DRAFT

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Papers to Appear in the Special Issue of the *Peabody Journal of Education*, to be Published in the Fall of 2008

Articles

PREFACE FOR THE SPECIAL ISSUE OF THE *PEABODY JOURNAL OF EDUCATION*, TO BE PUBLISHED IN THE FALL OF 2008

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The United States faces significant challenge in the fields of science, technology, engineering, and mathematics (often collectively referred to as STEM). Numerous reports from governmental, scientific, and civic communities have raised concerns over the quality of STEM education at all levels of the educational system, the shortage in the STEM labor force, and the decreasing competitiveness of student performance in STEM fields at the international level.

One indicator of the challenges lies in international comparison of student performance in math and science. The 2003 Trends in International Mathematics & Science Study (TIMSS), conducted by the National Center for Education Statistics of the U.S. Department of Education, ranked the United States 6th in 4th grade and 9th in 8th grade among industrialized nations in student performance in science (IEA 2003; Martin et al. 2004). Further, according to the 2003 Programme for International Student Assessment (PISA), an initiative of the Organisation for Economic Cooperation and Development (OECD), which assesses 15-year-olds' problem solving performances on various subjects, the U.S. scored below the average performance for the OECD countries (National Academy of Sciences 2007).

In light of these mixed performance records, the U.S. Congress has authorized several initiatives. Among the major strategies to address these concerns in STEM fields is the Math and Science Partnership (MSP) Program, a major national initiative funded by the National Science Foundation. As the NSF's original solicitation in 2002 stated, the MSP Program "seeks to improve student outcomes in high-quality mathematics and science for all students, at all pre-K-12 levels" (NSF 2001). At the same time, the Program promotes research and development in STEM. Toward these multiple objectives, the Program requires one or more Institutions of Higher Education (IHEs) to partner with K-12 public school districts to improve STEM activities. Since 2002, the MSP Program has awarded four cohorts of MSP grantees. The first three cohorts totaled 48 awards in 2002, 2003, and 2004, and their work is the subject of the studies highlighted in this volume.

Given the prominence of the MSP Program, the NSF has commissioned a multidisciplinary team of researchers from COSMOS Corporation, Brown University, and George Mason University to conduct a multi-year external evaluation. The collection of articles in this Special Issue represents a coordinated effort to evaluate the design, implementation, and some of the effects of the MSP Program. Taken as a whole, the research team maintains a comprehensive pool of disciplinary knowledge, including mathematics, chemistry, biology, physics, engineering, education, economics, political science, statistics, policy and program evaluation. Team members engage in a number of substudies, or briefs, which adopt different research designs and methods that range from econometric, psychometric, to qualitative and documentary analyses.

Led by COSMOS Corporation, the research team recognizes several design realities. The MSP Program consists of a set of separately funded projects. Each project was independently reviewed and approved as part of NSF's rigorous peer review process. In this regard, the Program attracted applicants who were likely to be experienced in organizing STEM activities that connect IHEs and school districts. In operational terms, the Program is defined by its awardees and the specific context within which each projects is situated. Although some MSPs invest in enhancing the quality of STEM activities at the university level, others focus on in-service activities on a particular STEM subject in a specific grade span in a cluster of public schools. The MSP Program therefore cannot be considered a homogenous effort that might, for instance, follow any singular research design, such as a randomized control experiment. Indeed, the MSP projects, themselves, employ an array of evaluative and research methods to study their varied strategies.

To study such a complex program that maintains multiple sites, institutions, foci, and relationships, the evaluation team adopts a comprehensive evaluation agenda that spans K-20. In his overview of the evaluation project, Robert K. Yin highlights that the essence of the program evaluation is to consider the MSP Program as a whole and not to assess any of the awards individually. His article traces the rationale behind a multi-institutional framework that covers a series of pathways in the K-20 span of mathematics and science education. For example, high school graduates may proceed to undergraduate and graduate careers, including the teaching profession that instructs the next generation on STEM fields. This systems approach calls for a series of briefs that collectively address the multifaceted inter-organizational and intra-organizational relationships in the MSP Program.

Three articles examine the challenge of teacher quality and supply in math and science. In “A Review of the Literature on Mathematics and Science Teacher Quality,” Johnna Bolyard and Patricia S. Moyer-Packenham synthesize approximately 150 studies on teacher quality and student outcomes in mathematics and science. At the secondary level, the authors found a generally positive relationship between teacher subject matter knowledge and pedagogical training and student achievement. However, at the elementary level, the relationship seems to be inconclusive. This may to be due to the observation that “elementary teachers are usually generalist and their credentials reflect this status.” These findings are likely to have broad implications on teacher training.

Using econometric methods, John Tyler and Svetla Vitanova examine the relationship between the MSP Program and the supply of certified teachers in Mathematics. In recent years, numerous studies have identified the shortage of certified math teachers as an important factor in the lack of academic progress in mathematics. In “Does MSP Participation Increase the Supply of Math Teachers? Developing and Testing an Analytic Model,” the authors propose a set of analytic parameters in estimating the extent to which the MSP Program may address this challenge of math teacher shortage. At issue is whether the MSPs can increase teacher supply given existing constraints, including district use of uncertified teachers, lack of flexibility in using differential salaries to attract teachers in math and science, and the value on salaries that potential teachers (or college graduates) place on compensation in the labor market. Using Texas's three MSPs for illustrative purpose, Tyler and Vitanova argue for the reasonableness of their developed model in estimating the MSP Program effect on teacher supply.

Patricia S. Moyer-Packenham, Johnna Bolyard, Anastasia Kitsantas, and Hana Oh examine the ways in which grantees in the MSP Program document teacher quality in math and science fields. The research team analyzed 123 annual and evaluation reports, in addition to awardees websites, publications, and presentations. Based on an extensive documentary analysis of 48 MSP-funded projects, the research team found that the awardees have relied on externally-designed surveys and observations to define teacher quality and characteristics, including teacher beliefs and subject knowledge. The awardees' focus on these kinds of teacher characteristics did not come as a surprise, as they are connected to student achievement. While awardees' documents show their understanding on the complexity of teaching, locally-designed instruments often lack psychometric information.

Closely connected to teacher supply and quality is the delivery of curriculum, an issue addressed in "Mathematics Curriculum Systems: Models for Analysis of Curricular Innovation and Development." In this article, Margret A. Hjalmarson applies three models to analyze and categorize curriculum systems in the MSP Program sites. The three analytical perspectives are not meant to be mutually exclusive but instead provide different lenses on the curriculum foci. First, the content-based model directs our attention to the mathematics a student should know. It enables us to investigate how students engage in learning and how teachers address standards-based objectives. Second, the pedagogically-based approach illuminates the instructional methods used to engage the students. Particularly relevant are teachers' belief systems, mathematical knowledge, skills development, and interpretative practices. Third, the learner-centered perspective pays particular attention to learner-related goals and the ways teachers provide support for accomplishing these goals. This perspective enables us to consider the learning gaps among student subgroups.

To be sure, curricular and other activities in the MSP sites are situated in the broader context of partnerships between IHEs and school districts. In "A Review of Instruments to Evaluate Partnerships in Math and Science Education," Jennifer Scherer argues the importance of conducting self-evaluation as part of the ongoing effort to improve the work of partnerships. The author conducts a careful synthesis of the literature on self-evaluation and the evaluation instruments across various fields in human, social, and education services. This comprehensive review shows that there are a number of useful assessment instruments that measure the context, structure, capacity, and the intergovernmental and intraorganizational conditions of partnerships. The paper observes the utility in making use of different aspects of these existing instruments to address the needs of the MSPs. In other words, there are a great deal of existing tools available for self-assessment purposes.

Two articles address the issue of student achievement from different analytical perspectives. In “Initial Trends in MSP-Related Changes in Student Achievement with MIS Data,” Dimiter Dimitrov uses a within-group design and examines the relationship between the degree of MSP Program participation and student achievement. The annual survey of K-12 districts in the MSP Program for the first three program years provided the data for school and teacher participation as well as the school identification for gathering student achievement data. During the first three program years, the MSP Program’s participating schools show overall improvement in math and science proficiency. In examining teacher participation in MSP activities, Dimitrov observed a positive relationship between the school's targeted teacher participation in MSP-related activities and student proficiency in math and science at the elementary and high school levels. No observable relationship is found for middle schools. Since this paper uses a within-group design, it does not include a control group for the analysis. The latter is the focus of the next article.

Kenneth Wong and Ted Socha employ a comparative approach on student achievement. Their pilot study proposes a set of analytical steps for comparing schools that participate in the MSP Program and their non-participating peers in the same state. The study focuses on a sample of participating schools in one MSP in one state as identified by the annual survey of the K-12 districts in the MSP Program. The non-participating schools were systematically matched with the Program’s participating schools on eight demographic variables to form a comparison group. Student performance data come from publicly accessible school-level data that the research team retrieved from the state's department of education website for 2002-03 through 2004-05, as well as data available from the National Center for Education Statistics' Common Core of Data. This paper offers detailed documentation on how to operationalize two matching methods for comparative purposes. The paper concludes that carefully executed matching methods are promising for large scale comparative analysis on the effects of the MSP Program across different states.

Finally, Robert K. Yin, Daryl Chubin, and Edward Hackett investigate the complex issue of innovative activities in the broader context of the MSP Program as an education R&D effort. In "Discovering 'What's Innovative:' The Challenge of Evaluating Education R&D Efforts," the research team agues that the MSP Program can be assessed by contributions made to new ideas and practices in education. Because all R&D activities can be described in terms of one or more of four processes, namely, uncovering, inventing, explaining, and substantiating, the evaluation team can focus on monitoring innovative outcomes by examining evidence about the four processes in the MSP Program.

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Brown University. Robert K. Yin (COSMOS) serves as Principal Investigator (PI) and Jennifer Scherer (COSMOS) serves as one of three Co-Principal Investigators. Additional Co-Principal Investigators and their collaborating institutions (including discipline departments and math centers) are Patricia Moyer-Packenham (GMU) and Kenneth Wong (Brown).

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Glossary of Terms and Abbreviations for the Math and Science Partnership Program Evaluation (MSP-PE)

AP Program	Advanced Placement Program
ED	U.S. Department of Education
ED-MSP	Mathematics and Science Partnerships program administered by the U.S. Department of Education; a counterpart to NSF's MSP Program
IHE	Institution of higher education
LEA and SEA	Local education agency and state education agency
MAT	Master of Arts in Teaching
M/S or M&S	Math and science
MSP Program or NSF-MSP	NSF's Math and Science Partnership Program.
MSP-MIS	Math and Science Partnership (Program's) Management Information System, to obtain annual data from each MSP-funded project
MSPnet	MSPnet (the Math Science Partnership Network) provides the MSP program with a web-based, interactive electronic community (www.mspnet.org)
MSP-PE	Math and Science Partnership Program Evaluation
MSPs or MSP awardees	Math and Science Partnership awardees funded by the National Science Foundation under the MSP Program
NAS	National Academy of Sciences
NCLB	The No Child Left Behind Act signed into law in January 2002
NSB	National Science Board
NSF	National Science Foundation
OMB clearance	Office of Management and Budget, an agency of the executive branch of the federal government; OMB clearance is required to collect data from 10 or more individuals using a standardized data collection instrument
PD	Professional development
PIs or co-PIs	Principal investigators or co-principal investigators
Pre-K-12	Encompasses pre-Kindergarten, Kindergarten, and grades 1-12
R&D	Research and development
RETA	Research, Evaluation, and Technical Assistance
STEM (education)	Science, technology, engineering, and mathematics (education)
TA	Technical Assistance
TIMSS	Trends in International Mathematics and Science Study

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