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Abstract: The Mathematics Teacher Transformation Institutes (MTTI) program attempts to develop math teacher leaders in part by providing content, inquiry and leadership courses aimed at making them more effective teachers. We assessed progress by observing teacher leaders' teaching practices, and encouraging them to introduce or extend student-centered pedagogy in their classrooms. We found there was little relationship between our measures of mathematics content knowledge and student-centered pedagogy. But teachers who employed student-centered pedagogy tended to have more highly-engaged math students in their classrooms.

Keywords: effective mathematics teaching; math content knowledge; student-centered teaching; student engagement.

Improving student achievement in mathematics and science has been a concern in the United States of America since the early 1980s when international tests began showing U. S. students falling behind most developed countries in mathematics and science skills. Many U. S. students do not obtain the knowledge and skills, particularly in science, technology, engineering, and mathematics (STEM), which are required for success in the global marketplace of the 21st century (National Academy of Sciences, 2006).

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Educators, educational researchers, and policy makers have not always agreed about the reasons for the failure of U. S. students to perform. Some argue many mathematics teachers have inadequate mathematical content knowledge themselves, and thus are unable to teach their students to the highest level (Ahuja, 2006; Ginsburg, Cooke, Leinwand, Noell & Pollock, 2005). Others (Darling-Hammond, 2007; National Council of Supervisors of Mathematics [NCSM], 2008; National Council of Teachers of Mathematics, 2000; Office of Science and Technology Policy, 2006; U.S. Department of Education, 2004; National Science Board, 2006), in part, relate such an educational failure not only to the lack of qualified teachers with solid content knowledge in STEM, but also to a profound lack of understanding of teaching and learning in grades K-12, which may lead to the use of ineffective teaching practices. For Brown and Borko (1992), and Ball and Bass (2000), understanding content knowledge and methods of inquiry in mathematics are at the core of effective teaching and learning. The use of inquiry-based approaches to instruction, in which students have opportunities to construct their own understanding of basic concepts, is thought by many educational theorists to be most appropriate in developing students' understanding of mathematics and science concepts. Such approaches call for teachers to be able to engage students in critical, in-depth, higher-order thinking through use of manipulatives, technology, cooperative learning and other pedagogical approaches that enable students to construct mathematics concepts on their own through reasoning, verifying, comparing, synthesizing, interpreting, investigating or solving problems, making connections, communicating ideas and constructing arguments (Grouws & Shultz, 1996; National Council of Teachers of Mathematics [NCTM], 2000). These approaches are characteristic of what is often called student-centered teaching as opposed to the so-called "traditional" approaches in which the predominant view is that mathematics teaching is a show-and-tell as well as a supervision of drills and practice (Davis, 1988). In this view, it is assumed that learning occurs passively when students absorb received knowledge from an all-knowing teacher or expert. This approach is often referred to as "teacher-centered." The Mathematics Association of America (MAA, 2008) argues that in order to prepare students for the increasingly complex mathematics of this century, a student-centered approach to teaching is more appropriate than the traditional teacher-centered approach. The MAA (2008) asserts the need to develop pedagogies that could be used effectively to facilitate students' mathematical abilities. In essence the MAA (2008) advocates for an increase in student-centered teaching and learning and a decrease in teacher-centered pedagogy. One assumption is that an increase in student-centered teaching will result in increased student engagement in mathematics and, by implication, this increased engagement will lead, in turn, to increased student achievement. For example, various researchers argue that students are more engaged and achieve more when teachers relate new learning to prior learning, model problems and provide them with a variety of opportunities to apply and use knowledge and skills in different learning situations (Kemp & Hall, 1992; Rosenshine, 2012; Taylor, Pearson, & Walpole, 1999).

Logic Model and Theory of Action for the Project

One of the aims of the Mathematics Teacher Transformation Institutes (MTTI) is to encourage participant teachers to develop both their mathematics content knowledge and a student-centered pedagogy, assuming that these developments will lead to increased student engagement in mathematics. This research aimed to see whether the goal was met, and the assumption was justified.

MTTI is a National Science Foundation (NSF)-funded program designed to support the development of teacher leaders to strengthen mathematics teaching and learning in New York City, especially in Bronx middle and high schools. MTTI developed a three-year three-dimensional program that focuses on deepening participating teachers' content knowledge, broadening their pedagogical repertoire through the process of inquiry, and developing their leadership capacities across a number of domains within the context of a professional community. The model engages teachers in a process of inquiry that does not cease in asking questions and understanding problems, continually revisiting critical issues relative to teaching and learning, designing plans to resolve the issues, implementing the plans, and collecting and analyzing data to assess the effectiveness of the designed plans. As teachers improve their pedagogical skills, they increase their ability to explain terms and concepts to students, interpret students' statements and solutions, engage students in critical, in-depth, higher order thinking (Copeland, 2003; Grouws & Shultz, 1996; Hill, Rowan, & Ball, 2005; National Council of Teachers of Mathematics [NCTM], 2000). Essentially, the aim is to develop teachers' student-centered pedagogy.

MTTI is funded to support two cohorts of 40 teachers with at least four years teaching experience over five years. The first cohort completed the program after three years in June 2011. This paper reports results from the first cohort. The research component of MTTI seeks to broaden the knowledge base on teaching and learning in mathematics through new understanding of: 1) how the study of conceptually-challenging mathematics—particularly in algebra and geometry—benefits teachers; 2) how classroom-based action research contributes to critical and analytical understanding of the relationships between teaching practices and student learning; and 3) how multi-levels of support prepare teachers with at least four years teaching experience for leadership roles.

MTTI's theory of action, depicted in Figure 1, hypothesizes in essence that teacher background and characteristics, school climate (especially as represented through teacher-teacher interactions) and MTTI experiences will impact participants' teacher-leader practices, one of which is effective teaching. The three main components making up MTTI experiences are math content courses, inquiry-based action research courses (pedagogy), and a leadership course.

MTTI aims to supplement math teachers' content knowledge and help teachers make and sustain fundamental shifts in practice. Our hope is that such changes will result in more effective teaching and teacher leadership. In turn, we hope that effective math teaching will lead to increased student engagement in math.

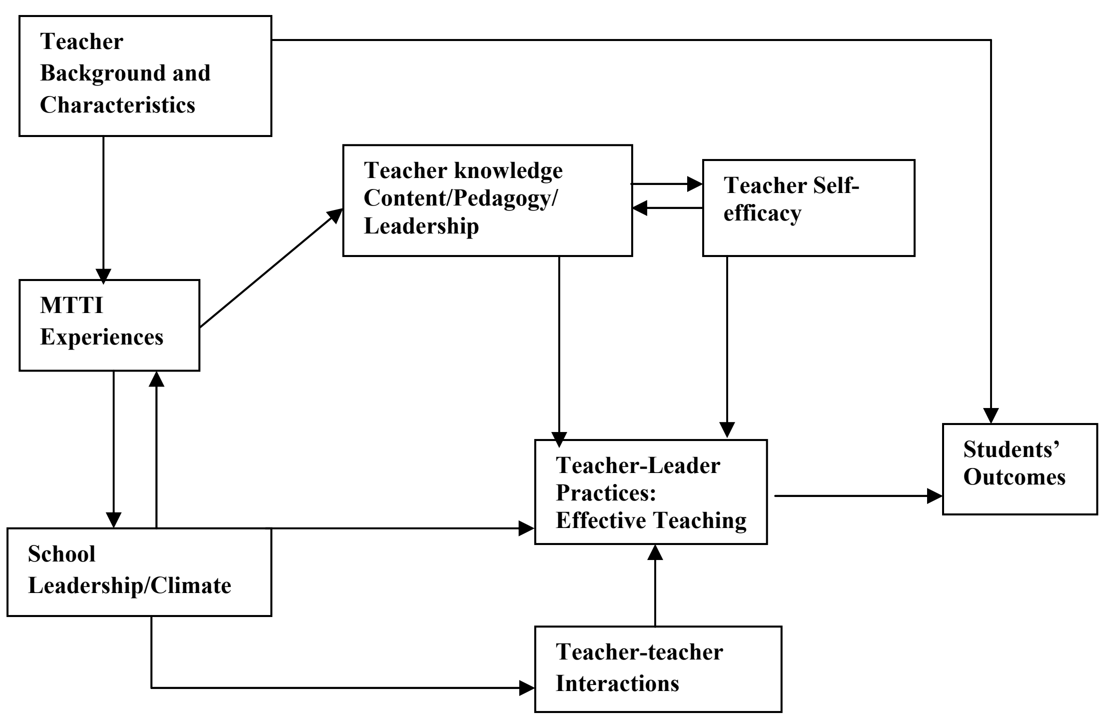

Figure 1. MTTI's theory of action.

MTTI Project Outline

Improving Teachers' Math Content Knowledge

Two courses aimed at improving MTTI participants' math content knowledge were run throughout the spring and fall semesters of 2009. One of the courses was in math fundamentals and the other in geometry. The math fundamentals course focused on algebra and integrated mathematics. The geometry course was based around geometric proofs, and was related to the New York state standards for geometry. Participants in the geometry course were required to undertake projects related to the topics taught in the course. The courses were taught by members of the Lehman College mathematics faculty.

Action Research Courses

MTTI participants took a two-part course series in classroom-based inquiry including action research. The course series ran for a total of 90 classroom hours. Part 1 of this series took place during spring 2010, "Classroom Inquiry in Middle and High School Mathematics." Part 2, "Mathematics Inquiry Applications," was offered during fall 2010. These courses focused on helping MTTI teachers examine the effectiveness of their pedagogical practices by identifying and describing their students' errors and misconceptions, reviewing literature on research and theories about mathematics teaching and learning, and using alternative assessments and technology. During Part 2, MTTI teachers or teams of teachers used mixed methods to develop and complete Action Research Projects, to assess the performance of their students. As of May 2011, 23 MTTI teachers developed 29 Action Research projects, involving 1,017 students: 378 from middle schools and 639 from high schools. The course series was taught and coordinated by a member of the Lehman College secondary education department.

Statistics Course

For summer 2010, all MTTI participants were offered a choice of mathematics courses, the last mathematics course they would be taking as part of the program. They could choose either a Statistics (and Probability) course or a second Geometry course. Virtually all of them chose the Statistics course and we offered two sections of the course to accommodate all the participants who wanted the course (and did not offer the Geometry course). The MTTI participants wanted a statistics course for three main reasons: 1) they discovered during the Action Research courses that they did not know the statistics required to complete their projects; 2) many had the opportunity to become involved in their school's self-evaluation and assessment and felt they needed more statistical knowledge to analyze the overwhelming amount of data available to them internally, and their principals were eager for them to serve on these teams; and 3) several were being asked to teach Advanced Placement (AP) Statistics at their high schools. It appears that most of the teachers' preferred the statistics course over the second geometry course for professional reasons other than a desire to improve their mathematical knowledge for teaching students.

Leadership Seminars 1 & 2

The Leadership Seminar 1 began in February 2011; Leadership Seminar 2 began in May 2011. The Director of the New York City Mathematics Project (NYCMP), and the MTTI Director led the seminars. In Fall 2010, they met with the participants three times during the Action Research course. Because it was important to lay groundwork for further exploration of the Common Core State Standards (2010), the first meeting focused on the Standards. The other two meetings focused on levels of cognitive demand for mathematical tasks as well as case studies from *Implementing Standards-Based Mathematics Instruction* (Stein, Smith, Henningsen, & Silver, 2009).

MTTI Teacher-Consultants

Six MTTI teacher-consultants visited participants in their schools to provide support. The teacher-consultants were retired mathematics teachers with many years' experience, and were drawn from the teacher-consultants who provided a similar service for the NYCMP. The teacher-consultants visited participants twice per month for one half-day on each visit. They supported participants in dealing with pedagogical and leadership issues.

Research Questions

The MTTI project is extremely wide-ranging and made up of several components. However, this paper concentrates on our attempt to answer the following three research questions:

1. Did participating in MTTI increase participants' mathematical and pedagogical knowledge?
2. Did participating in MTTI increase participants' use of student-centered pedagogy in the classroom?
3. Did any increase in either mathematical content knowledge or student-centered pedagogy lead to an increase in student engagement in mathematics?

Method

Math Content Knowledge

Math content knowledge was measured by two sets of pre-post tests developed by the University of Louisville's Center for Research in Mathematics and Science Teacher Education (Bush & Nussbaum, 2004). One of the tests was for Algebra and Ideas, and the other was in Geometry and Measurement. Both tests were set at the middle school level. The tests were part of the Diagnostic Teacher Assessment in Mathematics and Science (DTAMS) instrument that was validated using a sample of 1,600 middle-school teachers (Saderholm, Ronau, Brown, & Collins, 2010). Saderholm and his colleagues determined the equivalency reliability of the pretests and posttests by computing the Pearson product moment correlation. This, they report, was greater than .80. Inter-scorer reliability was also greater than .80. The two Louisville tests were administered before and after the relevant content courses were completed.

Each University of Louisville test contained 20 items. The first 10 items were multiple-choice items and a correct answer scored 1 point. Items 11-20 were open-ended response items each divided into two parts. A correct answer on the first part scored 1 point. A maximum of 2 points were available for answers to the second part, giving a possible score of 40 points. The tests were blinded and scored at the University of Louisville Center for Research in Mathematics and Science Teacher Education by members of the research team under the supervision of the Center's director.

The two MTTI courses, one in math fundamentals and the other in geometry, took place throughout the spring and fall semesters of 2009. Two pre-post tests were administered in association with these courses. These tests are referred to as MTTI tests. The MTTI Algebra and Ideas test dealt with: patterns, functions, and relationships; expressions and formulas; and equations and inequalities. The MTTI Geometry and Measurement test dealt with: two-dimensional geometry; three-dimensional geometry; transformational geometry; and measurement.

These two MTTI tests were designed by MTTI math faculty. The possible score on the MTTI fundamentals test was 100, and the possible score on the MTTI geometry test was 90. The same test was used as both the pretest and the posttest for the MTTI math fundamentals and geometry tests. The MTTI tests were scored by a member of the Lehman College math faculty not associated with the two MTTI courses, based on rubrics developed by the math faculty members who taught the courses.

The questions on the University of Louisville tests assessed participants' general content knowledge. In contrast, the MTTI tests were directly related to the content taught in the two courses.

Math Pedagogical Knowledge

According to our theory of action, the second component of a math teacher's capacity for teacher leadership concerns their mastery of pedagogical practices appropriate both for their students and for the mathematics concepts they teach. Information about this component comes from questions on the Louisville Algebra and Ideas and Geometry and Measurement tests, classroom observations, and teachers' work in the classroom-based inquiry courses.

As mentioned above, the second part of items 16-20 on the Louisville tests measured pedagogical content knowledge and the maximum possible score on these items was 10. An example of a question measuring pedagogical content knowledge is as follows:

> *Q. 16 A student claims that all squares are congruent to each other because they all have four congruent sides.*
> *a. Why is this claim incorrect?*
> *b. Explain how you would help the student understand the error in his thinking.*

The pedagogical content scores were analyzed separately from the scores on the other questions.

Classroom Observations

Three retired math educators who had previous experience in observing teachers in their classrooms were trained to be observers for the MTTI project. They were trained to use a five-minute time-sampling system in which they were asked to observe for five minute blocks of time and note whether or not any one or more of the pedagogic and/or management behaviors (examples below) was used by the teacher. At the end of training, inter-rater reliability was .71.

Beginning in the fall 2009 term, the observers visited the MTTI teachers' classrooms at least four times each term. Through January of 2011, 265 observations had taken place. The classroom observation protocol ([COP], Lawrenz, Huffman, & Appledoorn, 2000) contains, among other things, information about types of instructional activities. Some of these activities were judged *a priori* to be indications of student-centered pedagogy, including small group discussions, class discussions, hands-on activities, cooperative learning, student presentations, and use of a learning center or station. Some were considered *a priori* to indicate teacher-centered pedagogy, including lecturing, lecturing with limited class discussion, modeling problem solving, and demonstrations by the teacher. The exact nature of some activities (e.g. writing work or reading seat work) could not be determined *a priori*. In these cases, the observers used their own judgment whether the activity was student-centered, teacher-centered, or indeterminate.

On average, each observation lasted for about 50 minutes, with most observations being for 45 or 50 minutes. An observation was capped at 60 minutes. The vast majority of observations in high schools were conducted in algebra, integrated math, or geometry classes. A few observations were conducted in advanced math classes, including seven observations in pre-calculus classes and eight observations in calculus classes.

Student Engagement

One of the sections of the observation protocol mentioned concerned the level of Student Engagement (SE) rated as high, medium, or low. During each observation, SE was rated as high when 80% or more of students were engaged, as low when 80% or more of students were off-task, and as mixed otherwise. An engaged student was seen as one who, during the time of the observation, was involved in the lesson in meaningful ways; that is, he/she participated in all classroom activities, collaborated effectively with the teacher and with other students, and was reflective about his/her learning.

The findings from the use of the instruments outlined above for assessing math content knowledge, pedagogical knowledge, and student-centered pedagogy were related to those for student engagement outlined in this section to determine if there was any relationship among the variables.

Results

Math Content Knowledge

Thirty-two participants took both the pretest and posttest versions of the two University of Louisville tests and the MTTI faculty-designed tests. Mean scores on the University of Louisville test of algebra and ideas increased significantly from 25.8 at pretest to 29.8 at posttest. However, mean scores on the University of Louisville test of geometry and measurement did not differ significantly from pretest (22.6) to post-test (20.7) (Tables 1 & 2).

Scores on the MTTI faculty-designed fundamentals test increased significantly from 36.5 at pretest to 48.0 at posttest. Scores on the MTTI geometry course content test also increased significantly from 26.6 at pretest to 36.0 at posttest (Tables 3 & 4).

Table 1

Pre- and post-test means for the Louisville Algebra test

	Mean	Std. Deviation	N
Louisville Algebra Pretest Total/40	25.75	6.309	32
Louisville Algebra Posttest Total/40	29.81	5.544	32

Significant: $t_{(30)} = 4.61$, $p<.001$

Table 2

Pre- and post-test means for the Louisville Geometry test

	Mean	Std. Deviation	N
Louisville Geometry Pretest Total/40	22.56	7.211	32
Louisville Geometry Posttest Total/40	20.72	6.371	32

Not significant: $F_{(1,31)}= 3.45$, $p=.073$

Table 3

Pre- and post-test means for the MTTI Fundamentals test

	Mean	Std. Deviation	N

MTTI Fundamentals Pretest Total/100	36.47	6.567	32
MTTI Fundamentals Posttest Total/100	48.00	5.639	32

Significant: $t_{(29)} = 5.01, p<.001$.

Table 4

Pre- and post-test means for the MTTI Geometry test

	Mean	Std. Deviation	N
MTTI Geometry Pretest Total/90	26.58	6.421	32
MTTI Geometry Posttest Total/90	36.03	5.894	32

Significant: $t_{(30)} = 4.61, p<.001$

Pedagogical Content Knowledge

The average number of correct answers for the five questions of the Louisville Algebra and Ideas test relating to pedagogical content knowledge increased significantly from 4.44 to 5.16 across test administrations. This suggests that MTTI participants' pedagogical content knowledge for algebra and ideas increased following engagement with a course in the fundamentals of mathematics. The mean pedagogical content knowledge scores for the Louisville Geometry and Measurement test declined slightly from pretest (3.90) to posttest (3.55) administrations, but this decrease was not significant (Tables 5 & 6).

Taken together these results indicate that in general participants' math content and pedagogical content knowledge increased from beginning to end of the MTTI course.

Table 5

Pre- and posttest means for the pedagogical items on the Louisville Algebra test

	Mean	Std. Deviation	N
Louisville Algebra Pretest Total/10	4.44	1.722	32
Louisville Algebra Posttest Total/10	5.16	1.629	32

Significant: $t_{(31)} = 2.49$, $p = .018$.

Table 6

Pre- and posttest means for the pedagogical items on the Louisville Geometry test

	Mean	Std. Deviation	N
Louisville Geometry Pretest Total/10	3.90	2.146	32
Louisville Geometry Posttest Total/10	3.55	2.602	32

Not significant: $t_{(31)} = .706$, $p = .486$.

As mentioned above, from the classroom observation protocols, instructional activities were coded as teacher-centered, student-centered or indeterminate, at 5-minute intervals. For example, lecture was considered teacher-centered while cooperative learning was considered student-centered. However for some activities (e.g. "writing"), there was insufficient information on the observer's report to determine the student-centeredness of the activity; these were given a coding of "indeterminate." For each lesson, the percent of time spent in each of these three categories was then calculated. Across all observations and all teachers and all semesters, the range of time spent was: in teacher-centered activities, 30.2%; in student-centered activities, 30.4%; and in activities that could not be clearly classified as either, 39.4%. There was no significant change across the semester for the percent of time spent in teacher-centered vs. student-centered activities

($\chi 2$ (10) = 5.29, p = .87). Thus, it appears that student-centered pedagogy did not increase over the timespan of the MTTI course for Cohort 1.

Student Engagement

In the fall 2009, spring 2010, and fall 2010 semesters, observers assessed the level of student engagement in math class at five-minute intervals. They recorded three possible levels of engagement: low engagement (80% or more of students off-task); medium engagement (mixed engagement); and high engagement (80% or more of students engaged). High engagement increased from fall 2009 to spring 2010. In the spring semester, high engagement had increased significantly from about 40% of observations to 63.5% of observations. In fall 2010 high engagement decreased to 48%. However, across the three semesters low engagement decreased from nine percent in fall 2009 to four percent in fall 2010 (Figure 2). These findings provide some evidence for an increase in high student engagement over the time-span of the MTTI project, and certainly evidence of a decrease in low student engagement.

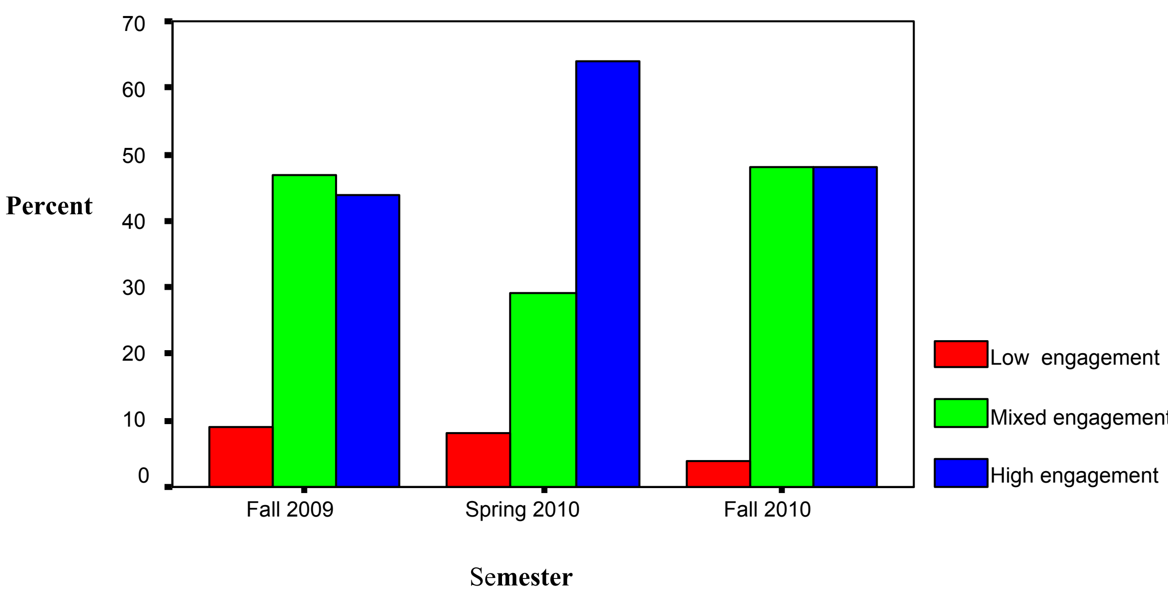

Figure 2. Level of student engagement by semester.

Student-Engagement, Math Content and Pedagogical Knowledge, and Student-Centered Teaching

Math content knowledge and pedagogical content knowledge did not significantly predict the percentage class time featuring student-centered pedagogy (Tables 7 & 8) or percentage of high student engagement in math class (Tables 9 & 10).

Table 7
Math content and pedagogical content knowledge as measured by the Louisville tests as predictors of student-centered pedagogy.

	Sum of Squares	df	Mean Square	F	Sig.
Regression	205.206	4	51.302	.104	.980
Residual	8390.215	17	493.542		
Total	8595.422	21			

a. Predictors: (Constant), Geometry Content Knowledge change, Geometry Pedagogical Knowledge Change, Algebra Content Knowledge change, Algebra Pedagogical Knowledge change
b. Dependent Variable: Percent Student Centered Pedagogy

Table 8
Math content knowledge as measured by the MTTI tests as predictors of student-centered pedagogy.

	Sum of Squares	df	Mean Square	F	Sig.
Regression	619.584	2	309.792	.729	.497
Residual	7228.263	17	425.192		
Total	7847.847	19			

a. Predictors: (Constant), MTTI Geometry change, MTTI Algebra change
b. Dependent Variable: Percent Student Centered Pedagogy

Table 9
Math content and pedagogical content knowledge as measured by the Louisville tests as predictors of high student engagement in math class

	Sum of Squares	df	Mean Square	F	Sig.

Regression	5659.604	4	1414.901	.837	.520
Residual	28728.310	17	1689.901		
Total	34387.915	21			

a. Predictors: (Constant), Louisville Geometry Content Knowledge change, Algebra Content Knowledge change, Algebra Pedagogical Knowledge change, Geometry Pedagogical Knowledge change
b. Dependent Variable: Percent high engagement

Table 10
Math content knowledge as measured by the MTTI tests as predictors of high student engagement in math class.

	Sum of Squares	df	Mean Square	F	Sig.
Regression	5772.912	2	2886.456	1.973	.170
Residual	24873.178	17	1463.128		
Total	30646.090	19			

a. Predictors: (Constant), MTTI Geometry change, MTTI Algebra change
b. Dependent Variable: Percent high student engagement

To determine if there was a relationship between student-centered teaching (SCT) and student engagement, we derived two groups of participants; Group A (High SCT) consisted of the six participants who were observed to display the most student-centered teaching techniques as assessed by the classroom observers across both the fall 2009, spring 2010 and fall 2010 semesters; and Group B (Low Student Centered) consisted of the six MTTI participants who exhibited the least student-centered teaching techniques assessed in the same manner across the same time period. For Group A, the mean percentage of time spent in student-centered teaching activities was 48.7% (s.d.=9.0) across all semesters, while for Group B, it was only 15.7% (s.d.=9.2).

We then examined the relationship between student centered teaching and student engagement. We calculated the levels of student engagement for the two groups (high and low SCT) for each semester and a mean value across semesters. We found that students of Group A (high SCT) teachers were significantly more likely to be highly engaged in their math classes than students of Group B (low SCT) teachers: $\chi 2$ (1) = 5.81, p = .02 (See Table 11).

Table 11

Level of student engagement for the High and Low SCT groups

Level of SCT	High Engagement	Mixed Engagement	Low Engagement
High	62.4%	33.4%	4.3%
Low	44.7%	48.7%	6.6%

Discussion

We found that MTTI teachers' content knowledge in the fundamentals of mathematics improved significantly following their participation in the program. However, there was no significant relationship between teachers' increase in content knowledge and their use of student-centered teaching or the engagement level of their students in math class. This may have been because the measures we used to assess content knowledge did not adequately tap into participants' pedagogical knowledge. Support for this view comes from additional data from the observations, which show that the classroom observers rated teachers' mastery of math concepts highly. The observers also reported that participants made extremely few mathematical errors while they were teaching.

It is also worth noting that the University of Louisville tests were tests of general mathematics concepts and pedagogy, while the MTTI math tests were related to the MTTI math courses, but not necessarily to the specific concepts and pedagogy that MTTI teachers were using in their classrooms. The math content of the MTTI courses was determined by the Lehman College mathematics faculty member teaching each course. In general, the content of the math courses was related to the New York State math standards, but it was not related specifically to the content that the teachers were teaching in their classroom. It might not be surprising, therefore, that there was no significant relationship between MTTI teachers' math concept knowledge as measured by the Louisville and MTTI tests and their classroom practices as reported by the observers.

We suggest that the discrepancy between the University of Louisville Geometry and Measurement test results (lack of improvement) and those of the MTTI Geometry test results (significant improvement) may have been due to the lack of fit between the MTTI geometry course, which was designed to correspond to New York State's secondary geometry curriculum, and the items on the Louisville exam.

The content of the Louisville tests had been established with reference to teams of mathematicians, math educators, and math teachers who conducted literature reviews for appropriate content as defined by national recommendations (Saderholm, Ronau, Brown, & Collins, 2010). This resulted in tests that contained content that math experts thought that math teachers generally ought to know and be able to teach, rather than items that assessed mastery of specific course content or what teachers needed to know to be able to teach particular students.

In addition, fewer MTTI teachers had experience in or were currently teaching geometry compared to algebra. This was in part because, until relatively recently, most emphasis had been placed on algebra by New York State's Board of Regents. Since teachers were being asked to focus more on teaching algebra than geometry, this might explain why the MTTI teachers generally improved more on the Algebra and Fundamentals test than the Geometry tests.

We discovered that teachers who employed a high level of student-centered, inquiry-based pedagogy tended to be more effective as math teachers than those who used a low level of student-centered teaching, at least if effectiveness is assessed by the extent to which their students were engaged in the lesson.

Anecdotally, participants reported that as a result of participation in the classroom-based inquiry (action research) courses, they changed their own teaching practices and saw improvements in motivation toward participating in mathematics on the part of their students. These findings are based on self-report, and in the future we are going to ask teachers to formally assess whether changes in students' motivation to engage actually occur.

For this study, the main variable used for assessing the effectiveness of teaching is level of students' engagement in math class. In part, this was because we had difficulty in gathering pre- and post-test data for state-mandated student tests. To some extent this was because, in order to obtain ethical approval from the New York City Department of Education for the study, we could not track individual students during the period of the research, nor could MTTI teachers conduct research activities using students in their own classes as participants.

For MTTI Cohort 2, we are able to ask MTTI teachers to collect data from their students as long as those students' identities are not revealed. Therefore, we are in the process of administering math performance tasks to the students of MTTI Cohort 2. These performance tasks reflect the new Common Core State Standards for Mathematics (2010) which are being introduced in New York City schools in the fall 2012 semester. This is in an attempt to obtain student achievement data. We will then be able to look at the relationship, if any, between student-centered pedagogy, student engagement, and student achievement.

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