendix C show descriptive statistics for students and instructors across some of these variables. We are using a growth model at level 1 after many discussions within our group and with Steve Raudenbush and Tony Bryk (3 of us attended the HLM seminar with them in Chicago). It is unconventional to use a growth model with only two time points, but it is a legitimate method and gives the best representation of our data.

One of the surprising aspects of our analysis has been how many decisions we must make about analysis tools and methods, and how consequential those decisions are. For example, we have looked at what IRT parameters to use – our own v. LMT's; what type of estimation procedure to use – maximum likelihood (ML), expected a posteriori (EAP), or maximum a posteriori (MAP); how to treat measurement error; and whether to use gain or posttest score as our outcome variable. In the models reported here, we use LMT parameters, EAP estimation, with measurement error in a growth model.

The unconditional model allocates variance across the levels. This model is:

Level 1- Growth:
Y = P0 + P1*(TIME) + E (TIME is 0 or 1)
Level 2 - Student:
P0 = B00 + R0
P1 = B10 + R1
Level 3 - Instructor:
B00 = G000 + U00
B10 = G100 + U10 (E, R, and U are random error)

From this model we get the following data:

Mean Pretest score: 50.77 (This is an IRT score, with the mean set to 50, SD 10)
Average gain: 7.36
Student level variance: 4.04
Instructor level variance: 5.75

Doing these calculations with error means that measurement error is accounted for, and thus the variance at the student level is smaller.[1] To give you a sense of the difference, if we do the same model without error, we get variance of 79 at the student level, 7 at the instructor level. (Keep in mind that variance is a pure number with no units.) The iterative estimation that occurs in the program systematically reduces the variance when measurement error is assumed – the part of the variance that is measurement error is removed and what is left is the "true" student variance.

[1] The variance at student level is smaller because part of the variance is from measurement error and it is singled out. The variance at instructor level should be the same according to simulation studies if measurement error is known and constant. The differences here at instructor level is an interesting question. The possible reasons are:

1. The measurement error is not constant.
2. The measurement error is estimated in IRT model and it is not really known.

The best model so far – the one that explains the most variance and includes significant predictors – is the following:

Model 2:
Level 1: Growth model
Level 2: CACT
Level 3: Primary Textbook, Methods

Level 1 Model
Y = P0 + P1*(TIME) + E (Time is 0 or 1 for pre or post respectively)
Level-2 Model
P0 = B00 + R0
P1 = B10 + B11*(CACT) + R1
Level-3 Model
B00 = G000 + U00
B10 = G100 + G101(TEXT_PRI) + G102(METHODS) + U10
B11 = G110

In this model, CACT is the ACT or SAT score reported by the student, put on a common scale. TEXT_PRI is 0 if the instructor does not use one of the 14 textbooks for such a class, or 1 if he/she does use one of the textbooks. METHODS is a measure we developed from the instructor survey that reflects student engagement with the mathematics. Appendix D explains the measure in more detail. Results of Model 2 are:

Mean Pretest: 51.83
Average Gain, no primary textbook, average methods: 4.36
Average Gain, Add primary textbook 4.40
Average Gain, Change in methods by one point: 2.60

So, an instructor who uses one of the books and is one point above average in methods would have a predicted posttest score of:

51.83 + 4.36 + 4.40 + 2.60 = 62.19

The output from the HLM program is shown in Appendix D.

With the final student and instructor data in hand as of December 10, we will update the data set and continue analysis over the next few months.

Another part of the data we have started to work on is what we are calling opportunity to learn analysis. We have data by topic for students, and we have data from instructors about how much time they spend on specific topics and what their goals were for that instruction. We are developing measures to put these two together in a model. This is in preliminary stages and we don't have results yet.

Case studies of mathematics classes for elementary teachers

For the last few months, we have devoted a lot of time to analyzing case study data. We are in the process of writing papers focused on these cases for submission to the Psychology of Mathematics Education North America conference next fall. We have a paper accepted at ICMI-19 next summer about the use of proof in one of our case study classrooms. Work in progress includes:

A paper analyzing and comparing multiplication of fractions across two teachers with different approaches

A case study of a single teacher who uses methods based on Cognitively Guided Instruction

A paper describing how semiotics can be used in these classes

We have a very large corpus of data, including digitized video (in a software program called Transana that makes analysis easier) and field notes. Each graduate student has taken responsibility for one instructor and is becoming expert about that instructor's teaching. In our meetings, we focus on an issue or concept and work to analyze how one or more of the instructors approaches that idea. We have stayed in the domain of fractions with particular interest in definition; multiplication; and reasoning and proof.

Graduate Student Development

Over the course of the project, many graduate students have contributed to the work. Information about students who have worked on the project is included in Appendix E. We meet as a whole group once a week for 2+ hours, at which time we work on data analysis, plan writing projects, and discuss other aspects of the project. In recent meetings we have jointly viewed video from our case studies and discussed aspects of the mathematics and teaching.

A separate data analysis group meets about once a week to work on multilevel modeling and other issues associated with the quantitative work. Data management has been a big effort, keeping our codes and coordination straight, and staying in line with IRB requirements (e.g., deleting names in a timely manner, etc.).

In addition to the graduate students, we have been fortunate to have Dr. Jane-Jane Lo, Associate Professor of Mathematics at Western Michigan University, working on the project since Fall 2007. She meets with us every week and has been instrumental in implementing the fieldwork part of the study and writing about it. Dr. Lo added a sub-study on Taiwanese preservice elementary teachers about which we have a paper submitted.

Publications and Presentations

We have made many presentations about this work, and now have a few publications in print or in process. I have listed these in Appendix A below.

Plan for the January 4, 2009, Meeting

Our meeting is at 2:30 pm, Sunday January 4, at 565 Pennsylvania Avenue, Washington DC. This is an apartment building behind the Newseum. We will meet on the 2nd floor in the common room. The doorman will tell you how to get there. We are scheduled for a very short meeting, but I would love to spend more time with any of you who are available. I will make reservations for dinner at a nearby restaurant if anyone is available.

The main goal of the meeting is to get your input on data analysis and on setting priorities for writing and publication. I will give a brief presentation going into some detail about our HLM models and at least one of our cases. Then I hope to hear from you and get your feedback and advice. In particular, I would like to discuss the various decisions we face about analytic methods. I would also like your input about hypotheses to explain the variation across instructors.

It would also be useful to hear your thinking about how best to use the case studies. What would you like to know about how these classes are taught, the variation in approaches across instructors, or common (or unique) difficulties these instructors face.

As you can probably tell from this report, the project has many facets, lots of data, and many possibilities for how to proceed over the next 18 months with analysis and writing.

Appendix A: Presentations and Publications

Presentations

Lo, J.J., & McCrory, R. (2009). *Proof and proving in a mathematics course for prospective elementary teachers.* To be presented at ICMI-19, Taipei, Taiwan, July 2009.

McCrory, R. (2008, December). What matters? Models for achievement in mathematics courses for elementary teachers. Presentation to the University of Georgia Mathematics Education Colloquium.

McCrory, R., Francis, A., & Young, S. (2008, July). *Resource use by instructors of mathematics classes for future elementary teachers* Paper presented at the International Committee on Mathematics Instruction (ICMI-11), Monterrey, Mexico.

Lo, J.-J., Kim, R. Y., & McCrory, R. (2008, July). *Teaching Assistants' uses of written curriculum in enacting mathematics lessons for prospective elementary teachers.* Paper presented at the Joint meeting of the International Group and the North American Chapter of Psychology of Mathematics Education Morelia, Mexico.

McCrory, R. (March 2008). *Current research on mathematics classes for future elementary teachers.* Workshop on Elementary Teacher Preparation in Mathematics. Institute for Mathematics and Education, Dr. William McCallum, Director, University of Arizona, Tucson, February 28-March 1, 2008.

McCrory, R. (May 2007). *Mathematics classes for prospective elementary teachers*, Plenary address at the Workshop, Critical Issues in Teacher Education: Teaching Teachers Mathematics,

Mathematical Sciences Research Institute, Berkeley, CA, May 30 – June 1, 2007. Video available at http://www.msri.org/communications/vmath/VMathVideos/VideoInfo/3215/show_video

McCrory, R. (June, 2006). *Studying the mathematical preparation of teachers in undergraduate programs.* Presentation to the National Academies of Education Committee on the Study of Teacher Preparation Programs in the United States, http://www7.nationalacademies.org/teacherprep/index.html, Washington, D.C.

McCrory, R., (February 2008). Symposium: *Mathematics for elementary school teaching: What is it and how do teachers learn it?* Organizer: Raven McCrory. Discussant: Dr. Deborah Ball, University of Michigan. Papers presented by: Raven McCrory, Michigan State University; Joel Zeitlin, Jerry Gold, Hillary Hertzog, and Nancy O'Rode, California State University, Northridge; DeAnn Huinker and Kevin McLeod, University of Wisconsin, Milwaukee. Annual meeting of the American Association of Colleges of Teacher Education, AACTE. New Orleans, LA.

McCrory, R. (January 2008) *The Mathematical education of elementary teachers.* Paper presented at the annual joint meeting of the American Mathematical Society and the Mathematical Association of America, San Diego, CA.

McCrory, R. (January 2008). *Undergraduate mathematics classes for elementary teachers: An overview of research projects.* Symposium organized by Raven McCrory. Papers presented by: Beth Costner and Frank Pullano, Winthrop University; Lou Ann Lovin, James Madison University; Meg Moss, Pellissippi State Technical Community College; Stephanie Smith, Georgia State University; Raven McCrory, Michigan State University. Discussants: Heather Hill, Harvard University, & Sybilla Beckmann, University of Georgia. Annual meeting of the Association of Mathematics Teacher Educators (AMTE), Tulsa, OK.

McCrory, R. (April 2007). *Symposium: A study of undergraduate mathematics classes for prospective elementary teachers: Methods and results.* Discussant: Jennifer Lewis, University of Michigan. Papers from the ME.ET project presented at AERA2007, Chicago, IL.

McCrory, R. (March 2007). *Knowledge for teaching: What are we measuring?* Presented at the National Council of Teachers of Mathematics annual conference, Atlanta, GA. March 22, 2007. Session organized by William S. Bush, University of Louisville. Discussant: Heather Hill, Harvard University.

McCrory, R., & Cannata, M. (January, 2007). *The mathematical education of elementary teachers: The content and context of undergraduate mathematics classes for teachers.* Paper presented at the annual conference of the Association of Mathematics Teacher Educators (AMTE), Irvine, Ca.

McCrory, R. (October, 2005). *Undergraduate mathematics courses for prospective elementary teachers: What's in the books?* Paper presented at the annual meeting of the Psychology of Mathematics Education, North America (PME-NA), Roanoke, VA.

McCrory, R. (May, 2005). *Fractions in undergraduate mathematics textbooks for teachers.* Session conducted at the Mathematical Knowledge for Teaching K-8 workshop for the Mathematical Science Research Institute (MSRI), Asilomar, CA.

Wallace, R., Stylianides, A., & Siedel, H. (November, 2004). *Mathematics textbooks for teachers.* Presentation to MSU Mathematics Education Colloquium, East Lansing, MI.

Publications

Lo, J.J., Francis, A. P, & McCrory, R. (Submitted 2008) Taiwanese and U.S. Prospective Elementary Teachers' Mathematical Knowledge for Teaching: An Exploratory Study, *Learning and Individual Differences*

Lo, J. J., & McCrory, R. (Submitted 2008) Teaching Assistant's Uses of Textbook in Enacting Mathematics Lessons for Prospective Elementary Teachers. *Mathematical Thinking and Learning.*

McCrory, R., Siedel, H., & Stylianides, A. (in revision). Mathematics textbooks for elementary teachers: What's in the books? (Submitted the *to Journal for Research in Mathematics Education*, 2007)

McCrory, R. (2006). Mathematicians and mathematics textbooks for prospective elementary teachers. *Notices of the AMS*, *53*(1), 20-29.

Appendix B: Data Collection Tables

Table 1: Pre and Post-test Forms Administered, Fall 05 – Fall 08

Form		Instructors	Sections	Number of forms	Matched pre/post
	PILOT TESTS				
A	Taiwan Posttest (2008)			105	
A	MTH201 FS05 Pretest	6	8	95	60
B	MTH202 SS06* Posttest for A,	5	7	198	
C	MTH201 SS06 Pretest group 1	4	5	71	60
D	MTH201 SS06 Posttest Group 1			61	
D	MTH201 SS06 Pretest Group 2	3	3	55	30
C	MTH201 SS06 Posttest Group 2			32	
	FINAL FORMS				
E	Fall06 Pretest	8	12	280	218
MSU Form E	Pretest, FS 2006, MSU Math201	5	8	119	88
G	Fall06 Posttest			430	
F	Fall06 Pretest	12	18	421	314
H	Fall06 Posttest			333	
F	Spring07 Pretest	3	3	144	71
H	Spring 07 Posttest			80	
E	Fall 07 Pretest	2	3	81	32
G	Fall 07 Post test			34	
F	Fall 07 Pretest	7	8	257	159

Form		Instructors	Sections	Number of forms	Matched pre/post
H	Fall 07 Post test			169	
E	Spring 08 Pretest	1	2	37	24
G	Spring 08 Post test			29	
F	Spring 08 Pretest	2	3	71	59
H	Spring 08 Post test			66	
E	Summer 08 Pretest	1	1	12	11
G	Summer 08 Post test			11	
E	Fall 08 Pretest (not yet in dataset)	1	1	103	90
G	Fall 08 Posttest (not yet in dataset)			90	
	Column totals	60	82	3384	1216
	Forms EFGH only	42	59	2767	1066
	Individuals, all forms/EFGH only			2136 / 1701	
	EFGH in dataset	41	48		976

20 Math items on E and H (without common items)

20 Math items on F and G (without common items)

6 common items on E and F

46 unique mathematics items on the final four forms – from Fall 06 to Fall 08

Table 2: Instructor Surveys Distributed and Returned, Fall 05 – Fall 08

	Surveys Distributed		Surveys Returned	
	Fall 2006	Total	Fall 2006	Total
All Instructors	136	146	56	78
Instructors with Student Data		42		39

Table 3: Observations Completed, Fall 2007-Fall 2008 (Pseudonyms only)

Name	Session Length	Video Sessions (hours)	Video of Fraction Sessions (hours)	Observation Sessions (hours)
Dee	1	17 (17 hr)	7 (7 hr)	1 (1 hr)
Edie	3.5	20 (70 hr)	10 (35 hr)	18 (63 hr)
Eliot	1	10 (10 hr)	10 (10 hr)	1 (1 hr)
Jamie	1.5	4 (6 hr)	4 (6 hr)	4 (6 hr)
Pat, Section 1	2	6 (12 hr)	6 (12 hr)	6 (12 hr)
Pat, Section 2	2	6 (12 hr)	6 (12 hr)	6 (12 hr)
Sam	1.5	4 (6 hr)	4 (6 hr)	4 (6 hr)
Stevie	1	40 (40 hr)	10 (10 hr)	40 (40 hr)
Totals		107 (173 hr)	57 (98 hr)	80 (141 hr)

Appendix C: Descriptive Statistics

Table 4: Student characteristics

Variables	Coding and Range	Mean	SD
Pretest Score	17 – 82	50.68	10.20
Prior Knowledge (CACT)	12 – 36	23.19	4.41
I like Math	0 = Strongly disagree, disagree, undecided 1= Strongly agree or agree	0.39	0.49
College Level	1 = Freshman 2 = Sophomore 3 = Junior 4 = Senior or higher	2.22	0.90
College Math Coursework	0 = none 1 = 1 2 = 2 3 = 3 4 = 4 or more	2.47	1.12
SES (Mother Education)	0 = Mother has no higher education 1 = Mother has higher education	0.46	0.50

Table 5: Correlations of student characteristics

	1	2	3	4	5	6	7	Variable Explanation
1	1.00	*0.48	*0.48	*0.08	-0.01	-0.01	*0.13	Pretest Score
2		1.00	*0.38	*0.11	-0.03	-0.01	*0.09	Post test Score
3			1.00	*0.28	-0.04	-0.01	*0.12	Prior Knowledge (C_ACT)
4				1.00	0.01	*0.14	-0.01	Attitude toward Math
5					1.00	*0.51	*-0.08	College Level
6						1.00	*-0.08	College Math Coursework
7							1.00	SES (Mother Education)

*Correlation significant at the .05 level

Table 6: Characteristics of Instructors

Variables	Coding and Range	Mean	SD
Primary Textbook from choice of 13	1 = a primary textbook on our list 0 = not a textbook on our list	0.65	
Primary Textbook from choice of 3	1 = Beckmann, Billstein,or Parker 0 = Not Beckmann, Billstein, or Parker	0.38	
Class Size	4 – 53	26.68	9.61
CACT	12 – 36	23.03	3.63
Years College Teaching Experience	0 – 41	15.73	10.79
Interest in teaching this course	0=no interest at all 1=limited interest 2=some interest 3=a great deal of interest	2.71	0.63
Interest in teaching this course again	0=no interest at all 1=limited interest 2=some interest 3=a great deal of interest	2.75	0.59
Control Score	9 – 28	23.03	5.24
Teaching Methods (Average of 11 items. See Appendix D)	1.45 – 4.00	2.73	0.56

Appendix D: Measuring Instructional Methods

Instructors were asked "In your mathematics course, how often do your students engage in each of the following activities? Please check the box that best describes what happens in your course."

1. Never or almost never
2. Some lessons
3. Most lessons
4. Every lesson

The items shown in green were reverse coded to create a scale that essentially measures explicit student engagement with mathematical ideas as opposed to listening or watching. The range of scores was 1.45 – 4.0, and the mean was 2.7. A higher score suggests greater student involvement in doing mathematics; a lower score suggests more teacher-focused activity. The items are:

- Explain the reasoning behind an idea
- Work on problems for which there is no immediate method of solution
- Listen to you explain terms, definitions, or mathematical ideas (Reversed)
- Listen to you explain computational procedures or methods (Reversed)
- Analyze similarities and differences among several representations, solutions, or methods
- Work on mathematical communication and/or representation
- Make conjectures and explore possible methods to solve a mathematical problem
- Discuss different ways that they solve particular problems
- Write about how to solve a problem in assignments or tests
- Do problems that have more than one correct solution

HLM output:

Model 2 output:

With Error

	Coefficient	Error	T-Ratio	d.f.	P-Value
For INTRCPT1, P0					
For INTRCPT2, B00					
INTRCPT3, G00o	51.828893	0.629218	82.370	35	0.000
For POST slope, P1					
For INTRCPT2, B10					
INTRCPT3, G100	4.363961	1.059750	4.118	33	0.000
TEXT_PRI, G101	4.396435	1.390139	3.163	33	0.004
METHODS, G102	2.597124	1.095401	2.371	33	0.024
For CACT, B11					
INTRCPT3, G110	0.432249	0.074400	5.810	861	0.000

Without Error

	Coefficient	Error	T-Ratio	d.f.	P-Value
For INTRCPT1, P0					
For INTRCPT2, B00					
INTRCPT3, G000	52.184838	0.670686	77.808	35	0.000
For POST slope, P1					
For INTRCPT2, B10					
INTRCPT3, G100	4.213662	1.039269	4.054	33	0.000
TEXT_PRI, G101	4.815165	1.349947	3.567	33	0.001
METHODS, G102	2.618987	1.071028	2.445	33	0.020
For CACT, B11					
INTRCPT3, G110	0.369446	0.066013	5.597	861	0.000

Appendix E: Project Students

PhD Students

Rachel Ayieko is a first year graduate student in Teacher Education with a focus in mathematics education. She is working on case studies.

Andrea Francis is a PhD candidate in Educational Psychology. Her research is on trust in the classroom. She has training and skills in statistics and cognitive psychology and has been working on all aspects of the project, including modeling using HLM techniques and analysis of case study data. She is working with one of our subjects on a paper on semiotics in mathematics classes for elementary teachers.

Beste Gucler is a PhD candidate in Mathematics Education. Her research is on the development of the concept of limit historically and cognitively. She has taught the mathematics class for teachers at MSU and is working on case studies.

Jungeun Park is a 2^{nd} year graduate student in Mathematics Education. She has taught the mathematics class for teachers at MSU and is working on case studies.

Changhui Zhang is a PhD candidate in Measurement and Quantitative Methods. His research interest is in measurement error and he will likely use data from the ME.ET project for his dissertation. He is involved in data analysis including factor analysis of the attitudes and beliefs data and HLM modeling.

Sarah Young is a 3^{rd} year graduate student in Educational Psychology. Her research interest is group learning, and she is developing a specialty in quantitative data analysis. She has primary responsibility for the instructor survey and also contributes to data analysis in all parts of the project.

Undergraduate Students

Celeste Gates is an undergraduate in the McNair Fellowship program for minority students. She is doing a special project following up with students from one of the mathematics classes for elementary teachers to explore what they learned.

Jessica Liu is a freshman at MSU in the Honors Program. She is working with the project on case study analysis.

Past PhD students

Ga Young Ahn is a 3^{rd} year PhD student in Educational Psychology. Although she no long officially works on the project, she is completing a study of the problems in the mathematics textbooks for these courses. She has developed a coding scheme and is now analyzing data.

Xue Han Han received her PhD from MSU in 2007 after working for a year on the project. She assisted with data collection. She is currently Assistant Professor at the University of New Mexico.

Rae Young Kim received her PhD from MSU in 2007 in Measurement and Quantitative Methods. She worked on the project for two years and data manager and analyst. She is now employed as a statistician at ETS in Princeton, NJ.

Young Yee Kim is a PhD candidate in Teacher Education. She worked on the project for two years, assisting with data collection and analyzing policy documents.

Helen Siedel is a PhD candidate in Educational Studies at the University of Michigan. She has worked on the project since its inception, on loan from the Center for Proficiency in Teaching Mathematics (CPTM). This year, she is writing her dissertation on multiplication of integers in textbooks for teachers. Her primary focus has been on textbook analysis.

Andreas Stylianides received his PhD from the University of Michigan in 2005. He worked on the project in 2004-5, on loan from CPTM. His focus was on reasoning and proof in the textbooks for teachers, and he participated in all textbook coding and analysis. He is currently a lecturer in the Faculty of Education at Cambridge University in England.

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