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ABSTRACT

This report presents the results of survey research that collected responses of graduates (N=113, Fall 1999 through Fall 2001) from a reform-based mathematics and science teacher preparation program. All graduates' responses were compared to smaller subsamples of employed new elementary and middle school teachers with responses of a larger sample of previously surveyed practicing elementary and middle school teachers (referred to as our "national sample"). The statewide reform-based undergraduate teacher preparation program surveyed was the Maryland Collaborative for Teacher Preparation (MCTP). The MCTP is a funded National Science Foundation CETP program for teacher candidates who plan to become specialist mathematics and science upper elementary or middle level teachers. An instrument was crafted to measure the constructs of interest of the program's graduates. We named the instrument, MCTP Teacher's Beliefs and Actions of Mathematics and Science. This 51-item instrument included 45 items reported in the National Science Board's 1998 Science & Engineering Indicators (NSB-98-1). The survey was administered 3 times over a three-year period (1999-2001). The total response rate was 60%. A nonresponse bias check indicated no significant difference between respondents and nonrespondents. A statistical examination indicated that in a preponderance of areas the MCTP graduates' and employed new teachers' responses were more in alignment with a reform-based orientation than were responses by the national sample of teachers. This finding was highly significant since it was the goal of the MCTP to produce new teachers with reform-oriented views. There were a few areas that do not fit this pattern. These anomalous findings entice further consideration. (Contains 43 references.) (DDR)

What Beliefs and Intentions Concerning Science and Mathematics and the Teaching of Those Subjects Do Reform-Prepared Specialist Elementary/Middle Level Teachers Bring to the Workplace?

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Abstract

In this report we present the results of survey research that collected responses of graduates (N=113, Fall 1999 through Fall 2001) from a reform-based mathematics and science teacher preparation program. We compared all graduates' responses and smaller subsamples of employed new elementary and middle school teachers with responses of a larger sample of previously surveyed practicing elementary and middle school teachers (referred to as our "national sample"). The statewide reform-based undergraduate teacher preparation program surveyed was the Maryland Collaborative for Teacher Preparation (MCTP). The MCTP is a funded National Science Foundation CETP program for teacher candidates who plan to become specialist mathematics and science upper elementary or middle level teachers. We crafted an instrument to measure the constructs of interest of the program's graduates. We named the instrument, *MCTP Teacher's Beliefs and Actions of Mathematics and Science* . This 51-item instrument included 45 items reported in the National Science Board's 1998 Science & Engineering Indicators (NSB-98-1). The survey was administered three times over a three-year period (1999/2000/2001). The total response rate was 60%. A nonresponse bias check indicated no significant difference between respondents and nonrespondents. A statistical examination indicated that in a preponderance of areas the MCTP graduates' and employed new teachers' responses were more in alignment with a reform-based orientation than were responses by the national sample of teachers. This finding was highly significant since it was the goal of the MCTP to produce new teachers with reform-oriented views. There were a few areas that do not fit this pattern. These anomalous findings entice further consideration.

What Beliefs and Intentions Concerning Science and Mathematics and the Teaching of Those Subjects Do Reform-Prepared Specialist Elementary/Middle Level Teachers Bring to the Workplace?

This study is conducted within a macro-research agenda within the mathematics and science education research communities that are focusing on the possible links between features of teacher preparation programs and the performances of new teachers (Anderson & Mitchener, 1994; Coble & Koballa, 1996). Currently, there is considerable interest in preparing reform-based science teachers who can teach for understanding, use technology appropriately, and make connections with other subjects (see, for example, the National Council of Teachers of Mathematics [NCTM], 1991 and the National Resource Council [NRC], 1996). A salient theme that distinguishes our time period as judged from a review of a considerable number of sessions at recent NARST conference meetings is innovation in undergraduate science teacher preparation. Presently, however, there are few reports outside of small n case studies on what beliefs and intentions concerning the teaching of science (and mathematics) graduates of reform-based teacher preparation programs bring to the workplace (one prominent exception being Simmons, et. al, 1999).

In this report we present the results of survey research that collected responses of graduates (N=113, Fall 1999 through Fall 2001) from a reform-based mathematics and science teacher preparation program. We compared all graduates' responses and smaller subsamples of employed new elementary and middle school teachers with responses of a larger sample of previously surveyed practicing elementary and middle school teachers (referred to as our "national sample"). The statewide reform-based undergraduate teacher preparation program surveyed was the Maryland Collaborative for Teacher Preparation (MCTP). The MCTP is a funded National Science Foundation CETP program for teacher candidates who plan to become specialist mathematics and science upper elementary or middle level teachers. We crafted an instrument to measure the constructs of interest of the program's graduates. We named the instrument, *MCTP Teacher's Beliefs and Actions of Mathematics and Science* . This 51-item instrument included 45 items reported in the National Science Board's 1998 Science & Engineering Indicators (NSB-98-1).

This study is one in a series of studies in an extended-in-duration research program investigating the MCTP. Previous studies have been reported at NARST (previous 7 years), AERA (previous 6 years), AETS (three times), and NSTA (once). In addition, several studies have been reported in book chapter and journal form. Interested readers are directed to the attached comprehensive MCTP research reference list (note: most of these reports can be accessed by visiting the MCTP Web site, www.inform.umd.edu/UMS+State/UMD-Projects/MCTP/WWW/MCTPHomePage.html).

Context of the Study

The MCTP is a NSF funded statewide undergraduate program for students who plan to become specialist mathematics and science upper elementary or middle level teachers. While teacher candidates selected to participate in the MCTP program in many ways are representative of typical teacher candidates in elementary teacher preparation programs, they are distinctive by agreeing to participate in a program that consists of an extensive array of mathematics and science experiences (formal and informal) that make connections between the two disciplines.

The goal of the MCTP is to promote the development of professional teachers who are confident teaching mathematics and science using technology, who can make connections between and among the disciplines, and who can provide an exciting and challenging learning environment for students of diverse backgrounds (University of Maryland System, 1993). This goal is in accord with the educational practice reforms advocated by the major professional mathematics and science education communities:

The MCTP is designed around these notable reform-based recommendations:

• new content and pedagogy courses that model inquiry-based, interdisciplinary approaches combined with regular opportunities for teacher candidate reflection;

• the participation of faculty in mathematics, science, and methods committed to modeling best teaching practices (especially by diminishing lecture and emphasizing problem-solving);

• the development of field experiences in community schools with exemplary teachers trained to serve as mentors;

• the availability of summer internships in contexts rich in mathematics and science;

• and, the support of new teachers by university and school personnel during their first years of teaching.

Theoretical Assumption and Research Methodological Approaches

A fundamental assumption of the MCTP is that changes in pre-secondary level mathematics and science educational practices in the workplace require reform within the undergraduate mathematics and science subject matter and education classes teacher candidates take throughout their teacher preparation programs (NSF, 1993).To test this assumption, over a three year period (1999, 2000, 2001) we conducted three complementary studies: (1) A comparison survey study was designed to investigate all new MCTP teachers' beliefs about mathematics and science and their actions toward the teaching of those subjects; (2) An empirical study using a case study approach (N=5) was designed to investigate the socialization of a select sample of MCTP new teachers throughout their first few years of teaching experience; and, 3) A novel study using teaching case studies (N=15) designed to enrich the other two data sets by adding the program participants' own voices (new teachers as well as their veteran mentor teachers) as they detailed their successes and obstacles in implementing the project's goals in the workplace.

In this report, we focus on answering these highly significant research questions:

How do new specialist teachers of mathematics and science who graduate from an inquiry-based, standards-guided innovative undergraduate teacher preparation:

(1) view their subject disciplines;

(2) intend to enact their roles as teachers; and,

(3) compare in their beliefs and intentions concerning mathematics and science to other elementary/middle level teachers?

Data Collection Strategies

Instrumentation. We sought to collect the total population of MCTP graduates reported beliefs about mathematics and science and their intentions toward the teaching of those subjects, so that we could 1) describe our sample, and 2) compare our sample (total and disaggregated by level and subject) with a larger, more representative sample of practicing elementary and middle school mathematics or science teachers. Our strategy was to use existing reported survey items that practicing elementary and middle level teachers had previously responded. We sought to make a comparison between the MCTP graduates' responses about beliefs (mathematics/science) and intentions (mathematics/science instruction) with responses by representative practicing teachers in the workplace before the MCTP graduates entered employment. This goal required us to examine the literature for existing accepted and reported surveys that measured practicing teachers' constructs we targeted and then develop a new survey for the MCTP sample consisting primarily of items taken verbatim from those reported surveys.

We found success in our search when we inspected survey data reported in the National Science Board's 1998 Science & Engineering Indicators (NSB-98-1). Specifically, Figure 1-18 ("Percentage of science and mathematics teachers implementing reform activities"(National Center for Education Statistics, 1997/2000), Figure 1-19 (Teacher beliefs about the nature and teaching of mathematics and science: 1994-95) (Williams, Levine, Martin, Butler, Heid, & Haynes, 1997), and Figure 1-20 (Teacher perceptions of student skills required for success in mathematics and science: 1994-95) (Williams, et al, 1997) contained what we needed. From these existing surveys (and one other referred to on p. 1-25 that contained data on teachers' knowledge of the standards (Williams, et. al, 1997)), we crafted a new 51-item survey, *MCTP Teachers' Actions And Beliefs Of Mathematics And Science,* consisting of 45 previously administered items taken from those reported surveys. The constructs we measured were "Teachers' beliefs about mathematics (9 items)," "Teachers' beliefs about science (9 items)," "Teachers' use or intended use of instructional practices in mathematics (7 items) ," "Teachers use or intended use of instructional practices in science (7 items)," "Teachers' perceptions about student success in mathematics (6 items)," "Teachers' perceptions about student success in science (6 items)," "Teachers intentions about implementing reform activities in mathematics classes (6 items)," "Teachers' intentions about implementing reform activities in science classes (6 items),"and "Teachers' knowledge of the mathematics and science standards" (3 items). We added two items that related to a unique aspect of the MCTP, making connections between mathematics and science in instructional practice. We added another item that asked about the teacher's familiarity with the National Science Education Standards. We also included 4 items that asked background information. See the Appendix for a copy of the instrument.

Sample. We sent out our survey by mail to the MCTP program's graduates three times: in the spring 1999 to all graduates from 1997 to that date (n=57); in the fall 1999 (n=28); and finally, in the fall 2000 (n=28). Our total response rate was 60%, high for survey research of this type. Responses came from graduates of all seven of the MCTP participating institutions with baccalaureate programs We attribute the high level of response partially to the strategies for increasing a return rate to mail-in surveys we learned from Dillman (1978) (i.e., sending a token honorarium such as a $2 bill or a $1 coin in the first mailing, sending a later reminder letter with another copy of the instrument, and using email and telephone reminders).

To enhance the credibility of our analysis, we conducted a nonresponse bias check. Up to 2001 January, questionnaires were mailed to 113 MCTP teachers at their schools. Sixty MCTP graduates responded promptly. To check for nonresponse bias, 8 randomly selected MCTP graduates were contacted and encouraged to complete the survey. All eight completed the survey by mid-February, 2001. The 60 teachers who responded early were classified into the Early Responding Group, and the 8 teachers who responded late were classified into the Late Responding Group. Using the both the Pearson chi-squared statistic and the Cochran-Armitage Trend statistic, early and late response groups were compared on all 51 items.

The Pearson chi-squared statistic is an omnibus test, meant to detect differences of any sort between the groups. The Cochran-Armitage test (expressed as a Z-score) is sensitive against one particular type of difference: that differences between response patterns are associated with increasing levels of response. In this sense, the Cochran-Armitage test is qualitatively similar to a correlation between response level and group membership (coded as 0 or 1).

The chi-squared test and the trend test gave the same results on all 51 items. Only two out of 51 items are significantly different on both the chi-squared test and the trend test. However, with a type I error of 0.05, two significant differences might be expected by chance alone. We concluded that there was no difference among the early and late groups on their responses in this survey. Therefore, we believe that our analysis is free from nonrespondent bias, and that our report conveys accurately the beliefs and intentions of the MCTP graduates. See Table 1.

Findings

We conducted two levels of data analysis. For our first level of data analysis we examined our data to see how the MCTP graduates' responded to each item, by frequency and percent. For our second level of data analysis (i.e., comparing our sample's responses with a larger, more representative sample of practicing elementary and middle school teachers) we used inferential statistics. We first made comparisons by total MCTP response and practicing teacher response. We made the assumption that the MCTP graduates were all certified to teach at the differing levels of our practicing teacher samples and therefore were comparable groups. We wanted to compare if the MCTP graduates were different in any way from practicing teachers on a range of items that could be linked to reform-based perspectives. However, we were sensitive to possible arguments of group noncomparability (i.e., the MCTP graduates were not necessarily employed teachers at the time they responded to the survey, or if they were, they taught at differing levels and subjects). Therefore, to test if those differences between the samples made a difference, we next performed a comparison between dissaggregated MCTP samples by employed new teacher's level (elementary or middle level) and by subject focus (mathematics or science). What follows are our results reported by instrument section (representing our targeted constructs).

Subject Background. The majority of the sampled MCTP graduates were first year teachers (69.7%). Ninety-seven percent were in their first or second years of fulltime practice. The instructional level of the employed MCTP new teachers ranged from 1st and 2nd grade (10.2%) to 7th or 8th grade (32.2%). Two out of three respondents reported subject specialization--science (38.1%), mathematics (31%), and both science and mathematics (19.0%). A review of the completed surveys by a researcher familiar with the respondents also provided the following supplemental information. Sixty-one (90%) of the respondents were employed either as elementary or middle school teachers. Fifty-two point five percent were middle school teachers (23% mathematics; 14.8% science; and 14.8% both mathematics and science), and 47.5% were elementary teachers.

Nature and teaching of mathematics. We compared the responses of the MCTP graduates (n=68) and the larger practicing teachers' sample (n=478) by using the Pearson chi-squared test to compare proportions agreeing or strongly agreeing with each statement from this section of the instrument. The MCTP graduates' responses differed significantly ($p<.05$) from the national sample on several beliefs. Specifically, they were *less likely to believe:* that mathematics is primarily an abstract subject; that mathematics should be learned as sets of algorithms or rules that cover all possibilities; that a liking for and understanding of students are essential for teaching mathematics; and, that more than one representation should be used in teaching a mathematics concept. See Table 2-1.

A disaggregated analysis of the MCTP middle school mathematics teachers' responses (n=14) is reported in Table 2-2. The comparison group was practicing eighth grade teachers (n=246). We used the two-tailed *t* test for two independent samples to compare proportions agreeing or strongly agreeing with each statement. Pooled standard error was used, with degrees of freedom = (MCTP sample size) – 1. The MCTP standard error was $se^2=pq/n$, where p is the MCTP sample proportion. The standard errors for the national sample came from the reported MSEG report. The MCTP middle school mathematics teachers differed significantly ($p<.05$) from the national sample on two beliefs. They were *less likely to believe* that mathematics is primarily an abstract subject, and they *were less likely to believe* that if students are having difficulty, an effective approach was to give them more practice by themselves during the class.

Nature and teaching of science. The MCTP graduates' and the national sample were compared using the Pearson chi-squared test to compare proportions agreeing or strongly agreeing with each statement. The MCTP graduates differed significantly from the national sample ($p<.05$) on several beliefs. Specifically, they were *less likely to believe* : that science is primarily a formal way of representing the real world; that science is primarily a practical and structured guide for addressing real situations; that a liking for and understanding of students are essential for teaching science; that it is important for teachers to give students prescriptive and sequential directions for science experiments; and, that students see a science task as the same task when it is represented in two different ways. However, they were more likely to believe that if students get into debates in class about ideas or procedures covering the sciences, it can harm their learning. Refer to Table 3-1.

A disaggregated analysis of the MCTP middle school science teachers' responses (n=9) is reported in Table 3-2. Using the two-tailed *t* test for two independent samples to compare proportions agreeing or strongly agreeing with each statement, we compared the MCTP middle school science teachers and national samples (n=232). Pooled standard error was used, with degrees of freedom = MCTP sample size – 1. The MCTP standard error was $se^2=pq/n$, where p is the MCTP sample proportion. The standard errors for the national sample came from the MSEG report. The MCTP middle school science teachers differed significantly ($p<.05$) from the national sample on two beliefs. They were *less likely to believe* that it is important for teachers to give students prescriptive and sequential directions for science experiments. However, they were *more likely to believe* that science is primarily a practical and structured guide for addressing real situations.

Perceptions of Student Skills Required for Success in Mathematics. The MCTP graduates and national samples were compared using the Pearson chi-squared test to compare proportions responding "very important" on each statement. The MCTP graduates differed significantly ($p<.05$) from the national sample on several beliefs. Specifically, they were *less likely to think:* it is very important for students to remember formulas and procedures, and to think in a sequential manner. Refer to Table 4.

A disaggregated analysis of the MCTP middle school mathematics teachers' responses (n=14) is reported in Table 4-2. Using the two-tailed *t* test for two independent samples to compare proportions agreeing or strongly agreeing with each statement, we compared the MCTP and national samples. Pooled standard error was used, with degrees of freedom = MCTP sample size – 1. The MCTP standard error was $se^2=pq/n$, where p is the MCTP sample proportion. The standard errors for the national sample came from the MSEG report. The MCTP teachers differed significantly from the national sample on one belief. Specifically, they *are less likely to think* it is very important for students to think in a sequential manner.

Perceptions of Student Skills Required for Success in Science. The MCTP graduates and national samples were compared using the Pearson chi-squared test to compare proportions responding "very important" on each statement. The MCTP graduates differed significantly ($p<.05$) from the national sample on several beliefs. Specifically, they were *less likely to think* : it is very important for students to remember formulas and procedures, and to think in a sequential manner. Refer to Table 5-1.

A disaggregated analysis of the MCTP middle school mathematics teachers' responses (n=9) is reported in Table 5-2. Using the two-tailed *t* test for two independent samples to compare proportions agreeing or strongly agreeing with each statement, we compared the MCTP and national samples. Pooled standard error was used, with degrees of freedom = MCTP sample size – 1. The MCTP standard error was $se^2=pq/n$, where p is the MCTP sample proportion. The standard errors for the national sample came from the MSEG report. The MCTP middle school mathematics teachers differed significantly ($p<.05$) from the national sample on one belief. Specifically, they were more likely to think it is very important for students to support solutions.

Familiarity with Mathematics and Science Education Standards Documents. The MCTP and national samples were compared using the Pearson chi-squared test to compare proportions of familiarity with the document. The MCTP graduates differed significantly ($p<.05$) from the national sample on familiarity with two documents. MCTP teachers are likely *to be less familiar* with the Mathematics standards document, Curriculum and Evaluation Standards for School Mathematics, but were likely to *be more familiar* with the Science standards document, Benchmarks for Science Literacy. And, although no comparison could be made between the groups concerning the National Science Education Standards (there were no reported national data on practicing teachers' familiarity with that document), 63.2% of the MCTP sample reported familiarity with that document. See Table 6-1.

A disaggregated analysis of the MCTP middle school teachers' responses is reported in Table 6-2. Using the two-tailed *t* test for two independent samples to compare proportions agreeing or strongly agreeing with each statement, we compared the MCTP and national samples. Pooled standard error was used, with degrees of freedom = MCTP sample size – 1. The MCTP standard error was $se^2=pq/n$, where p is the MCTP sample proportion. The standard errors for the national sample came from the MSEG report. We compared responses by MCTP middle school mathematics teachers (n=14) and the national sample eight-grade mathematics teachers on Item 31. No significant difference between the groups in was found. We compared responses by MCTP middle school science teachers (n=9) and the national sample eight-grade science teachers on item 32. MCTP middle school science teachers were significantly ($p<.05$) more familiar with the science standards document Benchmarks for Science Literacy. In addition, they reported an 88.9% familiarity with the National Science Education Standards.

Teachers use of instructional practices in mathematics. For this analysis, we disaggregated the sample by level, elementary and middle school, and by subject specialty (mathematics).

Elementary Teachers

There were 29 employed MCTP Elementary School Teachers who taught mathematics (and other subjects). The *Public School Teacher Survey on Education Reform (1996)* reported on practices of 473 elementary school teachers in any mathematics classes that they may have taught. The actual number of respondents may vary from item to item. Using the two-tailed *t* test for two independent samples to compare proportions agreeing or strongly agreeing with each statement, we compared the MCTP and national samples. Pooled standard error was used, with degrees of freedom = MCTP sample size – 1. The MCTP standard error was $se^2=pq/n$, where p is the MCTP sample proportion. The standard errors for the national sample came from the TSER report. The MCTP elementary school teachers differed significantly from the national sample on all practices. They were *more likely to* : assist all students to achieve high standards; provide examples of high-standard work; use authentic assessments; use standards aligned curricula; use standards-aligned textbooks and materials; and, use telecommunication-supported instruction. Also, 93.1% stated that would make connections with science in their practices. See Table 7-1.

Middle School Mathematics Teachers

There were 14 employed MCTP Middle School Mathematics Teachers. The *Public School Teacher Survey on Education Reform (1996)* reported on practices of 396 middle school teachers in any mathematics classes that they may have taught. The actual number of respondents may vary from item to item. Using the two-tailed *t* test for two independent samples to compare proportions agreeing or strongly agreeing with each statement, we compared the MCTP and the national samples. Pooled standard error was used, with degrees of freedom = MCTP sample size – 1. The MCTP standard error was $se^2=pq/n$, where p is the MCTP sample proportion. The standard errors for the national sample came from the TSER report. The MCTP middle school mathematics teachers differed significantly from the national sample on several actions. They were *more likely to* : assist all students to achieve high standards; provide examples of high-standard work; use authentic assessments; use standards-aligned curricula; and, use telecommunication-supported instruction. Also, 92.31% stated that they made connections with science in their practices. See Table 7-2.

Teachers use of instructional practices in science. For this analysis, we disaggregated the sample by level, elementary and middle school, and by subject specialty (science).

Elementary Teachers

There were 29 employed MCTP Elementary School Teachers who taught mathematics (along with other subjects). The *Public School Teacher Survey on Education Reform (1996)* reported on practices of 473 elementary school teachers in any science classes that they may have taught. The actual number of respondents may vary from item to item. Using the two-tailed *t* test for two independent samples to compare proportions agreeing or strongly agreeing with each statement, we compared the MCTP and national samples. Pooled standard error was used, with degrees of freedom = MCTP sample size – 1. The MCTP standard error was $se^2=pq/n$, where p is the MCTP sample proportion. The standard errors for the national sample came from the TSER report. The MCTP elementary school teachers differ significantly from the national sample on all practices. They were *more likely to* : assist all students to achieve high standards; provide examples of high-standard work, to use authentic assessments; use standards aligned curricula; use standards-aligned textbooks and materials; and, use telecommunication-supported instruction. Also, 96.6% stated that they made connections with mathematics in their practices. See Table 8-1.

Middle School Science Teachers

There were 9 employed MCTP Middle School Science Teachers. The *Public School Teacher Survey on Education Reform (1996)* reported on practices of 396 middle school teachers in any science classes that they may have taught. The actual number of respondents may vary from item to item. Using the two-tailed *t* test for two independent samples to compare proportions agreeing or strongly agreeing with each statement, we compared the MCTP and national samples. Pooled standard error was used, with degrees of freedom = MCTP sample size – 1. The MCTP standard error was $se^2=pq/n$, where p is the MCTP sample proportion. The standard errors for the national sample came from the TSER report. The MCTP middle school science teachers differed significantly from the national sample on several practices. They were *more likely to* : assist all students to achieve high standards, to use authentic assessments; use standards-aligned curricula; use standards-aligned textbooks and materials; and, use telecommunication-supported instruction. Also, 100% stated that they made connections with mathematics in their practices. See Table 8-2.

Discussion

The goal of the MCTP is to produce new teachers who are confident teaching mathematics and science using technology, who can make connections between and among the disciplines, and who can provide an exciting and challenging learning environment for students of diverse backgrounds. Along all measures, the present analysis provides evidence that the graduates of this program hold perspectives that support these aims. The present analysis also provides a striking comparison between the perspectives of practicing MCTP teachers and other teachers at the same level and subject specialization. Along all measures (many determined to be statistically significant) the MCTP new teachers express more reform-oriented perspectives concerning subject matter and instruction. These findings suggest strongly that a systematic, reform-based undergraduate science and mathematics program can produce new teachers who enter the workplace with desired perspectives. Whether these perspectives impact instructional choices over time in the desired direction of the reform movement remains undetermined. However, our results suggest that at least initially the reform-oriented perspectives do convey to the workplace.

It is intriguing, however, that among all the other positive findings, our analysis shows two anomalous results. The first anomalous finding was that when the MCTP graduates are compared with the entire sample of practicing teachers, the MCTP graduates are more likely to believe that if students get into debates in class about ideas or procedures covering the sciences, it can harm their learning ($p<.0003$). While the percentage of MCTP graduate responses is low (7.4%), the result is surprising given that the MCTP program promoted student discourse. And, while the new MCTP middle school teachers' responses to this item were not determined to be statistically different than the sample of practicing middle school teachers, 11.1% also expressed this view. The second anomalous finding was that MCTP graduates differed significantly from the national sample on familiarity with a standards document. MCTP teachers are likely *to be less familiar* with the mathematics standards document, Curriculum and Evaluation Standards for School Mathematics ($p<.0000$). While the percentage of MCTP middle school school teachers' responses to that item suggests some familiarity with that standard document (47%), the percentage did not match the percentage familiar with the science standards documents (approximately 65%). This finding was surprising given the emphasis of all the standards documents in MCTP courses.

Educational Implications

These are exciting times within the science (and mathematics) teacher preparation communities. The reform movement (as guided by recommendations in the mathematics and science standards documents) are influencing increasingly all aspects of the professional development of mathematics and science teachers, particularly in undergraduate teacher preparation. The present study adds empirical data to the discussion on what impact on teachers' beliefs and intentions concerning mathematics and science large scale reform-based undergraduate teacher preparation programs can achieve (Pekarek, Krockover, & Shephardson, 1996).

The study also points a clear direction at needed research--the impact of the workplace on graduates of such high quality programs. An exploratory study (McGinnis, Parker, & Graeber, 2000) of five new MCTP elementary and middle level teachers suggested that what happens to them in extant school cultures impacts dramatically the type and quality of their teaching practices. We believe that additional research using other methodologies (particularly case study) examining high quality, reform-based mathematics and science teachers in the workspace is necessary to generate new insights for policy makers concerned with improving the induction years of high quality mathematics and science teachers.

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Appendix:

MCTP Teacher's Actions And Beliefs Of Mathematics And Science

Directions: Please select the letter response that best represents your actions and beliefs.

SECTION I.

To what extent do you agree or disagree with each of the following statements?

Choices:

(A) (B) (C) (D)

Strongly disagree Disagree Agree Strongly agree

Mathematics

1. is primarily an abstract subject.

2. is primarily a formal way of representing the real world.

3. is primarily a practical and structured guide for addressing real situations.

4. should be learned as sets of algorithms or rules that cover all possibilities.

5. A liking for and understanding of students are essential for teaching math.

6. If students are having difficulty, an effective approach is to give them more practice by themselves during the class.

7. More than one representations should be used in teaching a math concept.

8. Some students have a natural talent for math and others do not.

9. Basic computational skills on the part of the teacher are sufficient for teaching elementary school math.

Science

10. is primarily an abstract subject.

11. is primarily a formal way of representing the real world.

12. is primarily a practical and structured guide for addressing real situations.

13. Some students have a natural talent for science and others do not.

14. A liking for and understanding of students are essential for teaching science.

15. It is important for teachers to give students prescriptive and sequential directions for science experiments.

16. Focusing on rules is a bad idea. It gives students the impression that the sciences are a set of procedures to be memorized.

17. If students get into debates in class about ideas or procedures covering the sciences, it can harm their learning.

18. Students see a science task as the same task when it is represented in two different ways.

SECTION II.

To be good at mathematics [science] at school, how important do you think it is for students to [fill in the blank with each of the items below] ?

(A) (B) (C)

Not important Somewhat important Very Important

<u>In Mathematics</u>

19. remember formulas and procedures?

20. think in sequential manner?

21. understand concepts?

22. think creatively?

23. understand math use in real world?

24. support solutions?

<u>In Science</u>

25. remember formulas and procedures?

26. think in sequential manner?

27. understand concepts?

28. think creatively?

29. understand science use in real world?

30. support solutions?

SECTION III.

What is your familiarity with the reform documents?

(A) (B) (C) (D) (E)

Not at all Small extent Fairly Moderate extent Great extent

31. Mathematics standards document (<u>Curriculum and Evaluation Standards for School Mathematics</u>).

32. Science standards document <u>Benchmarks for Science Literacy</u>.

33. Science standards document <u>National Science Education Standards.</u>

SECTION IV.

Please indicate if you use (or would use if you taught mathematics and science) the instructional strategies listed below.

(A) No (B) Yes

In Mathematics

34. Assisting all students to achieve high standards.

35. Providing examples of high-standard work.

36. Using authentic assessments.

37. Using standards aligned curricula.

38. Using standards-aligned textbooks and materials.

39. Using telecommunication-supported instruction.

40. Making connections with science.

In Science

41. Assisting all students to achieve high standards.

42. Providing examples of high-standard work.

43. Using authentic assessments.

44. Using standards aligned curricula.

45. Using standards-aligned textbooks and materials.

46. Using telecommunication-supported instruction.

47. Making connections with mathematics.

SECTION V

48. If you have taught since graduation, for what duration?

a. in beginning year b. 1 to 2 years c. 3 to 4 years d. > 4 years

49. If applicable, what grade level are you teaching this year?

a. 1 or 2 b. 3 or 4 c. 5 or 6 d. 7 or 8 e. other

50. If applicable, are you a specialized teacher (by content)?

a. yes b. no

51. If you are a specialized teacher, what is your content area?

a. mathematics b. science c. both mathematics and science d. other

Table 1. Nonresponse Bias Test: Comparison of the MCTP Teachers Early Responding Group with Late Responding Group

Item	df	χ^2	*p*	(Z) Cochran – Armitage Trend	2-tailed *p*
1	3	3.611	.307	-.2229	.8236
2	3	1.295	.730	-1.1366	.2557
3	3	.346	.951	.0731	.9418
4	3	1.634	.652	-.0997	.9206
5	3	1.953	.582	-.6924	.4887
6	3	2.924	.403	.0624	.9502
7	3	2.735	.434	.2285	.8192
8	3	.586	.900	.5519	.5810
9	3	.637	.888	-.5545	.5793

10	3	5.455	.141	-.0421	.9664
11	3	1.687	.640	-.0492	.9607
12	3	3.048	.384	-.9897	.3223
13	3	1.973	.578	-.2485	.8037
14	3	4.166	2.44	-.8194	.4126
15	3	5.526	.137	-.3804	.7036
16	3	1.298	.730	1.0918	.2749
17	3	2.549	.467	-.0557	.9556
18	3	3.674	.299	.4189	.6753
19	2	1.509	.470	-.2505	.8022
20	2	7.780	.020*	2.5069	.0122*
21	1#	.418	.518	-.6469	.5177
22	2	2.478	.290	.6208	.5348
23	1#	.048	.827	.2186	.8270
24	2	.177	.915	.3340	.7384
25	2	1.578	.454	.9052	.3654
26	2	1.253	.535	.6563	.5116
27	2	.177	.915	-.0583	.9535
28	2	1.025	.599	.4842	.6282
29	2	.177	.915	-.0583	.9535
30	2	3.488	.175	.8501	.3953
31	4	5.463	.243	-.1774	.8529
32	4	3.832	.429	1.8251	.0680
33	4	1.593	.810	.8265	.4085
34	1	.690	.406	.8307	.4062
35	1	.707	.397	.8469	.3971
36	1	1.406	.236	1.186	.2356
37	1	.690	.406	.8307	.4062
38	1	1.045	.307	1.0224	.3066
39	1	.538	.463	.7336	.4632
40	1	.123	.726	.3508	.7257
41	1	.717	.397	.6469	.3971

42	1	.717	.397	.8469	.3971
43	1	1.406	.236	1.1860	.2356
44	1	4.046	.044*	2.0115	.0443*
45	1	1.045	.307	1.0224	.3066
46	1	.533	.465	.7298	.4655
47	2	.629	.730	.7259	.4679
48	2#	.330	.848	.4728	.6364
49	4	1.911	.752	.2507	.8020
50	1	1.154	.283	1.2659	.2055
51	3	2.713	.438	.1108	.9117

Some options are not selected by responders, degrees of freedom were reduced.

Table 2. Background of MCTP Graduates at Time of Survey Response			
Sample Size		Number	Percent
Total....................................		68	100%
Number of years teaching			
	In beginning year	46	69.7%
	1 to 2 years......................................	18	27.3%
	3 to 4 years.....................................	2	3.0%
	More than 4 years..............................	0	0.0%
Instructional level			
	1st or 2nd grade.................................	6	10.2%
	3rd or 4th grade.................................	10	16.9%
	5th or 6th grade.................................	19	32.2%
	7th or 8th grade.................................	19	32.2%
	Other...	5	8.5%
Specialized teacher (by content)			
	Yes...	40	66.7%
	No..	20	33.3%
Main subject area taught			
	Mathematics....................................	13	31.0%
	Science..	16	38.1%
	Both mathematics and science...............	8	19.0%
	Other...	5	11.9%
Employed elementary or middle school teacher		61	100%
	Elementary	29	47.5%
	Middle school	32	52.4%
	Middle school (mathematics)...............	14	23.0%
	Middle school (science).....................	9	14.8%
	Middle school (math and science)......	9	14.8%

Table 3-1. Comparison of MCTP Graduates' Beliefs about the Nature and Teaching of Mathematics with Those of MSEG Sample by Percentage Agreeing or Strongly Agreeing

Item	MCTP[1]	National[2]	?2	p
1. Math is primarily an abstract subject.	10.4%	31.0%	12.19	.0005*
• Math is primarily a formal way of representing the real world.	74.2%	79.1%	.81	.3678
• Math is primarily a practical and structured guide for addressing real situations.	85.3%	88.8%	.71	.3989
• Math should be learned as sets of algorithms or rules that cover all possibilities.	19.7%	35.2%	6.27	.0123*
• A liking for and understanding of students are essential for teaching math.	86.8%	96.5%	12.56	.0004*
• If students are having difficulty, an effective approach is to give them more practice by themselves during the class.	13.2%	22.4%	2.99	.0839
• More than one representation should be used in teaching a math concept.	66.7%	98.3%	5.06	.0245*
• Some students have a natural talent for math and others do not.	73.1%	81.4%	2.55	.1106
• Basic computational skills on the part of the teacher are sufficient for teaching elementary school math.	26.5%	17.3%	3.33	.0681

[1] *MCTP Graduates' Beliefs and Actions of Mathematics and Science (2001), n=* 68.

[2] *National Center for Education Statistics,* Mathematics and Science in the Eighth Grade *(2000), n* =478.

Table 3-2. Comparison of MCTP New Teachers' Beliefs about the Nature and Teaching of Mathematics with Those of MSEG Sample by Percentage Agreeing or Strongly Agreeing

Item	MCTP[1]	National[2]	*t*	*p*
1. Math is primarily an abstract subject.	0.0%	31.0%	-7.95	.0000*
2. Math is primarily a formal way of representing the real world.	57.1%	79.1%	-1.60	.1332
• Math is primarily a practical and structured guide for addressing real situations.	85.7%	88.8%	-.32	.7511
• Math should be learned as sets of algorithms or rules that cover all possibilities.	14.2%	35.2%	-.210	.0558
• A liking for and understanding of students are essential for teaching math.	92.9%	96.5%	-.52	.6132
• If students are having difficulty, an effective approach is to give them more practice by themselves during the class.	0.0%	22.4%	-7.47	.0000*
• More than one representation should be used in teaching a math concept.	100%	98.3%	1.70	.1149
• Some students have a natural talent for math and others do not.	92.9%	81.4%	1.55	.1448
• Basic computational skills on the part of the teacher are sufficient for teaching elementary school math.	14.3%	17.3%	-.30	.7711

[1] *MCTP New Teacher's Beliefs and Actions of Mathematics and Science (2001): Middle school mathematics teachers. n=* 14.

[2] *National Center for Education Statistics,* Mathematics and Science in the Eighth Grade *(2000): Eighth-grade mathematics teachers. n* =246.

Table 4-1. Comparison of MCTP Graduates' Beliefs about the nature and teaching of Science with Those of National Sample by Percentage Agreeing or Strongly Agreeing

Item	MCTP[1]	National[2]	?2	*p*
• Science is primarily an abstract subject.	15.4%	18.2%	.31	.5782
• Science is primarily a formal way of representing the real world.	70.8%	84.3%	7.32	.0068*
• Science is primarily a practical and structured guide for addressing real situations.	77.9%	88.0%	5.24	.0221*
• Some students have a natural talent for science and others do not.	55.2%	62.0%	1.14	.2865
• A liking for and understanding of students are essential for teaching science.	79.4%	89.6%	6.00	.0143*
• It is important for teachers to give students prescriptive and sequential directions for science experiments.	45.5%	75.8%	26.56	.0000*
• Focusing on rules is a bad idea. It gives students the impression that the sciences are a set of procedures to be memorized.	41.2%	32.0%	2.26	.1326
• If students get into debates in class about ideas or procedures covering the sciences, it can harm their learning.	7.4%	2.8%	13.38	.0003*
• Students see a science a task as the same task when it is represented in two different ways.	27.4%	42.8%	5.37	.0205*

[1] *MCTP Graduates' Beliefs and Actions of Mathematics and Science (2001), n=* 68.

[2] *National Center for Education Statistics,* Mathematics and Science in the Eighth Grade *(2000), n* =478.

Table 4-2. Comparison of MCTP New Middle School Science Teachers' Beliefs about the Nature and Teaching of Science with Those of MSEG Sample by Percentage Agreeing or Strongly Agreeing

Item	MCTP[1]	National[2]	*t*	*p*
1. Science is primarily an abstract subject.	44.4%	18.2%	1.55	.1590
• Science is primarily a formal way of representing the real world.	88.9%	84.3%	.43	.6811
• Science is primarily a practical and structured guide for addressing real situations.	100%	88.0%	4.14	.0033*
• Some students have a natural talent for science and others do not.	33.3%	62.0%	-1.79	.1112
• A liking for and understanding of students are essential for teaching science.	88.9%	89.6%	-.06	.9500
• It is important for teachers to give students prescriptive and sequential directions for science experiments.	33.3%	75.8%	-2.64	.0299*
• Focusing on rules is a bad idea. It gives students the impression that the sciences are a set of procedures to be memorized.	55.5%	32.0%	1.38	.2036
• If students get into debates in class about ideas or procedures covering the sciences, it can harm their learning.	11.1%	2.8%	-1.59	.1509
• Students see a science a task as the same task when it is represented in two different ways.	33.3%	42.8%	-.58	.5752

[1] *MCTP New Middle School Science Teacher's Beliefs and Actions of Mathematics and Science (2001): n=* 9.

[2] *National Center for Education Statistics,* *Mathematics and Science in the Eighth Grade* *(2000): Eighth-grade mathematics teachers. n* =232.

Table 5-1. Comparison of MCTP Graduates' Perceptions of Student Skills Required for Success in Mathematics with Those of MSEG Sample by Percentage Responding " Very Important."

Item	MCTP[1]	National[2]	?2	P
• Remember formulas and procedures?	26.5%	43.0%	6.73	.0095*
20. Think in sequential manner?	42.6%	79.5%	43.02	.0000*
21. Understand concepts?	95.6%	88.9%	2.89	.0891
22. Think creatively?	55.9%	65.4%	2.35	.1255
23. Understand math use in the real world?	89.7%	81.7%	2.67	.1025
24. Support solutions?	89.7%	80.8%	3.19	.0743

[1] *MCTP Graduates' Beliefs and Actions of Mathematics and Science (2001), n=* 68.

[2] *National Center for Education Statistics,* Mathematics and Science in the Eighth Grade *(2000), n* =478.

Table 5-2. Comparison of MCTP Teachers' Perceptions of Student Skills Required for Success in Mathematics with Those of MSEG Sample by Percentage Responding " Very Important."

Item	MCTP[1]	National[2]	t	p
19. Remember formulas and procedures?	42.9%	43.0%	-.01	.9943
20. Think in sequential manner?	28.6%	79.5%	-4.11	.0012*
21. Understand concepts?	92.9%	88.9%	.53	.6024
22. Think creatively?	42.9%	65.4%	-1.63	.1275
23. Understand math use in the real world?	85.7%	81.7%	.41	.6879
24. Support solutions?	85.7%	80.8%	.48	.6394

[1] *MCTP Teacher's Beliefs and Actions of Mathematics and Science (2001): Middle school mathematics teachers. n=* 14.

[2] *National Center for Education Statistics,* Mathematics and Science in the Eighth Grade *(2000): Eighth-grade mathematics teachers. n* =246.

Table 6-1. Comparison of MCTP Graduates' Perceptions of Student Skills Required for Success in Science with Those of MSEG Sample by Percentage Responding "Very Important."

Item	MCTP[1]	National[2]	?2	p
25. Remember formulas and procedures?	14.7%	25.5%	3.79	.0517
26. Think in sequential manner?	39.7%	79.6%	50.04	.0000*
27. Understand concepts?	88.2%	84.0%	.82	.82
28. Think creatively?	61.8%	73.0%	3.70	.0546
29. Understand math use in the real world?	88.2%	79.2%	3.08	.0795
30. Support solutions?	89.7%	86.1%	.66	.4148

[1] *MCTP Graduates' Beliefs and Actions of Mathematics and Science (2001), n=* 68.

[2] *National Center for Education Statistics,* Mathematics and Science in the Eighth Grade *(2000), n* =478.

Table 6-2. Comparison of MCTP New Middle School Science Teachers' Perceptions of Student Skills Required for Success in Science with Those of MSEG Sample by Percentage Responding "Very Important."

Item	MCTP[1]	National[2]	*t*	*p*
25. Remember formulas and procedures?	11.1%	25.5%	-1.28	.2349
26. Think in sequential manner?	44.4%	79.6%	-2.09	.0696
27. Understand concepts?	88.9%	84.0%	.46	.6611
28. Think creatively?	66.7%	73.0%	-.39	.7065
29. Understand science use in the real world?	88.9%	79.2%	.88	.4052
30. Support solutions?	100%	86.1%	4.63	.0017*

[1] *MCTP New Middle School Science Teacher's Beliefs and Actions of Mathematics and Science (2001): n=* 9.

[2] *National Center for Education Statistics,* Mathematics and Science in the Eighth Grade *(2000): Eighth-grade science teachers. n* =232.

Table 7-1. Comparison of MCTP Teachers' Familiarity with Documents with That of MSEG Sample by Percentage at Least Fairly Familiar.

Item	MCTP[1]	National[2]	?2	p
31. Mathematics standards document (Curriculum and Evaluation Standards for School Mathematics).	47.0%	85.0%	57.00	.0000*
32. Science standards document Benchmarks for Science Literacy.	66.0%	26.0%	46.41	.0000*
33. Science standards document National Science Education Standards.	63.2%	-------	-------	-------

[1] *MCTP Teachers' Beliefs and Actions of Mathematics and Science (2001). n=* 68.

[2] *National Center for Education Statistics,* Mathematics and Science in the Eighth Grade *(2000). n* =478.

Table 7-2. Comparison of MCTP Teachers' Familiarity with Documents with That of MSEG Sample by Percentage at Least Fairly Familiar.

Item	MCTP[1]	National[2]	*t*	*p*
31. Mathematics standards document (Curriculum and Evaluation Standards for School Mathematics).	64.3%	85.0%	-1.61	.1319
32. Science standards document Benchmarks for Science Literacy.	88.9%	26.0%	5.84	.0004*
33. Science standards document National Science Education Standards.	88.9%	-------	-------	-------

[1] *MCTP Teacher's Beliefs and Actions of Mathematics and Science (2001): Middle school mathematics teachers (item 31), n=* 14. *Middle school science teachers (item 32, item 33), n=* 9.

[2] *National Center for Education Statistics, Mathematics and Science in the Eighth Grade (2000): Eighth-grade mathematics teachers (item 31), n* =246. *Eighth-grade science teachers (item 32), n* =232.

Table 8-1. Comparison of MCTP Elementary School Teachers' Use of Instructional Practices in Mathematics with Those of National Sample by Percentage Responding "Yes".

Item	MCTP[1]	National[2]	t	p
34. Assisting all students to achieve high standards.	100%	77%	7.67	.0000*
35. Providing examples of high-standard work.	100%	63%	8.81	.0000*
36. Using authentic assessments.	100%	55%	10.00	.0000*
37. Using standards aligned curricula.	100%	64%	9.00	.0000*
38. Using standards-aligned textbooks and materials.	92.9%	66%	4.28	.0002*
39. Using telecommunication-supported instruction.	64.3%	20%	4.61	.0001*
40. Making connections with science.	93.1%	-------	-------	-------

[1] *MCTP Teacher's Beliefs and Actions of Mathematics and Science (2001): Elementary school teachers. n=* 29.

[2] *Public School Teacher Survey on Education Reform (1996). n=473.*

Table 8-2. Comparison of MCTP Middle School Mathematics Teachers' Use of Instructional Practices in Mathematics with Those of TSER Sample by Percentage Responding "Yes."				
Item	MCTP[1]	National[2]	t	p
34. Assisting all students to achieve high standards.	100%	85%	7.14	.0000*
35. Providing examples of high-standard work.	100%	66%	8.10	.0000*
36. Using authentic assessments.	100%	49%	9.27	.0000*
37. Using standards aligned curricula.	92.9%	72%	2.63	.0208*
38. Using standards-aligned textbooks and materials.	85.7%	72%	1.33	.2062
39. Using telecommunication-supported instruction.	69.2%	27%	3.09	.0093*
40. Making connections with science.	92.3%	-------		

[1] *MCTP Teacher's Beliefs and Actions of Mathematics and Science (2001): Middle school mathematics teachers. n=* 14.

[2] *Public School Teacher Survey on Education Reform (1996). n=396.*

Table 9-1. Comparison of MCTP Elementary School Teachers' Use of Instructional Practices in Science with Those of National Sample by Percentage Responding "Yes."				
Item	MCTP[1]	National[2]	*t*	*p*
41. Assisting all students to achieve high standards.	100.0%	71%	9.06	.0000*
42. Providing examples of high-standard work.	100.0%	48%	14.86	.0000*
43. Using authentic assessments.	100.0%	44%	13.33	.0000*
44. Using standards aligned curricula.	96.4%	66%	5.71	.0000*
45. Using standards-aligned textbooks and materials.	85.7%	58%	3.70	.0010*
46. Using telecommunication-supported instruction.	75.0%	17%	6.57	.0000*
47. Making connections with mathematics.	96.6%	-------	-------	-------

[1] *MCTP Teacher's Beliefs and Actions of Mathematics and Science (2001): Elementary school teachers. n=* 29.

[2] *Public School Teacher Survey on Education Reform (1996). n=473.*

Table 9-2. Comparison of MCTP Middle School Science Teachers' Use of Instructional Practices in Science with Those of National Sample by Percentage Responding "Yes."

Item	MCTP[1]	National[2]	t	p
41. Assisting all students to achieve high standards.	100.0%	78%	5.00	.0011*
42. Providing examples of high-standard work.	88.9%	64%	2.06	.0730
43. Using authentic assessments.	100.0%	42%	10.36	.0000*
44. Using standards aligned curricula.	100.0%	65%	8.14	.0000*
45. Using standards-aligned textbooks and materials.	100.0%	60%	9.09	.0000*
46. Using telecommunication-supported instruction.	75.0%	29%	2.85	.0247*
47. Making connections with mathematics.	100.0%	-------		

[1] *MCTP Teacher's Beliefs and Actions of Mathematics and Science (2001): Middle school science teachers. n=9*

[2] *Public School Teacher Survey on Education Reform (1996). n=39*

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