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Math and Science Partnership Program Evaluation (MSP-PE)

Articles Published in Peer-Reviewed Journals: Progress by MSPs and RETAs in Contributing to Education Research and Practice

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The present draft is based on materials, information, and data that were available as of November 2008.

PREFACE

This study is one in a series of briefs for the Math and Science Partnership Program Evaluation (MSP-PE), conducted for the National Science Foundation's Math and Science Partnership Program (NSF-MSP). The MSP-PE is conducted under Contract No. EHR-0456995. Since 2007, Bernice Anderson, Ed.D., Senior Advisor for Evaluation, Directorate for Education and Human Resources, has served as the NSF Program Officer. The authors are Darnella Davis, Ed.D. and Robert K. Yin, Ph.D. of COSMOS Corporation. Kelsey Van Dyke (COSMOS) provided research assistance.

The MSP-PE is led by COSMOS Corporation. Robert K. Yin (COSMOS) serves as Principal Investigator (PI). Darnella Davis (COSMOS) serves as one of three Co-Principal Investigators. Additional Co-Principal Investigators are Kenneth Wong (Brown University) and Patricia Moyer-Packenham (Utah State University).

In addition to field notes and archival materials, this manuscript incorporates information available from the MSPs' annual and evaluators' reports submitted to NSF by November 2008.

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Progress by MSPs and RETAs in Contributing to Education Research and Practice

This study examines the contributions to education research and practice by NSF's Math and Science Partnership (MSP) Program. NSF's overall strategic plan calls for "advancing discovery, innovation and education beyond the frontiers of current knowledge, and empowering future generations in science and engineering" (NSF 06-48). In keeping with the overall strategic plan, the 2008 MSP Program solicitation (NSF 08-525) specifically states: "The Math and Science Partnership (MSP) program is a major research and development effort…MSP projects contribute to the knowledge base for mathematics and science education and serve as models that have a sufficiently strong evidence base to be replicated in educational practice." The MSP Program therefore falls within the broader context of research and development and current efforts to improve science, technology, engineering, and mathematics (STEM) education.

The MSP Program consists of comprehensive, targeted, and institute awards (MSPs) as well as research, evaluation, and technical assistance (RETA) awards. The study's findings show that the awardees have generated a large number of scholarly and practice-oriented publications. By this measure, the MSP Program appears to be making a solid contribution to education research and practice.

A. The Context for the MSP Program's Research and Development Role

A National Concern

Public concern over the need to improve education for U.S. students is tempered by the desire to make evidence-based decisions grounded in sound research. Historically, the relationship of educational research to practice has been fraught with challenges that range from ideological dissonance between researchers and practitioners to a lack of utility or the misapplication of research-based innovations (Henderson, Beach,

Finkelstein, and Larson, 2008; Hubbard, 2006; Hutchinson and Huberman, 1993). Recent efforts to develop a clearinghouse of instructional tools based on sound evidence have yielded but a trickle of research in mathematics and science education, amidst much controversy over reliability and timeliness (Herman, Boruch, Powell, Fleishman, and Maynard, 2006; Mervis, 2004; Schoenfeld, 2006). The logical implication is that additional avenues still need to be sought to enhance the relationship of research to practice, especially in the service of enhancing science, technology, engineering, and mathematics (STEM) education.

As another example aimed specifically at mathematics education, the National Mathematics Advisory Panel (2008) acknowledged the need for more research, especially research that identifies:

- Effective instructional practices, materials, and principles of instructional design;
- Mechanisms of learning;
- Ways to enhance teachers' effectiveness, including teacher education, that are directly tied to objective measures of student achievement; and
- Item and test features that improve the assessment of mathematical knowledge.

The Panel called for incentives to entice many accomplished researchers, who study basic components of mathematics learning, to shift their emphasis and invest some portion of their time to relevant educational research (p. xxvii). The Panel also encouraged the creation of cross-disciplinary research teams that bring psychologists, economists, and mathematicians together with mathematics educators.

The MSP Program's Objectives

An R&D Framework. As part of its MSP Program solicitations, NSF uses a framework based on one developed by RAND in 2003. The framework (see Exhibit 1) depicts a cycle of knowledge production and improvement of practice with many points of entry including:

- Studies of basic processes;
- Development and testing of new theories and knowledge;
- Development of tools, materials, and methods;
- Interventions, e.g., curriculum, professional development, or instructional programs;
- Use, development, and documentation of interventions in practice; and
- Findings about program effects and practices, i.e., insights about problems or new questions and problems.

The RAND R&D cycle presents a potential sequence for improving STEM education that underscores the importance of creating multi-disciplinary professional communities with expertise in practice, research, development, and dissemination. The report in which the R&D cycle appears (RAND Mathematics Study Panel, 2003) stresses the need for making research available to the public in a form that facilitates external evaluations of any stated claims. In essence, the cycle reflects the generation, framing, examination, generalizing, and extension of concepts and practices noted by the American Statistical Association, also as mentioned within NSF's solicitations (NSF 08-526).[1] The new ideas and practices positioned within this cycle of knowledge production and improvement of practice, which moves from basic to more applied research, can cover a broad range of topics.

[1] NSF's Division of Research on Learning in Formal and Informal Settings (DRL) also cited the model in a science education solicitation (NSF 07-595) and presented the modified RAND model as DRL's conceptual framework of a cycle of innovation and learning within which all of its programs are designed to complement each other.

A Practical Orientation. In terms of the nature of the research, the MSP Program does not specifically encourage *basic* research. In fact, despite being considered an R&D program, the early MSP solicitations urged awardees to work with large numbers of K-12 students. Thus, contained in the MSP solicitations are two messages germane to NSF's expectations for the MSPs. One envisions the MSP Program as a major R&D effort, while the second—as laid out in the initial RFP—encourages partnerships to "develop projects likely to impact 10,000 students or more," noting that funding requests should correlate with the scale and complexity of the proposed project in terms of the numbers of students and preservice and inservice teachers potentially impacted by the MSP project (NSF 02-190). The bulk of comprehensive and targeted MSPs' resources were therefore devoted to reaching thousands of students and hundreds of teachers, with some comprehensive funding levels attracting proposals that spanned across multi-state lines (subsequent funding of institute and RETA awards carried other stipulations).

Even without the objective of enacting improvements at a large scale, the social sciences tend to embody a more practical orientation when compared to the physical or natural sciences. Education research is similarly oriented toward the application of new ideas or practices.[2] Yet, as with all kinds of research, development occurs over a rather lengthy period of time and only in the rarest cases occurs as discrete events. Similarly, the funding of the development process usually occurs over multiple awards from multiple sponsors, making attribution to a given sponsor, much less to a single program such as the MSP Program, extremely tenuous. Thus, expectations about new ideas and practices that might emerge from the MSP Program include a strong practical orientation, existence within a stream of ideas and practices, and potentially lengthy dissemination and publication lags.

Current efforts to introduce research-based improvements into STEM education may draw wisdom from previous efforts such as the U.S. Department of Education's (ED) Project Innovation Packages, the Pilot State Dissemination Project, the Research

[2] A 2004 NSF portfolio review found that the vast majority of projects within the Division of Education and Human Resources (EHR) covered the practical portions of the research and development cycle (NSF 05-03).

and Development Utilization Program, the National Diffusion Network, the Educational Resources Information Center (ERIC) (Hutchinson and Huberman, 1993), as well as the more recent approach employed by ED's What Works Clearinghouse. Each of these initiatives has struggled to ensure quality while maximizing the reach of innovations. Each also underscores the difficulty of finding the most effective applications for research and development, or to borrow a term from the health field "knowledge translation" (Armstrong, Waters, Roberts, Oliver, and Popay, 2006).

Within the field of STEM education, these experiences signal a growing emphasis on the interactive nature of developing and adopting innovations into teaching and learning. The interactive aspect of the development and adoption process is particularly germane to the MSP Program in terms of the reciprocity required to initially engage K-12 practitioners and STEM institution of higher education (IHE) faculty in learning communities, as well as to sustain these relationships over time (Yin, July 2009).

In one respect, innovations in their early stages may be considered as concepts, whether they are radical or incremental, that ultimately serve to reorganize or restructure the way things are done within an organization, system, or society. They are new in that they are previously unknown or untested. Some contend that innovations are identified only in hindsight. This is seen in the criteria for judging the merit of research and development efforts for any number of prestigious prizes. For the Nobel prize, "a written work must have been issued in print or have been published in another form" and the research in question should have been verified by other researchers and become generally accepted (Clinedinst, 2005). This process results in prizes that are awarded years or even decades after completion of the original work.

For the current study, innovations may be thought of as new ideas emerging from the MSP Program and constituting potential practices for widespread use. As such, reference is made here to "candidate innovations" or simply "new ideas and practices" produced through R&D, or research-based, efforts. Such efforts involve the use of

formal research methods and the collection of empirical data, and the ideas must eventually appear in published form, to permit public scrutiny and peer review.[3]

A Variety of MSP Configurations. Innovations may spring from any of the four types of MSP awards within the MSP Program: comprehensive awards (an awardee covering an entire K-12 grade span); targeted awards (covering a selected number of grades or topics); institute awards (focusing on teacher training); or research, evaluation, and technical assistance (RETA) awards. The RETAs may study, support, provide tools for, or otherwise collaborate with one or more of the comprehensive, targeted, or institute MSPs, and the collaboration may include similar projects not funded directly by the NSF-MSP Program.

Among the various types, the RETAs' R&D efforts should constitute the clearest source of innovations. Specifically:

> *"The MSP RETA projects are intended to enhance the capacity of the MSP comprehensive and targeted projects to achieve their goals and to contribute to the development and dissemination of the knowledge base necessary to achieve sustained educational reform"* (NSF 03-541).

The RETAs were to support rigorous and innovative evaluation projects that developed models and tools for documenting, assessing, and assisting comprehensive, targeted, and institute MSP projects' progress toward their goals. Even when carrying out technical assistance, the RETAs also could conduct research focusing on at least one of the MSP Program's five key features: 1) Teacher Quality, Quantity, and Diversity; 2) Challenging Courses and Curricula; 3) Institutional Change and Sustainability; 4) Partnership-Driven Focus; and 5) Evidence-Based Design and Outcomes.

[3] Such "research-based" innovations may be contrasted to "craft-based" innovations. The latter may lead to important advances in practice, but the innovations are transferred from one craft environment to another, without any necessary empirical study. These "craft-based" innovations therefore fall outside of the scope of this present study.

The 2003 MSP Program solicitation (NSF 03-605) also encouraged support for research on the characteristics that define STEM teacher intellectual leadership and the factors that contribute to its development. Such efforts would include development of assessments of teacher growth in content knowledge, mathematics or science education leadership, and reflective practice.

As previously mentioned, the valued research contributions must appear in some formal empirical form, usually taking the form of scientific, peer-reviewed publications. However, a multi-year period is usually needed to complete the research and then to develop the formal papers, much less to get them published. Typically, the publication cycle can take 18 months, while the data referenced in the manuscript may have been collected and analyzed 18 months prior to initial submission, resulting in a three-year lag. As a result, only in the later years of the MSP Program might the extent of the MSPs' contribution even begin to surface. Recognizing this lag, the present study nevertheless completed a preliminary review in 2008 of the MSP Program's publications.

B. Methodology

Framework for Evaluating R&D Contributions

Among the series of MSP-PE's studies, one is especially germane to this review: "Discovering 'What's Innovative:' The Challenge of Evaluating Education R&D Efforts" (Yin, Hackett, and Chubin, 2008). The article discusses the R&D objectives of the MSP Program against the backdrop of previous educational innovations. The article suggested a possible evaluation strategy (p. 675) that has been applied by the present study.

The strategy first identifies four discovery processes that may be pursued either alone or in combination: *uncovering, inventing, explaining, or substantiating* (see Exhibit 2 for examples of each process). The strategy goes on to suggest that evaluating the R&D accomplishments arising within a program can appropriately occur through the

monitoring of publications as the specific evidence of the four types of discovery and innovation. The publication processes are subject to a constant interplay between claim and counterclaim (e.g., Kelly and Yin, 2007), as new ideas or practices undergo peer review. In other words, each journal, by agreeing to publish a paper through its peer-review process, in effect vouches for the quality and the newness of the ideas in the paper as well as the soundness of the paper's research methods.

The present study therefore did not engage any additional set of experts to assess the quality of the published works. The ideas contained in these works were accepted as R&D contributions. The main research question posed by the current study then directed attention to the problem of attribution: whether the published work was based on data coming from an MSP's or a RETA's activities (and appeared no earlier than 2003-04), and if not, whether the work showed any connection to an MSP awardee.

Data Sources

Sources. To identify published works, the MSP-PE team first consulted the awardees' annual and evaluation reports, compiling a list of candidate documents. This list was expanded to include materials available online at MSPnet or published materials arising from the projects' own work, including items identified through reviews of the field notes from the MSP-PE's own site visits.[4] Where appropriate, the study team made follow-up calls to appropriate MSP staff or partnering organizations and conducted an extensive Internet search for the listed authors and citations, or affiliated institutions.

Data were collected for 48 comprehensive, targeted, and institute MSPs as well as for 28 RETAs. For the RETAs providing technical assistance, the expectation was that they would support educational practices, while other RETAs would be contributing more directly to research and development.

[4] For the comprehensive, targeted, and institute MSPs, the status of their R&D efforts was one of four major topics covered by the MSP-PE's own site visits, made to 47 MSPs from 2006 to 2008.

Thus, the initial list of candidate items benefited from access to a variety of sources. Recognizing that the first MSPs became active in 2002-03 and the lag time needed for publication of even preliminary findings is likely to be at least 12 months, only items appearing during or after 2003-04 are included. Finally, items referenced in the abstracts for the MSP Program's 2009 Learning Network Conference provided an opportunity to include more recent publications or manuscripts.

Limitations. First, and for the most part, the large number of candidate ideas and practices prohibited more than a brief review of texts, abstracts, summaries, or in some cases, titles (where additional information was not readily available). The study's analysis is therefore constrained by these limitations. In cases where no sound assessment of the nature of the effort could be made, items were eliminated or relegated to an "undetermined" or "doubtful" category.

Second, although a number of MSPs and RETAs include their own external evaluations among the items generated through their awards, these documents and their findings are not included here. Instead, the MSPs' evaluations are treated in a separate MSP-PE study that synthesizes those efforts (Yin, forthcoming).

C. Findings

Research Publications by the MSPs

Overall Contributions by the MSP Program. Evidence of the MSPs' and RETAs' contributions falls into two categories: 1) published works, and 2) other documented items. Within the trajectory of scholarly research and development, formal publication is the expected output, with other outputs normally indicating a more preliminary or tentative status. Within formal publications, peer-reviewed journal articles normally

reflect a dual review process of external review plus an editorial review.[5] Book-length publications generally undergo at least an editorial review, whether authored by a single individual, a group of authors, or when comprised of chapters by a series of different authors.

A Pool of 279 Published Works. The review of extant MSP data sources resulted in a list of 628 candidate items, of which 279 were published works of one sort or another (see Exhibit 3). All of the other candidate items appeared in the form of papers, manuscripts, presentations, or unpublished tools/products (see Appendix A and Exhibit A-1).

Examining the number of works produced from 2004 through 2008 reveals that the largest number was published in 2007 (about 30 percent), when many MSPs were nearing the end of their funding period and might have been expected to produce their findings. The second largest number occurred in 2005 (just over 20 percent).

When examining the average number of published works by type of MSP or RETA awardee, institute awardees, despite their small number and later start, have generated on average a larger number than any other type of awardee (an average of 7.1 publications[6]). The comprehensive MSPs averaged the second highest number (5.5 publications), perhaps due to their relative maturity and broader scope, and the targeted MSPs averaged 3.2 publications. Finally, RETAs on average produced the least number of published works (2.2 publications per RETA).

When the RETA awardees were separated by their primary focus, i.e., either technical assistance (TA) or R&D, the results differed somewhat. The average number of published works among TA RETAs was a fraction of the average number for research-

[5] The term "peer-reviewed journal" follows the more general definition: "one that has submitted most of its published articles for review by experts who are not part of the editorial staff" (American College of Physicians, 1993). This broader definition may include but is distinct from the narrower term "refereed publications" which refers to the process in which an editor sends a manuscript to three or four external specialists for comment and a determination as to the merit of the submission.

[6] This average masks an unequal distribution with nearly half of the publications produced by one awardee and none generated by one in four institutes.

focused RETAs (0.5 and 3.5 published works, respectively). Despite this difference, research-focused RETAs still generated fewer published works on average than institute or comprehensive awardees, and just barely more than targeted awardees.

The MSP Program also anticipated the generation of concepts that could be tried and then replicated, based on strong evidence of their utility in supporting programmatic objectives. A preliminary analysis showed that at least 16 of the 279 published works focused on the development or elaboration of replicable models. Some awardees are concerned with developing frameworks for improving assessments or understanding student inquiry. Others are concerned with models for partnering, better structuring professional learning communities, or detailing a theory of action.

Despite the practicality required in reaching a large number of students, the concepts guiding these intentionally replicable models may be viewed as bridging theory and practice. In this respect, the focus of these published works is more clearly defining research topics that may require the development of new instrumentation or processes.

Potential Skew in the Distribution of Published Works, by MSP. Despite the generation of large numbers of published works by all types of MSP and RETA awardees, some of the individual awardees were more prolific than others. In one case, an awardee published 14 items in a special journal issue, then 14 more two years later. Three other awardees had 28, 24, and 24 published works respectively. However, despite the large number of published works by a few awardees, 50 of 82 awardees had at least one published work, with an average of 5.58 publications each.

Articles in Peer-Reviewed Journals. To examine a portion of the 279 published works more closely, the present study focused on articles appearing in journals, and in particular in peer-reviewed journals. Omitted and therefore to be covered in a follow-up study were therefore about half of the remaining 279 published works, including 8 books, 36 chapters in books, and 14 published manuals or protocols, with some in this last category having been commercially published for use in conjunction with textbooks. The

works appearing as journal articles nevertheless represented a good portion of the portfolio, deserving attention in their own right, especially because the existence of a peer-review process presumably was associated with the higher quality articles.

The list of 279 published works was therefore screened for those appearing as journal articles, along with the peer-review status of the journal. This resulted in identifying 143 articles published in 67 peer-reviewed journals (again, see Exhibit 3). The appearance of the 143 articles in peer-reviewed journals itself attests to the R&D contribution of the MSP Program. These articles constitute a body of work vetted through the process of claim and counterclaim inherent in the nature of peer-reviewed publications (Yin, Hackett, and Chubin, 2008).

A majority (58 percent) of the 67 peer-reviewed journals covered some STEM field. These included journals in STEM education as well as STEM disciplines. The remaining journals (41 percent) were outside of either STEM education or a STEM discipline (see Exhibit 4). Similarly, the bulk of the published articles (65 percent) appeared in some STEM field. The current study's main findings are based on assessing the extent to which the contents of the 143 articles actually reflected or were affiliated with the MSPs' or RETAs' activities.

Attribution Rating Scale. The assessment was based on a 14-point attribution rating scale applied to each of the 143 articles (see Appendix A for additional methodological details). The rationale for the assigned weights of the attribution rating scale was to distinguish among the varying degrees to which the peer-reviewed articles were connected to the MSPs' or RETAs' activities. The final attribution rating scale comprised five components, resulting in total scores that could range from 0 to 14:

1. The article explicitly states that the data come from or were about one or more of the MSPs' activities. = 7
2. The article credits the MSP or RETA award as a source of support for the research (a partial score of "2" was given where the publication mentioned the MSP or RETA but did not explicitly identify the MSP or RETA award as the source of support). = 4
3. The author(s) of the article is (are) affiliated with a core partner of the MSP or RETA. = 1
4. Some part of the data collection occurred after the MSP's or RETA's startup, not earlier. = 1
5. The topic of the article is consistent with the main activities of the MSP or RETA, even though the data may have come from some other source. = 1

TOTAL: 14

The assignment of the component scores permitted the articles to be assigned to four different categories, each describing the level of attribution (*high*, *medium*, *low*, and *no apparent connection*):

- *High* (articles scoring 6 or more points)—an article showed at least three connections or explicitly stated that its data came from an MSP's or RETA's activities;
- *Medium* (articles scoring from 2 to 5 points)—an article showed at least two connections to an MSP or RETA;
- *Low* (articles scoring 1 point)— an article exhibited only one connection; and
- *No Apparent Connection* (articles scoring 0 points)—an article exhibited no connection to an MSP or RETA even though the MSP or RETA had listed the article among its products in an annual report, on its Web site, or in other sources.

Publications of Non-Empirical Work. Some articles presented theoretical statements or practical exercises but did not necessarily involve any formal data collection. In those cases, the article could still attain a *high* rating if it:

- Credited the MSP or RETA award with support (4 points);
- Indicated that the author was affiliated with a core partner (1 point); and
- Covered a topic consistent with the main activities of the MSP or RETA (1 point).

By covering all these points, an article making a theoretical statement or presenting a practical exercise could achieve a total score of six. Alternatively, the article might not have exhibited all of these desirable features and would then have been rated *medium* or *low*.

The Attribution Rating Scale as it Pertains to RETAs Only. As part of their award conditions, the RETAs could collaborate with comprehensive, targeted, or institute MSPs as well as non-MSPs. Nevertheless, to maintain a consistent scoring procedure, RETAs' articles not indicating data collected from MSPs or mentioning the MSPs or the MSP Program in their text could therefore fail to attain a score of either "7" on the first scoring component or even a partial score of "2" on the second scoring component. At best, such RETAs could therefore only have been ranked *medium* or *low*. All RETAs, including those that might only have collaborated with non-MSP sites, are discussed in a later section of the current study, giving these kinds of variations attention in a qualitative sense and thus not overlooking them completely.

Attribution Rating Scores

All 143 articles were rated according to the directness of their connection to a given MSP's work. The result was that 39 articles (27.3 percent) scored "high," 43 (30.1

percent) "medium," 54 (37.8 percent) "low," and 7 (5.0 percent) appeared to have no apparent connection to an MSP or RETA (see Exhibit 5).[7]

Component Scores. Exhibit 6 presents a breakdown of the attribution rating scores by the five components of the rating scale. The results showed that 13.2 percent of the articles mentioned that the MSP or RETA was the source of evidence, 14.7 percent collected MSP data during the funded period, and 28.7 percent cited the MSP or RETA as a source of support. A majority of the articles covered the MSP's or RETA's main thrust, while most were authored by individuals affiliated with an MSP's or RETA's core partner. When viewed by MSP type and by RETA, the institute and RETA awards showed the highest proportion of articles with links to MSP- or RETA-funded activities (see Exhibit 7).

Potential Skew in the Distribution of Articles across MSPs and RETAs. Despite the prolific publication of research among a handful of MSP and RETA awardees described earlier, Exhibit 8 shows that many different MSP and RETA awardees have participated in producing the more highly rated peer-reviewed articles. For instance, the articles rated "high" come from 23 awardees, with 31 of the pool of 82 MSP and RETA awardees producing an average of 4.5 peer-reviewed articles.

R&D Contributions. Descriptions of the 39 articles scoring high on the attribution rating scale are provided in Exhibit 9. The 39 descriptions serve as illustrative summaries of the R&D contributions being generated by the MSP Program. Of these 39 articles, nine focused on research, 12 on practice, 15 on development, and three on dissemination. Those with the highest attribution scores (either 13 or 14 points) also are spread, with three focused on research, five on practice, four on development, and two on dissemination.

[7] The evaluation team located complete texts or abstracts for 117 of the 143 peer-reviewed articles, but only citations were available for the remaining 24 articles, which therefore could at best attain a rating of "1" if the author(s) was (were) affiliated with a core partner.

The nature of the research covered among these articles is highly varied on a number of dimensions. The topics range from state-level policy implications of student achievement trajectories to concepts that may augment current practices in teaching division. Study participants range from principals to STEM undergraduates to elementary school pupils, although most carry implications for improving teacher training, instructional practice, or a combination of both.

Contained within this body of publications are also articles focused on practice that argue, for example, in support of a statewide mathematics specialist master's degree, but are empirically grounded in the experiences of the authors. These "practice" articles may be helpful to awardees concerned with learning from STEM practitioners with leadership roles in their respective professional communities.

Among the articles with maximum scores of 14, the study team noted research reported by Semken and Freeman (2007) as an example of an excellent research study. It has a tight focus (in this case on the potential influence of place-based science instruction among undergraduate students from indigenous or historically inhibited communities), presents an appropriately chosen dataset, conducts a rigorous set of analyses, and states necessary caveats.

Finally, the peer-reviewed articles also have included those authored by undergraduate, graduate, or postdoctoral students. Thus, among the 143 articles, 10 were produced by aspiring mathematicians and scientists supported with MSP or RETA funds. In a number of cases, these students played a role in the MSP's or RETA's activities, either assisting in the development of curricula, contributing to teacher training, or helping in the collection or analysis of evaluative data. Overall, the findings show that the MSP and RETA awardees' efforts have produced many publications that have collectively signaled a visible contribution to education R&D.

RETAs' Activities

A closer examination of the activities of the RETA awards was warranted given their special charge to conduct research and development. Although the RETAs may serve either a largely technical assistance role or have a more research-oriented focus, as noted earlier, the expectation has been that the RETAs would constitute a clear source of innovations.

In its first three cohorts, NSF funded 28 RETA projects: 11 in 2002-03, 11 in 2003-04, and six in 2004-05. Notably, the RETAs were to collaborate with the comprehensive, targeted, or institute MSPs as research sites in efforts to understand the "processes that support continuous improvement of K-12 mathematics and science teaching and learning…" (NSF 03-541). Expected outputs include the development of new models and tools that MSPs could utilize and the technical assistance needed to put the models and tools to effective use.

The RETAs have had considerable variation in funding and project duration. Although many RETAs are five-year projects, at least one concerned with intrastate standards lasted only a year. Similarly, funding amounts ranged from just under $70,000 to nearly $5.4 million. An important caveat about the RETAs is their role as technical assistance providers. Twelve of the 28 RETAs that were funded by 2008 (42.9 percent) had as their main thrust the provision of technical assistance to MSP projects. This means that the remaining 57.1 percent were pursuing more research-oriented efforts. As such, this latter group of 16 non-TA RETAs is of greater interest to this present study.

RETAs' Collaborations with the MSPs. The nature of the interface between the RETAs and the comprehensive, targeted, or institute MSPs has varied according to each project's core activities. As of 2007, most of the RETAs (17 of the 22 responding to MSP-MIS queries[8]) had collaborated with MSPs to some degree: six had worked very closely with MSPs; three had collected data while making some contribution to their

[8] These data are drawn from the MSP management information system (MSP-MIS).

MSP counterpart(s); and eight had only used the MSPs' assistance for data collection. Two of these 17 RETAs, in addition to working with the MSPs in one of the preceding ways, also had conducted conferences, evaluation summits, or meetings, inviting large numbers of MSP participants. None of the five remaining RETAs had any interactions with individual MSPs. With regard to the extent of collaboration between the RETAs and the MSPs, some RETAs were working with nearly 30 MSPs. For all 17 RETAs that reported working with MSPs, the average collaboration comprised 15 MSPs.

Patterns among the comprehensive, targeted, or institute MSPs collaborating with RETAs suggest that the early MSP awardees were the least involved with RETAs. This tendency may be due to the one-year lag in the initiation of the RETAs, as the first cohort of MSPs might not have incorporated RETA-partnering into their initial proposals. However, by the second cohort, the comprehensive, targeted, or institute MSPs may have begun to anticipate partnering with the RETAs. Thus, the most recent cohorts of these MSPs appear to be interacting with the largest number of RETAs. Further analysis of the nature of these interactions is needed to understand the relative benefits of working with a greater number of RETAs. However, such an investigation is beyond the scope of the current study.

As an example of the kinds of collaborations among comprehensive, targeted, or institute MSPs and RETAs, those RETAs engaged in developing instruments worked with participating MSP schools as data collection sites, to pilot and field-test items or protocols. In one instance, the RETA helped MSPs tailor an existing instrument to their individual needs, providing ongoing assistance in data collection and analysis throughout the process. For example, instruments can be used to match observations made at professional development events with classroom observations to assess the extent to which the training objectives have become part of classroom instruction. The RETAs also are well-positioned to coordinate the development and use of new measurement tools across several MSPs.

As another example, among RETAs intent upon doing research studies—such as those examining teacher induction, professional development, or content learning—the tendency was to collect data from the MSPs without necessarily providing direct benefits to the collaborating teachers, schools, or MSPs. Only one RETA reciprocated for its data collection functions by providing a 30-hour training course for principals.

In the aggregate, while many RETAs focused their activities on supporting comprehensive, targeted, or institute MSPs, many of them also either utilized the MSPs' schools as data collection sites or engaged in activities that did not involve the MSPs.

Again, for many of these RETA projects, the NSF-RETA award supported only a portion of a wider research and development endeavor that over time also received important funding from other sources. These RETA awards were therefore part of a larger stream of research, making it difficult to attribute specific R&D contributions to the NSF-RETA award.

RETAs' Project Activities. A preliminary review of extant documents provided some perspective on the RETAs' activities. Exhibit 10 shows the activities among the 16 research-oriented RETAs. A number of these research-oriented RETAs targeted their activities at improving instruments and tools for measuring education processes and outcomes, whereas others developed new education models or tested existing ones. Still others focused their activities on improving education practices.

Among the tools, knowledge, and educational strategies that arose from the RETAs' work were a number of emerging ideas and practices. Few comprehensive, targeted, or institute MSPs have engaged in efforts to shape policy, but two RETAs have provided new frameworks aimed at enhancing state policies.

RETAs' Efforts to Share Tools, Approaches, and Findings. In assisting the MSPs, all of the RETAs were expected to share their tools, approaches, and findings. To this end, the RETAs have presented their work and findings at professional conferences and

also have shared instruments and materials. With regard to the 143 articles in peer-reviewed journals (in contrast to all 279 published works) the RETAs have not differed markedly from the MSPs in the number of articles per awardee, and the RETAs' attribution ratings are somewhat higher than those for comprehensive, targeted, and institute MSPs (see Exhibit 7).

Some of the RETAs' scholarly articles, mainly published in education journals, have informed the education community in general and not just the MSPs. For example, the project staff of one RETA reported that a journal publication on cognitive validity of motivation-related assessments that appeared in the *Educational Psychologist* in 2007 had already become "mandatory reading in the field" (Karabenick et al., 2007). In general, the topics of RETAs' journal articles ranged from teacher quality and professional development to methodological issues in assessment.

Cross-site Use of RETA Instruments. Several instruments developed, tested, and piloted by RETAs are being utilized by a number of MSPs. The instruments cover a variety of topics such as the role of motivation in increasing performance, teacher content knowledge, and content area leadership expertise in practice. Reportedly, at least 10 comprehensive, targeted, or institute MSPs and two RETAs are using Learning Mathematics for Teaching (LMT) measures developed by the coordinators of one RETA, Ball and Hill (2008). These awardees form a portion of the 150 research projects, including numerous ED-MSPs that have received the LMT instruments. The utility of the LMT for MSP awardees is that it measures not just teacher content knowledge but teacher content knowledge for teaching.

Similarly, the School Staff Social Network Questionnaire (SSSNQ) has been validated and used in close partnership with an institute MSP. The web-based survey operationalizes the notion of leadership as a social influence. SSSNQ measures interactions by using social network analysis (Pustejovsky, Spillane, Heaton, and Lewis, 2008).

By design, two RETAs have played important roles in compiling and sharing education research information. These RETAs are discussed next.

The MSPnet RETA.[9] By funding one RETA (MSPnet) that created and continues to support an electronic learning community, NSF encouraged all MSP-related activities to be shared within the program and beyond. The distinctive creation of MSPnet has enabled comprehensive, targeted, and institute MSPs and RETAs to post information and queries and to support dialogues among individuals and groups with common interests.

The MSPs' and RETAs' available work may be accessed via MSPnet in four ways:

1) The MSP section of the online *Library* contains items deemed research-oriented and meeting publication or pre-publication specifications;
2) *Project Highlights* are more akin to announcements or promotional materials;
3) The *Conferences* section includes Posters that cover context; claims examined; design, data, and analysis; results; and conclusions; and
4) The *Resources* section provides a location for items not appropriate under the other links.

Decisions on how to classify items and where to post them (many items are posted under multiple categories) are made by MSPnet staff on an ongoing basis. In making their selections, staff keep in mind both the likely category fit and the item's potential interest for various audiences. The online site has a permission-based structure that enables postings to be viewed only by certain individuals, a single project or groups of projects,[10] members of the MSP community, or more broadly by the general public. Thus, publicly accessible items are only "the tip of the iceberg."

Since its inception, MSPnet has adapted to shifts in the demographics of its users. Based on feedback from surveys, focus groups, and informal conversations, the site's

[9] Information in this section is based on archival data and an interview with MSPnet staff conducted on November 17, 2008.

[10] One MSP has 30 working groups.

staff has adjusted content. As of fall 2008, staff noted that their initial audience was comprised of about 350 principal investigators but had grown to include some 5,000 members—many of whom are teachers being served through MSP or RETA project activities. Nearing the close of 2008, the site had been accessed by over 1.3 million discrete individuals.

Although MSPnet represents a groundbreaking effort to make information from the MSP Program available in a timelier manner than the normal publication cycle permits, and at an unusually large scale, not all MSP and RETA awardees have participated in this effort, where contributions are voluntary. In addition, MSPnet's goal of providing relevant resources in support of the MSPs' and RETAs' activities is attained by including many more education-related items than those attributable to the MSP Program. Finally, many journal articles, book chapters, or monographs produced directly by the MSP and RETA awardees are copyright-protected by commercial publishers and may not be shared through MSPnet.

As a by-product of these preceding conditions, only a small fraction of the published works and articles retrieved in the present study were available through MSPnet. First, only 15 percent of the 279 published works reviewed in this study were available from MSPnet. Second, of the 143 articles in peer-reviewed journals, only 10 percent were available.

Although copyright issues may strongly affect these proportions, MSPnet contains no readily-available complete listing of these MSP- and RETA-related works, either. Such a listing alone, possibly augmented by abstracts and manipulable by subject categories, would constitute an important service by MSPnet on behalf of its sponsoring MSP Program. In addition, MSPnet might even consider writing reviews of these published works. The reviews could be deliberately crafted to serve the needs of the MSPs and RETAs.

The KMD RETA. Another distinctive RETA information-sharing effort is the Knowledge Management and Dissemination (KMD) RETA. It reviews, synthesizes, and provides online links to resources designed to support ongoing MSP activities. The RETA developed a standards-of-evidence codebook to screen research-based literature. Its own reviews have included searches for relevant studies, instruments, and measures. KMD's efforts reflect NSF's MSP objective of encouraging partnerships to base their actions on sound, research-based evidence. For instance, the KMD Web site presents research-based resources for deepening teacher content knowledge and building teacher leaders, as well as a searchable database with descriptions of 62 instruments for measuring teacher knowledge.

In addition to these resources, KMD staff also seek to extend the notion of sources of evidence to cover expert knowledge or experience. For example, the staff claim that empirical research does not provide sufficient guidance for selecting action plans at the local level (Miller, 2008, p. 3). The need for guidance is important because the MSP awardees are expected to draw on the accumulated knowledge from the field, however incomplete. Thus, in addition to acquiring empirical research findings, KMD also is gathering *practice-based* insights among the MSP awardees. This expert knowledge and advice is being gleaned through interviews, focus groups, and online discussions and panels.

Synthesizing the lessons learned from these two sources, empirical research and practice-based knowledge gained from MSP participants, KMD then provides advice for MSPs' planning and ongoing activities. As such, KMD also acts as a clearinghouse, dispensing guidance for those less well schooled in deciphering research or accessing a larger pool of experiences.

The Importance of the RETAs' Overall Role in the MSP Program. The RETAs have been a valuable part of the MSP Program. They have strengthened the R&D mission of the program by engaging nationally recognized experts from STEM disciplinary and education fields. They also have extended the reach of their efforts by making greater

use of the MSPs' experiences, whether collecting data or conducting research studies—at times working with large numbers of MSPs and their participating teachers, schools, and districts. Another important RETA contribution has been in developing tools in the form of resources for providing instruction, measuring student or teacher progress, or interpreting data for improving teaching and learning. As seen in the two examples above, RETAs have played key roles in information sharing.

At the same time, there is room for improvement. The RETAs should now have a greater understanding of the coordination needed to implement more successful collaborative activities. They also may be in a better position to disseminate useful information in a timely manner, while tailoring appropriate messages to relevant audiences.

D. Conclusions and Recommendations

The 279 published works identified by this study, including 143 articles published in peer-reviewed journals, provide evidence that MSPs and RETAs are heavily engaged in the R&D processes of uncovering, inventing, explaining, or substantiating new ideas, as previously defined by Yin, Hackett, and Chubin (2008). There also is an even larger pool of unpublished work, suggesting that not all MSPs and RETAs have yet proceeded to share the results of their research and development efforts. Many MSPs and RETAs may still be working with preliminary results or have yet to arrive at summative conclusions. In addition, the present study did not review the MSPs' and RETAs' published books, chapters in books, or textbook manuals—which are subjects of ongoing analysis. Thus, any identification of new issues or areas of interest at this stage is tentative.

Collectively, the comprehensive, targeted, and institute MSPs and RETAs are making contributions on topics such as teacher learning, instructional implementation, student discourse, and more effective assessments aligned with coherent curriculum and

the associated professional development. They also are generating important data on the opportunities and constraints of engaging disciplinary faculty in partnerships with K-12 school districts.

Among the dissemination items are a number suggesting new or improved standards, policies, and practices that in turn must be vetted at scale to prove their worth. In this respect, the MSP Program is adding new knowledge that may ease the way from research to practice. Although it yields no panacea, the MSP Program appears to be moving the field closer to a data-driven, evidence-based orientation in the professionalization of teaching while bringing in partners with clearer roles for contributing to improvements in STEM content teaching and learning.

Patterns among these findings suggest that the MSP Program is addressing the needs identified in the 2008 National Mathematics Advisory Panel's report. The accomplishment is achieved through the development of instructional practices and materials; making inroads into the mechanisms of learning, and by efforts to enhance teacher quality (including teacher education). Efforts to improve the assessment of knowledge gains are aided by tying these enhancements to objective measures of student achievement, while identifying item and test features.

Since its inception, the MSP Program's objectives have continued to evolve, bringing greater emphasis to research on understanding STEM teacher intellectual leadership. Collectively, the comprehensive, targeted, and institute MSPs and RETAs are sharing new ways of thinking about instructional leadership, teacher content knowledge gains, and opportunities for reflective practice. Some final comments growing out of the present study, may be viewed in terms of two broad themes that are described below.

Crafting Educational Technologies. One area requiring fresh concepts is new education technologies. A number of MSPs and RETAs are grappling with using educational technologies, whether through research tools such as the analysis of video archives or instructional tools such as the use of Personal Digital Assistants (PDAs) that

relay information to a regional database and back to practitioners in a form that aids classroom instruction.

However, apart from potentially innovative uses of technology in collecting, archiving, and processing data, the MSPs' and RETAs' efforts might be more accurately described as tinkering with, rather than reconceptualizing, tools that facilitate improvements in STEM education. In fact, for the "T" (technology) in "STEM," the current research and development contributions do not include any extensive efforts to critically assess advances in the use of technology such as the use of PDAs for collecting data in classroom settings, e-mentoring technologies, or online professional development courses and distance learning technologies. Nonetheless, MSP and RETA partnerships offer an opportunity to elaborate existing approaches such as social network analysis, as in the case of one MSP which is tracing the dissemination of ideas among MSP participants, but also linking impacts to student achievement.

R&D Diffusion and Utilization. The promising new areas of interest identified in the current study will not impact the field unless they reach beyond a small number of interested individuals. Ideally, these R&D outputs will inform the design of new programs and policies. For example, the topics of interest among the highly rated peer-reviewed publications cover the delivery or content of professional development (9 of the 39 articles) and the examination of curriculum (8 articles), while the measurement of teacher content knowledge was the third most prevalent subject among this group of articles. The prevalence of these subjects could signal an improvement in the interface between knowledge acquisition and application (Davis, 2009).

To promote the diffusion and utilization of these professional development as well as other topics, the MSPs' and RETAs' coordination with state-funded MSPs (ED-MSPs)

(Abt Associates, 2008)[11] may be a desirable way of extending the reach of the MSP Program's R&D contributions. Through this counterpoint program, the MSP and RETA awardees have already leveraged resources in support of improving STEM education. The NSF-MSPs and RETAs are reportedly partnering with 304 ED-MSP projects and share at least 185 common partners that include schools, school districts, and community colleges, as well as universities and other community-serving organizations (U.S. Department of Education, 2008).

The ED-MSP partnerships offer a larger, and sometimes more diverse, pool of teachers, students, classrooms, and learning environments than would be reached through the NSF-MSPs' and RETAs' partners or collaborations. In a number of instances, ED-MSPs' collaborations would appear to offer a greater range of venues in which new curricula, learning resources, assessments, and instructional practices can be tried, tested, critiqued, and shared by a variety of administrators, practitioners, and faculty from education as well as STEM departments. At times, these partnerships extend the reach of NSF's efforts throughout a region, while others bring in minority serving institutions or community colleges. These additional partners potentially enrich the perspectives from which new ideas and practices may be examined.

In addition, NSF-MSP partnerships with ED-MSPs may offer an opportunity to benefit from the alignment of curriculum, assessments, professional development, and shared objectives while realizing economies of scale. Such coherence may facilitate research and development by providing the needed mix of large numbers and diverse settings in which to test the robustness of ideas and practices, thereby serving NSF's goal of attaining broader impacts. As such, these coordinated efforts provide fertile ground

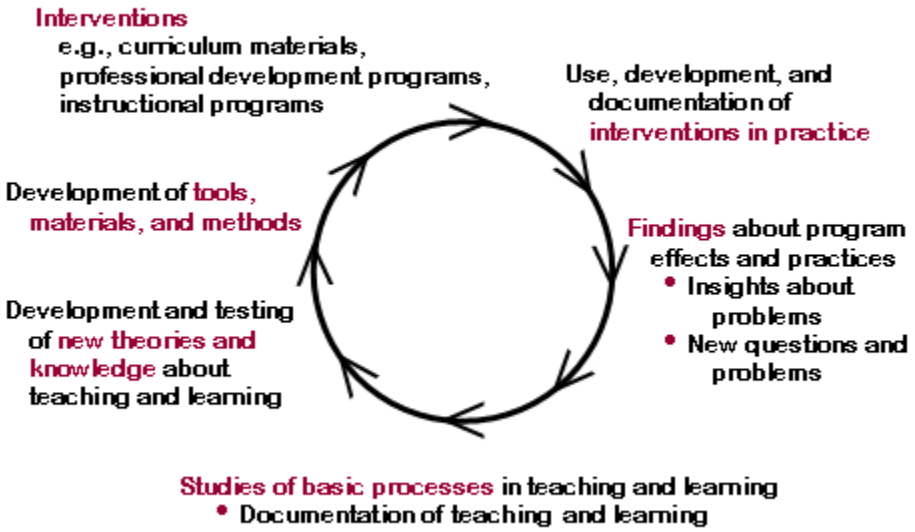
[11] The ED-MSPs—the "Mathematics and Science Partnerships"— are a counterpart to the NSF-MSP initiative, managed at the U.S. Department of Education. A U.S. House Committee report describes the complementarity of the two initiatives as follows: Whereas NSF's program is to fund "innovative programs to develop and establish new models of education reform, thereby remedying the lack of knowledge about math and science research," ED's program is aimed at "broadly implementing and disseminating new teaching materials, curricula, and training programs" (U.S. House of Representatives, 2003, p. 4). The ED-MSP is being separately evaluated, falling outside of the purview of the MSP-PE and hence of the present study.

upon which local, regional, and state agencies may build further R&D efforts and research to practice applications.

Yet, all of these considerations must take account of local contexts with their accompanying opportunities and constraints (Hubbard, 2006; Hutchinson and Huberman, 1993). This is particularly important given the distinctive nature of the MSP and RETA partnerships in bringing together K-12 practitioners and STEM faculty. Ideally, the MSP and RETA partnerships can overcome the resistance posed when the transfer of knowledge is perceived as a one-way flow, not only by accounting for the needs of intended recipients but by casting the user as an active participant co-constructing knowledge at every stage of the R&D cycle.

Exhibit 1

R&D CYCLE OF KNOWLEDGE PRODUCTION AND IMPROVEMENT OF PRACTICE



Source: RAND Mathematics Study Panel, 2003.

Exhibit 2

FOUR DISCOVERY AND INNOVATION PROCESSES

Process	Preceded by	Illustrative Item	Rivaled by
1. ***Uncovering***	• Making hunches → • Searching	Expectation (Pygmalion) Effect	Not new, not important, artifact
2. ***Inventing***	• Diagnosing → • Collecting/assembling → • Tinkering	Intelligence Testing	Not useful, not better, not novel ("obvious")
3. ***Explaining***	• Conceptualizing → • Criticizing extant theories → • Predicting	Time on Task	Not sound, not insightful, not logical, not plausible, not valid, not appropriate (e.g., reductionist)
4. ***Substantiating***	• Testing hypotheses → • Replicating → • Conducting meta-analyses	Summer Learning Loss	Spurious, uncontrolled, unsubstantiated, not statistically significant

Source: Yin, Hackett, and Chubin, 2008.

Exhibit 3

NUMBER OF PUBLISHED WORKS, BY TYPE (n=279 published works)

	No.	Percent
In Periodicals:		
- Peer-reviewed journals	143	51.2
- Non-peer-reviewed journals	15	5.4
- Journals with unknown review status	54	19.3
Subtotal	**212**	**75.9**
Other sources:		
- Book chapters	36	12.9
- Technical reports or monographs	9	3.2
- Manuals or protocols covering instrumentation or measurement tools	14	5.0
- Books	8	2.9
Subtotal	**67**	**24.0**
TOTAL	**279**	**99.9***

*Does not add to 100 percent due to rounding.

Source: See variety of sources described in the text.

Exhibit 4

DISTRIBUTION OF PEER-REVIEWED ARTICLES, BY JOURNAL DISCIPLINE (n=143 articles)

Discipline	Distribution			
	Of Journals		Of Articles	
	No.	Percent	No.	Percent
STEM Field:				
Science (general)	13	19.4	22	15.4
Chemistry	5	7.5	9	6.3
Biology	3	4.5	4	2.8
Engineering	3	4.5	4	2.8
Geography/geology	2	3.0	3	2.1
Math	9	13.4	19	13.3
Both Math & Science	4	6.0	32	22.4
Subtotal	**39**	**58.2**	**93**	**65.1**
Non-STEM Field:				
General	10	14.9	19	13.3
Evaluation, Research, Statistics, and Policy	6	9.0	9	6.3
Leadership	3	4.5	7	4.9
Learning, cognition	3	4.5	5	3.5
Teacher education	3	4.5	6	4.2
IHE	1	1.5	1	0.7
Administration	1	1.5	2	1.4
Information Technology	1	1.5	1	0.7
Subtotal	**28**	**41.9**	**50**	**35.0**
TOTAL	**67**	**100.1***	**143**	**100.1***

*Does not add to 100 percent due to rounding.

Source: See variety of sources described in the text.

Exhibit 5

NUMBER OF ARTICLES IN PEER-REVIEWED JOURNALS, BY ATTRIBUTION RATING SCORE (n=143 articles)

Attribution Rating	Articles	
	No.	Percent
High		
14	9	6.3
13	4	2.8
12	1	0.7
11	2	1.4
10	3	2.1
9	0	0.0
8	0	0.0
7	1	0.7
6	19	13.3
Subtotal	**39**	**27.3**
Medium		
5	2	1.4
4	2	1.4
3	0	0.0
2	39	27.3
Subtotal	**43**	**30.1**
Low		
1	54	37.8
No Apparent Connection		
0	7	5.0
TOTAL	**143**	**100.2***

*Does not add to 100 percent due to rounding.
Source: See variety of sources described in the text.

Exhibit 6

PEER-REVIEWED ARTICLES' ATTRIBUTION RATINGS, BY RATING COMPONENT

Attribution Rating Scale Component	Total No. with Positive Rating, by Variable (of 143 articles)*	
	No.	Percent
1. The article explicitly states that the data come from or were about the MSP's or RETA's activities.	19	13.2
2. The article credits the MSP or RETA award as a source of support for the research (a partial score of "2" was given where the publication mentioned the MSP or RETA but did not explicitly identify the MSP or RETA award as the source of support).	41	28.7
3. The author(s) of the article is (are) affiliated with a core partner of the MSP or RETA.	123	86.0
4. Some part of the data collection occurred after the MSP's or RETA's startup, not earlier.	21	14.7
5. The topic of the article is consistent with the main activities of the MSP or RETA, even though the data may have come from some other source.	84	58.7

*Table reports only positive ratings. When added, the negative ratings would total 100 percent for each rating item.

Source: See variety of sources described in the text.

Exhibit 7

PEER-REVIEWED ARTICLES' ATTRIBUTION RATINGS, OVERALL AND BY AWARD TYPE (n=143 articles)

By Type	High		Medium		Low		Total	
	No.	Average Score	No.	Average Score	No.	Average Score	No.	Average Score
MSPs								
Comprehensive	6	9.8	7	2.9	16	0.9	29	3.2
Targeted	15	10.3	9	2.2	25	1.0	49	4.2
Institute	7	8.4	13	2.0	14	0.8	34	2.8
RETAs	11	6.8	14	2.0	6	1.0	31	3.8
TOTAL	**39**	**9.1**	**43**	**2.2**	**61**	**0.9**	**143**	**3.6**

Source: See variety of sources described in the text.

Exhibit 8

DISTRIBUTION OF ARTICLES IN PEER-REVIEWED JOURNALS, BY ATTRIBUTION RATING AND NUMBER OF AWARDEES (n=143 articles)

Attribution Rating Category	Number of Awardees	Range of Articles Produced by MSPs and RETAs	Total Number of Articles
High			
	1	Over 6	6
	2	4-5	9
	3	2-3	7
	17	1	17
Subtotal	**23**	N/A	**39**
Medium			
	3	Over 6	26
	0	4-5	0
	4	2-3	9
	8	1	8
Subtotal	**15**	N/A	**43**
Low			
	4	Over 6	30
	0	4-5	0
	8	2-3	18
	6	1	6
Subtotal	**18**	N/A	**54**
No Apparent Connection			
	0	Over 6	0
	0	4-5	0
	2	2-3	5
	2	1	2
Subtotal	**4**	N/A	**7**
TOTAL	**31***	N/A	**143**

*Total represents MSPs and RETAs with publications, without overlap.
N/A=not applicable.
Source: See variety of sources described in the text.

Exhibit 9

DESCRIPTIONS OF ARTICLES WITH HIGH ATTRIBUTION SCORES, (n=39 articles)

Citation	Rating Focus and Attribution Score	
	Focus	**Score**
1. Anagnos, Thalia, Claire Komives, Nikos J. Mourtos, and Kurt M. McMullin, "Evaluating Student Mastery of Design of Experiment," *Proceedings of the 37th ASEE/IEEE Frontiers in Education Conference*, Milwaukee, WI, October 10-13, 2007. (MSP 35)	Develops and uses an instructional rubric to assess student mastery of design steps in engineering experiments, leading to course redesign and piloting of student-directed inquiries.	13
2. Ball, Deborah L., Mark Thames, and Geoffrey Phelps, "Content Knowledge for Teaching: What Makes it Special?" *Journal of Teacher Education*, Vol. 59, No. 5, 2008, pp. 389-407. (RETA 67)	Provides data supporting improved articulation of "pedagogical content knowledge" (PCK) by indicating at least two subdomains within PCK (knowledge of content and students, and knowledge of content and teaching) and one subdomain within "content knowledge" (specialized content knowledge unique to teaching, compared to common content knowledge needed by teachers and nonteachers alike).	6
3. Blount, David, and Judith Singleton, "The Role and Impact of the Mathematics Specialist from the Principals' Perspective," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 69-77. (MSP 44)	Studies policy and implementation issues involved in supporting mathematics specialists in local schools, highlighting principals' perspectives.	10
4. Bryant, Michael J., Kimberly A. Hammond, Kathleen M. Bocian, Michael F. Rettig, Cathy A. Miller, and Richard A. Cardullo, "School Performance will Fail to Meet Legislated Benchmarks," *Science*, 2008, 321, No. 5897, pp. 1781-1782. (MSP 13)	Projects proficiency rates for elementary school students in California based on analysis of state assessment data in the context of vulnerable subgroups of students with implications for PD planning, assessment tools, and legislation.	6
5. Cacciatore, Kristen L., Hannah Sevian, Jose Amado, and Jason J. Evans, "Connecting Solubility, Equilibrium, and Periodicity in a Green, Inquiry Experiment for the General Chemistry Laboratory," *Journal of Chemical Education*, Vol. 85, Issue 2, February 2008, pp. 251-253. (MSP 37)	Reports on the piloting and field testing of a inquiry-based chemistry experiment suitable for AP high school students.	13
6. Childs, Kimberly, Deborah Pace, and Karen E. Jenlink, "The Texas Middle and Secondary Mathematics Project: A Vision for Mathematics Educator Preparation in the 21st Century," Teacher *Education and Practice*, Vol. 17, Issue 4, Fall 2004, pp. 451-464. (MSP 20)	Describes the graduate degree program that prepares mathematics teacher leaders for middle and secondary schools.	6
7. Emdin, Christopher, and Ed Lehner, "Situating Cogenerative Dialogue in a Cosmopolitan Ethic," *Forum: Qualitative Social Research*, Vol. 7, No. 2, March 2006, Article 39. (MSP 38)	Examines the implications of supporting a dialogue of shared experiences and its impact on collective responsibility in the classroom, with the goal of improving teaching and learning in an urban setting.	6
8. Farley, Reuben W., William E. Haver and Loren D. Pitt, "Financial Support for Mathematics Specialists' Initiatives in Virginia," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 153-169. (MSP 44)	Describes the history of funding for development of a statewide mathematics specialist network and credential up to the start of the NSF-Teacher Professional Continuum (TPC) Program and the NSF-MSP Program.	6

(Continued)

(Exhibit 9, Continued)

Citation	Rating Focus and Attribution Score	
	Focus	**Score**
9. Fennell, Francis, "Elementary Mathematics Specialists--We Need Them Now! Follow Virginia's Lead," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 1-4. (MSP 44)	Presents the rationale for the advent of a statewide mathematics specialist requirement.	6
10. Ferrini-Mundy, Joan, Gail Burrill, and William H. Schmidt, "Building Teacher Capacity for Implementing Curricular Coherence: Mathematics Teacher Professional Development Tasks," *Journal of Mathematics Teacher Education*, Vol. 10, Issues 4-6, December 2007, pp. 311-324. (MSP 9)	Describes stronger teacher content knowledge when professional development is situated in a larger structure (where definitions and proofs and other math concepts were central), and shows how this reduced shallow and repetitive treatment in their own K-8 teaching.	14
11. Ford, Brent, and Melanie Taylor, "Investigating Students' Ideas about Plate Tectonics," *Science Scope*, Vol. 30, No. 1, September 2006, pp. 38-43. (MSP 62)	Studies development of a tool to measure middle school students' understanding of plate tectonics.	6
12. Halverson, Richard, Jeffrey Grigg, Reid Prichett, and Chris Thomas, "The New Instructional Leadership: Creating Data-Driven Instructional Systems in Schools," *Journal of School Leadership*, Vol. 17, No. 2, March 2007, pp. 159-194. (RETA 79)	Studies the implementation of data-driven instructional systems (DDIS) dedicated to making summative data on student learning useful for improving teaching and learning in schools.	7
13. Hedges, Melissa, DeAnn Huinker, and Meghan Steinmeyer, "Unpacking Division to Build Teachers' Mathematical Knowledge," *Teaching Children Mathematics*, Vol. 11, Issue 9, May 2005, p. 478. (MSP 10)	Demonstrates concepts needed to teach division, showing how these concepts augment those in existing teaching standards and textbooks.	6
14. Hill, Heather C., "Mathematical Knowledge of Middle School Teachers: Implications for the No Child Left Behind Policy Initiative," *Educational Evaluation and Policy Analysis*, Vol. 29, No. 2, 2007, pp. 95-114. (RETA 67)	Explores middle school teachers' mathematical knowledge for teaching and the relationship between such knowledge and teachers' subject matter preparation, certification type, teaching experience, and their students' poverty status.	6
15. Hill, Heather C., Deborah L. Ball, Merrie Blunk, Imani M. Goffney, and Brian Rowan, "Validating the Ecological Assumption: The Relationship of Measure Scores to Classroom Teaching and Student Learning," *Measurement: Interdisciplinary Research and Perspectives,* Vol. 5, No. 2-3, August 2007, pp. 107-118. (RETA 67)	Summarizes a RETA's attempts to uncover links between Learning Mathematics for Teaching (LMT) measures, classroom mathematics instruction, and student learning.	6
16. Hill, Heather C., Merrie Blunk, Charalambos Charalambous, Jennifer M. Lewis, Geoffrey C. Phelps, Laurie Sleep, and Deborah L. Ball, "Mathematical Knowledge for Teaching and the Mathematical Quality of Instruction: An Exploratory Study," *Cognition and Instruction*, Vol. 26, No. 4, October 2008, pp. 430-511. (RETA 67)	Tests the relationship between teacher subject matter knowledge and instruction, estimating its magnitude quantitatively and describing the factors that impinge on it qualitatively.	6
17. Hsu, Eric, Judy Kysh, Katherine Ramage, and Diane Resek, "Seeking Big Ideas in Algebra: The Evolution of a Task", *Journal of Mathematics Teacher Education*, Vol. 10, No. 4-6, December 2007, pp. 325-332. (MSP 28)	Demonstrates progress with lead teachers in using a "big idea" task to deepen their understanding of algebra while also providing ideas immediately useful in a classroom.	14

(Continued)

(Exhibit 9, Continued)

Citation	Rating Focus and Attribution Score	
	Focus	**Score**
18. Krause, Stephen, Veronica Burrows, J. Sutor, and Marilyn Carlson, "Addressing Gender Equity Pipeline Issues with a Workshop for High School Math and Science Teachers," *Frontiers in Education Annual Conference Proceedings*, Milwaukee, WI, October 10-13, 2007. (MSP 39)	Describes a workshop for high school science and mathematics teachers that explored gender issues, recording teachers' reflections in response to content on awareness, personal experience, literature findings, underlying causes, and possible ameliorative strategies and actions.	14
19. Krause, Stephen, Veronica Burrows, J. Sutor, and Marilyn Carlson, "High School Math and Science Teachers' Awareness of Gender-Equity Issues from a Research-Based Workshop," *American Society for Engineering Education Annual Conference Proceedings*, Honolulu, HI, June 26, 2007. (MSP 39)	Reports data collected from a workshop that was part of IHE course offerings to K-12 teachers; workshop focused on gender equity and gender barrier issues in K-12 math and science classrooms and how teachers might develop instructional strategies for overcoming these issues.	14
20. Krause, Stephen, Robert Culbertson, Marilyn Carlson, and Michael Oehrtman, "High School Teacher Change, Strategies, and Actions in a Professional Development Project Connecting Mathematics, Science, and Engineering," *Proceedings of the 38th ASEE/IEEE Frontiers in Education Conference*, Saratoga Springs, NY, October 22-25, 2008. (MSP 39)	Describes how a unifying concept of function is applied to promote conceptual competence in core content subjects and key problem solving processes within professional development courses and professional learning communities. Modules integrating math, science, and engineering are delivered in team-based studio labs complemented by associated PLCs.	13
21. Leege, Linda, Martha Schriver, and Karen Chassereau, "Under the Mistletoe," *The Science Teacher*, Vol. 75, No. 2, February 2008, pp. 48-52. (MSP 12)	Describes an inquiry-based life science project that incorporates science standards and collaborative research.	13
22. Lehner, Ed, "Creating Collaborative Third-Space Discourse to Address Coteaching Contradictions," *Forum: Qualitative Social Research*, Vol. 7, No. 4, September 2006, Article 19. (MSP 38)	Discusses the need for recursive, co-generative dialogue to navigate the differences among co-teachers to make co-teaching better.	6
23. Lias, Allan R., Sandra K. Fowler, E. Gregory Holdan, and Mark M. Maxwell, "Developing a Deep Understanding of Elementary School Mathematics: A Staff Development Partnership," *International Journal of Learning*, Vol. 12, 2006, p. 73. (MSP 11)	Uses "exemplary professional development materials" to help teachers develop a deeper mathematical understanding of elementary level math content and the pedagogical skills needed for deeper student understanding.	6
24. McClain, Anne, Dale Feldman, Lee Meadows, "Engineering Applications for Middle School Mathematics Education: Supporting an Inquiry-Based Classroom Environment," *Proceedings of the 2007 ASEE Annual Conference and Exposition*, Honolulu, Hawaii, June 24-27, 2007. (MSP 41)	Reports on research to help develop challenging middle school mathematics curricula, by deriving applications from the field of engineering.	14
25. Pagni, David, "Finding Areas on Dot Paper," *Mathematics Teaching in the Middle School*, Vol. 12, Issue 5, January 2007, pp. 274-282. (MSP 29)	Provides activity sheets to help middle school students discover area formulas (for rectangles, triangles, etc.) for themselves, to strengthen their ability to think mathematically.	10
26. Pecore, John L., Beth A. Christensen, Heather Mobley, and Nydia R. Hanna, "Earth Core: Enhancing Delivery of Geoscience Content in a Diverse School System During Times of Changing State Standards," *Journal of Geoscience Education*, Vol. 55, No. 5, December 2007, pp. 589-595. (MSP 12)	Describes a one-week workshop to increase teacher pedagogical knowledge of geoscience to meet revised state standards	14

(Continued)

(Exhibit 9, Continued)

Citation	Rating Focus and Attribution Score	
	Focus	**Score**
27. Pitt, Loren D., "Mathematics Teacher Specialists in Virginia: A History," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 23-31. (MSP 44)	Describes the history of current efforts to support mathematics specialists in Virginia and lessons learned from K-12 teacher encounters.	6
28. Pustejovsky, James E., James P. Spillane, Ruth Heaton, and James W. Lewis, "Understanding Teacher Leadership in Middle School Mathematics: A Collaborative Research Effort," *The Journal of Math and Science: Collaborative Explorations*, 2008. (RETA 74)	Draws data from Math in the Middle (MSP) participants to examine how teachers act as leaders in their schools while drawing support from a network of other teachers and IHE faculty.	14
29. Richard, Phillipe R., Josep M. Fortuny, Markus Hohenwarter, and Michel Gagnon, "GeogebraTUTOR: Une Nouvelle Approche pour la Recherche sur l'Apprentissage Compétentiel et Instrumenté de la Géométrie à l'Ecôle Secondaire," *Proceedings of the World Conference on E-Learning in Corporate, Government, Healthcare & Higher Education*, Québec, Canada, 2007. (MSP 45)	Describes a new approach to learning geometry along with scholarly applications for theory and development.	6
30. Rodriguez-Lopez, Margarita, and Arnaldo Carrasquillo, "Improving Conceptions in Analytical Chemistry: The Central Limit Theorem," *Journal of Chemical Education*, Vol. 83, Issue 11, November 2006, pp. 1645-1648. (MSP 8)	Describes relevance of teaching central limit theorem or including the topic in textbooks to help analytical chemistry students develop important skills.	6
31. Rosenberg, Steve, Mike Spillane, and Dan Wulf, "Heron Triangles and Moduli Spaces," *Mathematics Teacher*, Vol. 101, No. 9, May 2008, pp. 656-663. (MSP 29)	Examines whether triangles with the same area and perimeter are congruent as part of one MSP's efforts to develop mathematical thinking at the high school level.	11
32. Sack, Jacqueline J., "Commonplace Intersections within a High School Mathematics Leadership Institute," *Journal of Teacher Education*, Vol. 59, No. 2, 2008, pp. 189-199. (MSP 43)	Uses qualitative methods to study interactions between a professional developer and 30 teachers participating in inservice training, deriving lessons about resolving unanticipated conflicts.	14
33. Schilling, Stephen G., "The Role of Psychometric Modeling in Test Validation for the MKT Measures: An Application of Multidimensional Item Response Theory," *Measurement: Interdisciplinary Research and Perspectives*, Vol. 5, No. 2-3, August 2007, pp. 93-106. (RETA 67)	Examines the role of item response theory in test validation from a validity argument perspective.	6
34. Schilling, Stephen G., and Heather C. Hill, "Assessing Measures of Mathematical Knowledge for Teaching: A Validity Argument Approach," *Measurement: Interdisciplinary Research and Perspectives*, Vol. 5, No. 2-3, August 2007, pp. 70-80. (RETA 67)	Examines the validity argument approach; describes the motivation, conceptualization, and development of MKT measures; and details the interpretive argument.	6
35. Semken, Steven, and Carol B. Freeman, "Sense of Place in the Practice and Assessment of Place-Based Science Teaching," *Science Education*, Vol. 92, No. 6, November 2008, pp. 1042-1057. (MSP 39)	Reviews methods for teaching and evaluating "place-based" science that potentially makes undergraduate courses more appealing to students from indigenous or historically inhibited communities.	14

(Continued)

(Exhibit 9, Continued)

Citation	Rating Focus and Attribution Score	
	Focus	**Score**
36. Shen, Ji, Patrick C. Gibbons, John F. Wiegers, and Ann P. McMahon, "Using Research Based Assessment Tools in Professional Development in Current Electricity," *Journal of Science Teacher Education*, Vol. 18, No. 3, June 2007, pp. 431-459. (MSP 19)	Describes the development and testing of a research-based assessment tool to identify teachers' alternative content related conceptions and to discuss test results with teachers, as a way of improving professional development efforts.	10
37. Sinclair, Elizabeth, "The Mathematics Specialist: A Personal View," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, 2007. (MSP 44)	Describes the role of a mathematics specialist in a partner district and reflects on benefits from participation in NSF program.	11
38. Spillane, James P., "Distributed Leadership," *The Educational Forum*, Vol. 69, No. 2, Winter 2005, pp. 143-150. (RETA 74)	Examines how leadership is distributed over an interactive web of leaders and followers in regard to organizational routines, structures, and tools.	12
39. Spillane, James P., Amber Pareja, Carol Barnes, Eric Camburn, and Jason Huff, "Mixed Methods in Randomized Trials: Potentials and Pitfalls," *Educational Evaluation and Policy Analysis*, 2008. (RETA 74)	Studies the influence of leadership training experiences on participating principals' knowledge, practice, and their schools; uses qualitative and quantitative approaches in a randomized National Institute for School Leadership experiment.	6

Source: See variety of sources described in the text.

Exhibit 10

RESEARCH-ORIENTED RETAs' MAIN ACTIVITIES (n=16 RETAs)

Individual RETAs' Activities

1. Tested a methodology and procedures for evaluating PD programs and activities. Utilized interviews, a Web-based Activity Log, and previously developed surveys (the Surveys of Enacted Curriculum), to measure instructional practices of teachers and track PD. (RETA 56)
2. Used a Delphi panel and case study design, developed and tested a partnership model exploring how degrees of embeddedness among partners influence the process by which STEM educational outcomes are pursued and achieved. (RETA 60)
3. Investigated principals' leadership practices and empirical linkages between leadership practices, instruction, and students' math learning. Measured the nature of principals' leadership knowledge at baseline; provided leadership training through Lenses on Learning course; and measured leadership knowledge again to determine any changes in content knowledge or differences in the beliefs of teaching and learning. (RETA 66)
4. Examined teacher induction activities by carrying out in-depth case studies (interviews, observations, and document reviews) for selected induction programs. (RETA 69)
5. Conducted a systematic content analysis of problems in algebraic thinking to develop and disseminate a methodology of collaboration between mathematicians, teachers, and mathematics education researchers. Building on these efforts, instructional materials were developed that demonstrate the effectiveness of the methodology. (RETA 78)
6. Using a 4-year, longitudinal study design, examined the effects of STEM faculty engagement on teacher outcomes within the MSP program [Cohort II projects]. (RETA 71)
7. Using a survey in conjunction with interviews and observations, examined how leaders develop the capacity to integrate data use into instructional planning and practice within professional learning communities. (RETA 79)
8. Developed two sets of instruments to assess PD: 1) Developed, piloted, and field tested student and teacher assessment instruments to measure science content knowledge in three areas: Force and motion; plate tectonics; and flow of matter and energy in living systems, and 2) Created four tools which combine to measure opportunity to learn: classroom observation protocols; teacher interview protocols; daily instructional logs; and procedures for analyzing the enacted curriculum. (RETA 62)
9. Developed and tested motivation-related items to research how motivation-related outcomes contribute to student achievement. Created custom surveys for individual projects to measure motivation-related student outcomes. (RETA 65)
10. Created, validated, and piloted instruments to measure teachers' mathematics content knowledge and expanded the pool of items available to those wishing to construct their own instruments. (RETA 67)
11. Designed and piloted three tools to examine how distributed leadership practices effect changes in the practices in schools: 1) School Staff Network Survey, to identify instructional leadership; 2) Experience Sampling Methodology (ESM) log to document leadership practice; and 3) Instructional Leadership Daily Practice (DP) log, also to document practice. (RETA 68)
12. Conducted research syntheses to develop new models of the relationship between teacher characteristics and teacher quality. Developed a database of nearly 500 relevant studies and conducted research syntheses using a variety of new statistical strategies. (RETA 70)
13. Developed and field tested items and instruments to measure science misconceptions in earth and space science and physical science ("MOSART instruments"). (RETA 73)
14. Worked to develop theory about content leadership practice by continuing validation studies of the tools (previously developed under RETA 68) designed to generate empirical knowledge about content leadership practice and knowledge as well as how content leadership develops through formal and informal learning. Also designing leadership development modules with non-NSF funds. (RETA 74)
15. Developed a tool, the standards of evidence codebook, to examine, synthesize, and disseminate research studies in terms of their contributions to the subject knowledge base. Developing practice-based knowledge to complement research-based evidence as a resource for MSPs. (RETA 75)
16. Developed and conducted the Survey of MSP Evaluations to identify and address the challenges faced in the evaluation of the MSPs and developed designs for measuring outcomes of the MSP projects' activities. Utilized and shared a Web Alignment Tool (WAT), previously designed to produce reports on the alignment of curriculum standards and student assessments. (RETA 53)

Source: See variety of sources described in the text.

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APPENDIX

Appendix A

METHODOLOGY

Establishing the Pool of Candidate Items. The most recent annual and evaluators' reports (2003-04 or later), MSPs' and RETAs' Web sites, as well as MSPnet were reviewed for MSPs' and RETAs' contributions in the form of publications, presentations, documents, or tools. This process yielded 628 candidate items that appeared no earlier than 2003-04 (see Exhibit A-1).

The process of establishing the robustness of the initial list of 628 candidate items began by eliminating slides or presentations (n=107). These formats were deemed insufficient documentation for new ideas or practices. Tools and products (n=25) that were not formally disseminated through publication also were eliminated. The next step was to eliminate any paper (n=131) and then any manuscript (n=86) that did not meet the publication criteria. The criteria for determining if a document was published included:

1) The document must list the name of the source (i.e., journal, book, etc.) where it was published; and
2) The document must have been published, be "in press," or have been submitted for publication to a specific publisher.

Also eliminated were documents produced as part of the awardees' reporting obligations to NSF including annual reports themselves as well as the local evaluators' reports contained within them. (The body of unpublished work generated by the MSPs' local evaluators is the subject of a forthcoming MSP-PE substudy that is still underway.) Finally, newsletters, updates, as well as many technical reports or other diffusion vehicles promoted by the MSPs' and RETAs' were not included because they did not meet the criteria for a "fully-developed manuscript or a publication" intended to be strengthened through the claim and counterclaim process of peer review. This process left only those

items that had been published or were forthcoming in a named periodical or volume, still representing a large pool of published works (n=279).

The large number of published works prohibited a thorough examination of each item, necessitating a review based on accessible published works, abstracts, executive summaries, or a rapid assessment of the context in which the item emerged if the actual publication was unavailable. This process may have led to an inadvertent elimination of some viable publications or the inclusion of some items that greater scrutiny would have excluded.

To establish the peer-review status of the published works, the study team first examined the Web site for the cited journal or the journal publisher if appropriate. If these sources did not provide clear information about the peer-review process, the Educational Resources Information Center (ERIC) was consulted. ERIC contains a database of 947 journals and includes information on the peer-review status for many of these periodicals. The University of Maryland's Research Port Web site also was accessed for short descriptions of some journals that indicate the status of the peer-review process.

Winnowing the Pool. Establishing the peer-review status of the pool of candidate documents was the key to the final set of items reviewed in the present study. Among the 279 published works, 212 are articles appearing in periodicals. The remaining 67 published works are in the form of books (n=8), book chapters (n=36), manuals or protocols covering instrumentation or measurement tools (n=14), and technical reports or monographs (n=9).[1] Of the 212 articles appearing in periodicals, 143 articles are published in 67 peer-reviewed journals.[2] Exhibit A-2 contains a complete list of the 143 articles.

[1] For non-periodical publications, a consistent peer-review status could not be determined.

[2] This leaves 69 articles that were excluded from this study. Of the 69, 15 appeared in nine non-peer-reviewed journals, and 54 in journals whose peer-review status could not be determined. The final analysis of the 143 articles therefore represents a conservative estimate of the articles that might actually have appeared in peer-reviewed journals.

The limitations section of the main text provides a number of caveats about the study data and findings. Especially germane to the final attribution ratings of the 143 peer-reviewed articles is the fact that many articles may have inadvertently omitted their topic's connection to their MSPs' or RETAs' work or an acknowledgment of funding support by the MSP Program, resulting in more conservative but lower ratings. This is a subject that may be addressed in future directives by the MSP Program.

Attribution Rating Scale. The rating scale was based on five components. First, the assigned weights for the 14-point scale gave greatest recognition to those articles that analyzed and presented data from MSPs' activities. Peer-reviewed articles that showed evidence of this connection were assigned seven points.

Second, four points were given if the article acknowledged the MSP Program as a source of support for the research. Articles that mentioned the MSP or RETA but did not explicitly identify the MSP Program as a source of support were given a partial score of two of these four points.

Third, one point was given if the author(s) could be linked to the MSP or RETA as a member of a core partner, based on a search of the MSPs' and RETAs' extant documents or Web site, MSPnet, or the author's affiliated IHE or organization.

Fourth, one point also was given when the topic of the article was consistent with the main activities or objectives of the individual MSP or RETA. Fifth, one point was given if the article noted that the data under discussion had been collected within the time period designated in the study criteria, i.e., not earlier than 2003-04.

A score of zero thus resulted if none of the preceding conditions were met, even though the original article had been listed by an MSP or RETA in its annual reports, the MSP's or RETA's own Web site, or MSPnet.

Exhibit A-1

LIST OF CANDIDATE ITEMS, BY MSP

MSP*	Publication	Unpublished Manuscripts	Unpublished Papers	Presentation	Tools/ Products	Total Candidate Items
1	-	4	-	-	-	4
2	1	3	-	-	-	4
3	8	3	63	6	2	82
4	-	-	1	-	8	9
5	-	1	1	2	1	5
6	-	-	-	1	-	1
7	4	12	6	4	-	26
8	3	1	-	-	-	4
9	11	4	10	1	-	26
10	8	4	3	4	-	19
11	3	-	-	2	-	5
12	28	6	1	3		38
13	2	-	1	1	-	4
14	2	2	-	-	-	4
15	-	-	1	-	-	1
16	3	2	-	1	-	6
17	-	-	-	-	-	0
18	1	2	-	1	-	4
19	1	-	2	21	-	24
20	2	-	-	1	1	4
21	2	1	2	4	-	9
22	-	-	-	-	-	0
23	2	2	1	-	-	5
24	1	-	1	2	-	4
25	1	-	1	2	-	4
26	-	-	-	-	-	0
27	6	-	-	1	-	7
28	3	1	1	-	-	5
29	11	-	1	-	-	12
30	3	-	-	6	-	9
31	1	-	2	-	-	3
32	-	-	-	2	-	2
33	2	-	2	8	1	13
34	1	9	-	14	2	26
35	3	-	-	-	-	3
36	1	-	-	-	-	1
37	11	3	2	-	-	16
38	9	1	-	-	-	10
39	24	-	3	1	-	28
40	-	2	-	1	-	3
41	2	-	-	1	-	3
42	8	-	1	-	-	9
43	1	-	-	-	-	1
44	28	-	-	-	-	28
45	11	1	-	-	-	12
46	-	-	-	1	2	3
47	-	-	-	-	-	0
48	2	2	5	2	-	11

(Continued)

(Exhibit A-1, Continued)

MSP*	Publication	Unpublished Manuscripts	Unpublished Papers	Presentation	Tools/ Products	Total Candidate Items
49	7	-	2	2	-	11
50	-	-	-	-	-	0
51	-	1	-	1	-	2
52	-	-	-	-	-	0
53	-	-	1	-	-	1
54	-	-	-	-	-	0
55	-	-	-	-	-	0
56	-	2	-	1	-	3
57	-	-	-	-	-	0
58	-	-	1	1	-	2
59	1	-	-	-	-	1
60	-	1	-	2	-	3
61	-	-	-	1	-	1
62	1	3	2	-	-	6
63	2	-	-	1	-	3
64	-	-	-	1	-	1
65	-	1	1	-	-	2
66	1	-	-	-	-	1
67	18	3	-	-	-	21
68	1	-	-	1	-	2
69	5	-	-	-	-	5
70	1	-	-	-	-	1
71	-	5	-	1	-	6
72	-	-	-	-	-	0
73	1	-	-	-	1	2
74	24	3	6	1	4	38
75	1	-	1	1	1	4
76	1	-	5	-	-	6
77	N/A	N/A	N/A	N/A	N/A	**
78	-	-	-	-	-	0
79	3	1	-	-	-	4
80	1	-	-	-	-	1
81	1	-	-	-	-	1
82	-	-	1	-	-	1
83	-	-	-	-	2	2
TOTAL	279	86	131	107	25	628

***** One comprehensive MSP no longer receives funding, but did generate publications under the MSP Program and is therefore included here.

****** MSP #77 is the MSP-PE, which is excluded from this study.

N/A=not applicable.

Source: See variety of sources described in the text.

Exhibit A-2

ARTICLES IN PEER-REVIEWED JOURNALS, LISTED BY MSP OR RETA AWARDEE (n=143 articles)

Article No.	Citation	Original Abstract (some may be lightly edited)
1	Abdeljawad, C., "On Becoming a Mathematics Specialist - From Unlikely Beginnings," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 5-10.	Abstract not available.
2	Abid, M., M. Savolainen, S. M. Landge, J. Hu, G. K. S. Prakash, G. A. Olah, and B. Török, "Synthesis of Trifluoromethyl-Imines by Solid Acid/Superacid Catalyzed Microwave Assisted Approach," *Journal of Fluorine Chemistry,* Vol. 128, Issue 6, June 2007, pp. 587-594.*****	"A new solid acid/superacid catalyzed microwave assisted synthesis of trifluoromethyl-imines is described. Various α,α,α-trifluoromethylketones react readily with primary amines to produce the corresponding imines. Two different strategies have been employed; one is the application of microwave irradiation coupled with solvent-free solid acid catalysis. The other method, for highly deactivated substrates includes the use of a pressure vessel at 175 °C temperature, with solid superacid catalysis. Using the solid acid K-10 montmorillonite or the superacidic perfluorinated resinsulfonic acid Nafion-H, a wide variety of trifluoromethylated imines have been synthesized using the above methods. The products have been isolated in good to excellent yields and high selectivities."
3	Aguilar, M., "The Mathematics Specialist From a Dual Language Immersion Perspective," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp.53-56.	Abstract not available.
4	Anagnos, T., C. Komives, N. Mourtos, K.M. McMullin, "Evaluating Student Mastery of Design of Experiment," *Proceedings of the 37th ASEE/IEEE Frontiers in Education Conference*, Milwaukee, WI, October 10-13, 2007.	"Although ABET Outcome 3b explicitly requires engineering graduates to demonstrate "an ability to design experiments," engineering curricula rely heavily on cookbook experiments, in which students simply follow a sequence of steps in the form of a recipe and arrive at a predetermined result. Cookbook experiments do not require design by the students and therefore do not draw upon the critical thinking skills that lead to deeper learning."
5	Anderson, K., "The Mathematics Specialist as Visionary Strategist," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 33-35.	Abstract not available.
6	Atwood, R., J. Christopher, J., R.K. Combs, and A.E. Roland, "Inservice Elementary Teachers' Understanding of Magnetism Concepts Before and After Non-traditional Instruction," *Science Educator,* 2008. [No further details available.]	No abstract available.
7	Ball, D. L., M. Thames, M., and G. Phelps, "Content Knowledge for Teaching: What Makes it Special?" *Journal of Teacher Education*, Vol. 59, No. 5, 2008, pp. 389-407.	"This article reports the authors' efforts to develop a practice-based theory of content knowledge for teaching built on Shulman's (1986) notion of pedagogical content knowledge. As the concept of pedagogical content knowledge caught on, it was in need of theoretical development, analytic clarification, and empirical testing. The purpose of the study was to investigate the nature of professionally oriented subject matter knowledge in mathematics by studying actual mathematics teaching and identifying mathematical knowledge for teaching based on analyses of the mathematical problems that arise in teaching. In conjunction, measures of mathematical knowledge for teaching were developed."
8	Bastable, V., and L. Menster, "Designing Professional Development Activities for Mathematics Specialists," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 77-96.	Abstract not available.
9	Birnie, S. "Mathematics Specialists in Alexandria City Public Schools," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 35-38.	Abstract not available.

*****An asterisk denotes any of the 10 STEM discipline-focused academic articles produced by *MSP-funded* interns, graduate students, or other supported participants who are newly contributing to the STEM workforce, and are therefore included in this review. These articles generally produced low ratings because they did not draw data from, or reflect the main activities of, a specific MSP or RETA.

(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
10	Blount, D., and J. Singleton, "The Role and Impact of the Mathematics Specialist from the Principals' Perspectives," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 69-77.	Abstract not available.
11	Brenninkmeyer, L., and J. Spillane, "Problem-solving Processes of Expert and Typical School Principals: A Quantitative Look," *School Leadership & Management*, Vol. 28, No. 5, Nov. 2008, pp. 435-468.	"Principals are increasingly expected to be the instructional as well as administrative leaders of their schools. However, little is known about how principals reason through the instructional issues that they face. An analysis of principal reasoning in instructional contexts is critical. The study presented in this article draws on interviews with 36 predominantly elementary school principals in an urban setting. The authors look at principal problem-solving by comparing the cognitive processes that principals of varying degrees of expertise use in solving instructional scenarios."
12	Brickman, P., S.M. Glynn, and G. Graybeal, "Introducing Students to Cases," *Journal of College Science Teaching*, Vol. 37, No. 3, January 2008, pp. 12-16.	"Strategically introducing students to a controversial science case--before they read it, watch it, or listen to it--motivates them to learn from it and paves the way for successful discussion and debate. A strategic introduction also provides an opportunity for the instructor to demonstrate scientific reasoning and share guidelines for the discussion and debate. In this article, the authors describe and illustrate how instructors should introduce students to a controversial case and prepare them for debating issues related to it" [first paragraph of article].
13	Brown, B., "Exponential Growth through Pattern Exploration," *Mathematics Teacher*, Vol. 98, No. 6, February 2005, p. 434.	"This activity provides students in middle school and the early years of high school with models of exponent laws while relating differing fields of mathematics. Students use geometric constructions to create the Sierpinski triangle and to explore the concepts of similarity, self-similarity, area, and perimeter while reinforcing exponent and rational number operations."
14	Bryan, L. A., "Social Practices of Teaching and Learning in Two Mexican Escuelas Unitarias: Implications for U.S. Science Education," *Science Education*, 2005. [No further details available.]	No abstract available.
15	Bryan, L. and Tippins, D., "The Monets, Van Goghs, and Renoirs of Science Education: Writing Impressionist Tales as a Strategy for Facilitating Prospective Teachers' Reflections on Science Experiences," *Journal of Science Teacher Education*, Vol. 16, Issue 3, August 2005, pp. 227-239.	"A particularly useful pedagogical strategy for beginning a dialogue with prospective teachers about the ways in which their experiences and beliefs shape their development of professional knowledge is writing impressionist tales. Impressionist tales are a form of autobiography that portrays one highly personal perspective on a significant moment in time. In this pedagogical practice article, we describe our use of impressionist tales, summarize the assumptions underpinning our use of impressionist tales in science methods courses, provide several examples of our students' tales, and discuss the pedagogical advantages and the teacher educator's role in using impressionist tales to promote reflective thinking among prospective elementary science teachers."
16	Bryant, M.J., K. A. Hammond, K. M. Bocian, M. F. Rettig, C. A. Miller, and R. A. Cardullo, "Assessment: School Performance will Fail to Meet Legislated Benchmarks," *Science*, September 26, 2008, Vol. 321, No. 5897, pp. 1781-1782. Note: This is also available on MSPnet.	"The article presents an analysis of the proficiency goal for college-bound students in the U.S. There is a widely held concern that American students do not have the educational foundation to attain success in introductory science courses. Several educational reforms are established concerning the accountability of schools for proficiency in mathematics and English Language Arts (ELA). In 1994, the Improving America's School Act (IASA) ordered that states should set standards by 1999 and should measure students' achievement by 2000. The No Child Left Behind Act of 2001 mandated that 100% of students should be proficient in ELA and mathematics by 2014."
17	Cacciatore, K.L., H. Sevian, J. Amado, and J. J. Evans, "Connecting Solubility, Equilibrium, and Periodicity in a Green Inquiry Experiment for the General Chemistry Laboratory," *Journal of Chemical Education*, Vol. 85, Issue 2, February 2008, pp. 251-253.	"Presents a novel first-year chemistry experiment that asks students to replicate procedures described in sample lab reports that lack essential information. This structure is designed to promote students' experimental design and data analysis skills as well as their understanding of the importance and essential qualities of written and verbal communication between scientists."
18	Camburn, E., J. Spillane, and J. Sebastian, "Investigating the Validity of a Daily Log and its Utility for Assessing the Impact of Programs on Principals," *Educational Administration Quarterly*, 2008. [No further details available.]	"This study examines the validity of a daily log for measuring principal practice, and investigates the utility of the log for assessing the program impacts on principals. The study was conducted in an urban district in the Southeastern United States. The district has approximately 50 principals nearly all of whom participated in the study. The viability of the daily log was evaluated using four criteria: 1) Is it feasible to collect logs at scale?, 2) Is the log sensitive to program goals, 3) Is it sensitive to variation in principal practice over time?, and 4) Is it valid? The first two criteria were assessed through a discussion of the instrument design process, the log methodology, and data collection results. The third and fourth criteria were assessed through mixed method analyses examining data from daily logs, observations and an experience sampling instrument."

(Continued)

(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
19	Carlson, M., S. Bowling, A. Nieves, and K. Moore, "The Role of the Facilitator in Promoting Meaningful Discourse Among Professional Learning Communities of Secondary Mathematics and Science Teachers," Proceedings of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA), October 2007. Note: This is also available on MSPnet.	"This report describes the construct of decentering and its influence on the discourse of a professional learning community (PLC) of secondary mathematics teachers. We used decentering as a construct to describe a behavior in which one attempts to understand the mathematical thinking and/or perspective of someone else…This research is informing the instructional design for PLCs and PLC facilitator training. The findings also have the potential to contribute to the theoretical construct of decentering."
20	Charalambous, C.Y., "Mathematical Knowledge for Teaching and the Unfolding of Tasks: An Exploratory Study," *Journal for Research in Mathematics Education*, in press.	"A paper investigating the relationship between mathematical knowledge and the task demand of teaching" [excerpt from annual report].
21	Childs, K., J. Adams, and D. Pace, "From the Sandbox to the Ivory Tower," *Texas College Mathematics Journal*, August 2008. [No further details available.]	No abstract available.
22	Childs, K., D. Pace, and K.E. Jenlink, "The Texas Middle and Secondary Mathematics Project: A Vision for Mathematics Educator Preparation in the 21st Century," *Teacher Education and Practice*, Vol. 17, Issue 4, Fall 2004, pp. 451-464.	"The Texas State Middle and Secondary Mathematics Project is an innovative graduate degree program at Stephen F. Austin State University in partnership with 27 regional public school districts with the intent to prepare highly qualified mathematics practitioner-leaders at the middle and secondary levels. Designed to address acute teacher shortages and declining student achievement, the program offers advanced professional development for teacher participants that emphasizes strong mathematics content with practitioner leadership preparation."
23	Clark, P., K. Moore, and M. Carlson, "Documenting the Emergence of Speaking with Meaning as a Sociomathematical Norm in Professional Learning Community Discourse," *Journal of Mathematical Behavior*, Vol. 27, No. 4, 2008, pp. 297-310.	"We introduce the sociomathematical norm of "speaking with meaning" and describe its emergence in a professional learning community (PLC) of secondary mathematics and science teachers. We use "speaking with meaning" to reference specific attributes of individual communication that have been revealed to improve the quality of discourse among individuals engaged in discourse in a PLC. An individual who is "speaking with meaning" provides conceptually based descriptions when communicating with others about solution approaches. The quantities and relationships between quantities in the problem context are described rather than only stating procedures or numerical calculations used to obtain an answer to a problem. Solution approaches are justified with logical and coherent arguments that have a conceptual rather than procedural basis. The data for this research was collected during a year-long study that investigated a PLC whose members were secondary mathematics and science teachers. Analysis of the data revealed that after one semester of participating in a PLC where "speaking with meaning" was emphasized, the PLC members began to establish their own criteria for an acceptable mathematical argument and what constituted "speaking with meaning." The group also emerged with common expectations that answers be accompanied by explanations and mathematical operations be explained conceptually (not just procedurally). The course and PLC design that supported the emergence of "speaking with meaning" by individuals participating in a PLC are described."
24	Coldren, A., and J. Spillane, "Making Connections to Teaching Practice: The Role of Boundary Practices in Instructional Leadership," *Educational Policy*, Vol. 21, Issue 2, 2007, pp. 369-396.	"Administrators, particularly those who engage in instructional leadership, play a key role in school improvement. Past research describes the types of activities instructional leaders engage in but has paid little attention to how they do it. The authors use the case of one school to unpack instructional leadership as a practice, paying close attention to the tools that constitute that practice, the contextual factors that help to define it, and how it affects teaching."
25	Dark, D., "Making 'Cute' Count," *Teaching Children Mathematics*, Vol. 14, No. 3, October 2007, pp. 153-159.	"A holiday quilt project in a kindergarten classroom becomes a focus for exploring patterns, shapes, measurement, spatial relationships, and number sense. Cooperative group work, problem solving, and communication of mathematical ideas enhance the completion of the project."
26	Delaney, S. F., D.L. Ball, H.C. Hill, S.G. Schilling, and D.A. Zopf, "Mathematical Knowledge for Teaching: Adapting U.S. Measures for Use in Ireland," *Journal of Mathematics Teacher Education*, Vol. 11, No. 3, June 2008, pp. 171-197.	"This article describes a study in which measures of mathematical knowledge for teaching developed in the United States were adapted to measure mathematical knowledge for teaching in Ireland. When adapting the measures it was not assumed that the mathematical knowledge used by Irish and U.S. teachers is the same. Instead psychometric and interview-based methods were used to determine a correspondence between the constructs being measured, and ensure the integrity of item performance in the Irish context."

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(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
27	Delgado-Velez, M., A. Lugo-Chinchilla, L. Lizardo, I. Morales, Y. Robles, N. Bruno, J.W. Rodríguez, E. Ríos-Olivares, M. Correa, and F.L. Renaud, "Chronic Exposure of Human Macrophages in vitro to morphine and methadone induces Putative Tolerant/Dependent State," *Journal of Neuroimmunology*, Vol. 196, Issue 1-2, May 2008, pp. 94-100.*	"We have shown previously that whereas acute exposure of cultured murine peritoneal macrophages inhibits phagocytosis, chronic exposure results in a putative tolerant/dependent state. We now report similar observations using human cultured monocyte-derived macrophages (hMDM) from a control population and from methadone patients."
28	Emdin, C., "Teaching and Learning Science in an Urban School: Analogy as a Key to Communal Science Pedagogy," *AERA Online Yearbook of Urban Learning, Teaching, and Research*, 2006, pp. 46-52.	"This article articulates the results of an ongoing study in an urban school in New York City in which student and teacher researchers engage in practices that support the science success of the schools' predominantly Latino/a and African American population. By situating the study in the nature of corporate and communal practices, the article demonstrates the necessity for an expansion of approaches to teaching and learning that includes students' ways of knowing. Furthermore, the article shows the emergence of analogy as an outcome of embracing communal teaching practices."
29	Emdin, C., and E. Lehner, "Situating Cogenerative Dialogue in a Cosmopolitan Ethic," *Forum: Qualitative Social Research*, Vol. 7, No. 2, March 2006, Article 39.	"In this article, we acknowledge the transformative nature of cogenerative dialogues and focus on the ethical dimension of the practice in order to move educational research, classrooms and schools beyond the current conceptions of what is ethical. Utilizing a fusion of the Belmont Report with nuanced notions of fourth generation evaluation procedures, we root cogenerative dialogues in a philosophical approach to cosmopolitanism that acknowledges the differences between multiple participants, multiple fields, and varying ways of knowing and being. Firstly, we consider how rooting the character of the truly ethical research act in a cosmopolitan ideal can attain participant beneficence. Secondly, we consider how to avoid the potential pitfalls of authenticity criteria in the practice of cogenerative dialogues by enacting practices that maximize tactical authenticity."
30	Falk, J., and B. Drayton, "State Testing and Inquiry Based Science: Are They Complementary or Competing Reforms?" *Journal of Educational Change*, Vol. 5, No. 4, December 2004, pp. 345-387. Retrieved January 16, 2009 from MSPnet Web site.	"The effect of district strategies for improving high-stakes test scores on science teachers' practice is explored in case studies of six middle schools in six Massachusetts districts. At each school, science teachers, curriculum coordinators, principals, and superintendents shared their strategies for raising scores, their attitudes towards the test, the changes that they were implementing in their curriculum and pedagogical approaches, and the effects that the test was having on staff and on students."
31	Farley, R.W., W.E. Haver, and L.D. Pitt, "Financial Support for Mathematics Specialists' Initiatives in Virginia," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 153-169.	Abstract not available.
32	Fennell, F., "Elementary Mathematics Specialists--We Need Them Now! Follow Virginia's Lead," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp.1-4.	Abstract not available.
33	Ferrini-Mundy, J., "The TIMSS 2003 and PISA 2003 Reports: Sustaining Focus and Concern About the State of Mathematics Education in the United States," *Education Statistics Quarterly*, Vol. 6, No. 4, November 2005, pp. 26-28. Retrieved December 4, 2008 from National Center for Education Statistics Web site.	"In summary, international comparative research such as that of TIMSS and PISA is essential for developing a better understanding of the state of U.S. mathematics and science education. The periodic opportunity to benchmark U.S. performance against that of countries around the world provides the impetus needed for an ongoing examination of all aspects of the U.S. education system, including curriculum, instruction, and teacher education and preparation. In addition, the ongoing development of conceptual frameworks such as those produced for TIMSS 2003 and PISA 2003-which push collective thinking about what is appropriate in the K-12 curriculum for mathematics and science-is a welcome contribution to the literature in mathematics and science education that comes from a source outside of the U.S. education community-the international comparative studies community."
34	Ferrini-Mundy, J., G. Burrill, and W.H. Schmidt, "Building Teacher Capacity for Implementing Curricular Coherence: Mathematics Teacher Professional Development Tasks," *Journal of Mathematics Teacher Education*, Vol. 10, Issues 4-6, December 2007, pp. 311-324.	"Improving mathematics education in the United States has taken many forms. Our work has focused on two aspects: the content knowledge of teachers and a well-articulated coherent curriculum. Our aim was teacher "capacity building" that is enabling teachers to teach to coherent and significant mathematical curricular goals and describe the implementation in a large-scale project based at Michigan State University."

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(Continued)

(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
35	Firestone, W., and M. Cecilia Martinez, "Districts, Teacher Leaders, and Distributed Leadership: Changing Institutional Practice," *Leadership and Policy in Schools*, Vol. 6, Issue 1, February 2007, pp. 3-35. Retrieved November 10, 2008 from MSPnet Web site.	"The growing interest in distributed leadership reflects an effort to reconceptualize leadership in schools by exploring how leadership is spread across a variety of roles and to explore the process of leadership. Using case studies of four schools in three districts, this paper explores how leadership is distributed in school districts and asks about the role of teacher leaders in particular. It proposes that teacher leaders and districts can share three leadership tasks: procuring and distributing materials, monitoring improvement, and developing people. The district and teacher leaders play complementary roles. Districts tend to be distant forces, and teacher leaders are more personal. How effective teacher leaders are at people development will depend on the time they have, the knowledge they have, and their monitoring responsibility. These conditions depend partly on their administrative support. We suggest that districts may have more opportunity to influence teaching practice than past research had indicated."
36	Fisher, W., "Teacher-In-Residence Program at California State University, Chico," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 143-152.	Abstract not available.
37	Folsom, J., C. Hunt, M. Cavicchio, A. Schoenemann, and M. D'Amato, "How Do You Know That? Guiding Early Elementary Students to Develop Evidence-Based Explanations about Animals," *Science and Children*, Vol. 44, Issue 5, January 2007, pp. 20-25. Retrieved November 6, 2008 from MSPnet Web site.	"Our SCALE team of educators, curriculum developers, district administrators, and scientists believe that it is possible and beneficial for even the youngest students to participate in a rigorous scientific inquiry that builds a conceptual understanding of animals and the nature of studying animals. To test this idea, the University of Wisconsin-Madison and Madison Metropolitan School District created an inquiry-based unit, or an immersion unit, on animals, implemented it in kindergarten classrooms, and observed the students' responses. Our unit focused on guiding students to formulate explanations about animals based on scientific evidence."
38	Ford, B., and M. Taylor, "Investigating Students' Ideas about Plate Tectonics," *Science Scope,* Vol. 30, No. 1, September 2006, pp. 38-43.	"Giant exploding volcanoes...asteroids crashing into Earth...continents floating across the oceans...massive pools of lava...violent earthquakes splitting continents--middle school students hold a variety of ideas about Earth, how it has changed over time, and what has caused these changes. Listening to students talk about how the world works is fascinating. Some students describe ideas that are essentially correct; others reflect familiarity with the content, but their understanding is incomplete or includes inaccuracies. Still others have little understanding of the content, but imagine dramatic scenes of destruction when questioned about earthquakes, volcanoes, and plate tectonics. Beyond just listening, uncovering students' initial ideas and attending to how those ideas change over a unit of instruction are important to ensuring that students learn scientifically correct ideas. In this article, middle school students were interviewed about their ideas in plate tectonics and processes that shape Earth. This article also discusses the results of the interviews and their implications for classroom practice."
39	Freedman, M., "Converging on the Centroid," *Mathematics Teacher*, Vol. 101, No. 5, December 2007, pp. 394-396.	"Iterative averaging of the coordinates of the vertices of a triangle will converge to the median of the triangle."
40	Gakwaya, R., X. Li, Y.L. Wong, S. Chivukula, E.J. Collins, and J.J. Evans, "Examining the Collision-induced Decomposition Spectra of Ammoniated Triglycerides – Part III: The Linoleate and Arachidonate Series," *Rapid Communications in Mass Spectrometry*, Vol. 21, Issue 20, 2007, pp. 3262-3268.*****	"A series of positionally pure triglycerides (TAGs) of the form LXL, YLY, AXA, and YAY was synthesized and analyzed by reversed-phase high-performance liquid chromatography/tandem mass spectrometry. L and A represent the linoleate and arachidate moieties, respectively, and X and Y represent large arrays of fatty acid moieties of various chain lengths, degree of unsaturations, double-bond positions, and cis/trans configurations. The abundances of the collision-induced decomposition (CID) products of ammoniated TAGs were examined as a function of these parameters. The major CID products, the diglyceride (DAG) product ions and the MH+ ions, are plotted as functions of chain length for the saturated and monounsaturated series of X and Y…data are discussed in context of a broader project to develop and validate software algorithims to support a platform for comprehensive analysis of complex mixtures of TAGs."
41	Gates, D., "What Does it Mean to be an Elementary School Mathematics Specialist?," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 21-25.	Abstract not available.

*****An asterisk denotes any of the 10 STEM discipline-focused academic articles produced by *MSP-funded* interns, graduate students, or other supported participants who are newly contributing to the STEM workforce, and are therefore included in this review. These articles generally produced low ratings because they did not draw data from, or reflect the main activities of, a specific MSP or RETA.

(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
42	Glynn, S. M., and L. K. Winter, "Contextual Teaching and Learning of Science in Elementary Schools," *Journal of Elementary Science Education*, Vol. 16, No. 2, Fall 2004, pp. 51-63.	"Contextual Teaching and Learning (CTL) integrates inquiry, problem- and project-based learning, cooperative learning, and authentic assessment. Case studies were carried out on 21 teachers who used CTL to teach science in elementary schools to diverse groups of children."
43	Glynn, S. M., T. Koballa, D. Coleman, and P. Brickman, "Professional Development Cases", *Journal of College Science Teaching*, Vol. 36, No. 1, September 2006, pp. 10-12.	"A professional development case in college science teaching bridges the gap between educational theory and practice. A good case poses an interesting dilemma involving instructors, students, and administrators. Case discussions can help instructors take charge of their own professional development and create a community of shared professional support within their colleges. These discussions help overcome the sense of isolation that many instructors, particularly new ones, can experience."
44	Groetsch, C.W., "Nascent Function Concepts in Nova Scientia", *International Journal of Mathematical Education in Science and Technology*, Vol. 35, No. 6, November 2004, p. 867-875.	"The origin of the function concept is usually traced to Galileo's work on motion. We argue that specific proto-function concepts appeared in the work of Tartaglia a century before the publication of Galileo's Two New Sciences. The study of Tartaglia's ideas can be used in the classroom as a historical introduction to various function concepts, and certain modern extensions of Tartaglia's optimal range problem and inverse range problem are sources of enrichment for undergraduate courses in analysis, mathematical modeling and computation."
45	Grundstein, A., J. Durkee, and S. Ashley, "Incorporating Inquiry-based Learning in an Introductory Weather and Climate Laboratory Class," *Journal of Geoscience Education*, paper submitted for publication. [This item was included as a pending publication within a specified peer-reviewed journal.]	No abstract available.
46	Halverson, R., J. Grigg, R. Prichett, and C. Thomas, "The New Instructional Leadership: Creating Data-driven Instructional Systems in Schools," *Journal of School Leadership*, Vol. 17, No. 2, March 2007, pp. 159-194.	"The recent demand for schools to respond to external accountability measures challenges school leaders to create school instructional systems that use data to guide the practices of teaching and learning. This paper considers how local school leaders build data-driven instructional systems (DDIS) by developing new programs and using existing school functions to create an information flow through a school. The paper considers how leaders work with teachers and students to create DDISs to intentionally and systematically improve student learning. The paper begins by presenting a theoretical and analytic framework to understand how the systems that local school leaders create to develop a DDIS facilitate an "information flow" about student achievement in the school."
47	Hedges, M., D. Huinker, and M. Steinmeyer, "Unpacking Division to Build Teachers' Mathematical Knowledge," *Teaching Children Mathematics*, Vol. 11, Issue 9, May 2005, p. 478.	"The unpacking of the mathematical knowledge necessary for teaching division is examined. A core task for surfacing and unpacking one's division knowledge is presented and the understandings that might comprise a package of teacher knowledge for division is discussed."
48	Hill, H.C., "Mathematical Knowledge of Middle School Teachers: Implications for the No Child Left Behind Policy Initiative," *Educational Evaluation and Policy Analysis*, Vol. 29, No. 2, 2007, pp. 95-114.	"This article explores middle school teachers' mathematical knowledge for teaching and the relationship between such knowledge and teachers' subject matter preparation, certification type, teaching experience, and their students' poverty status."
49	Hill, H.C., "The Nature and Effects of Middle School Mathematics Teacher Learning Experiences," *Teachers College Record*, paper is under review. [This item was included as a pending publication within a specified peer-reviewed journal.]	No abstract available.
50	Hill, H.C., and D.L. Ball, "Learning Mathematics for Teaching: Results from California's Mathematics Professional Development Institutes," *Journal for Research in Mathematics Education,* Vol. 35, No. 5, November 2004, pp. 330-351. Note: This is also available on MSPnet.	"Widespread agreement exists that U.S. teachers need improved mathematics knowledge for teaching. Over the past decade, policymakers have funded a range of professional development efforts designed to address this need. However, there has been little success in determining whether and when teachers develop mathematical knowledge from professional development, and if so, what features of professional development contribute to such teacher learning. This lack was due, in part, to a lack of measures of teachers' content knowledge for teaching mathematics. This article attempts to fill these gaps. In it we describe an effort to evaluate California's Mathematics Professional Development Institutes (MPDIs) using novel measures of knowledge for teaching mathematics."

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(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
51	Hill, H.C., D.L. Ball, M. Blunk, I.M. Goffney, and B. Rowan, "Validating the Ecological Assumption: The Relationship of Measure Scores to Classroom Teaching and Student Learning," *Measurement: Interdisciplinary Research and Perspectives,* Vol. 5, No. 2-3, August 2007, pp. 107-118.	"This paper provides a summary of the authors' attempts to uncover links between their measures, classroom mathematics instruction, and student learning. This paper also provides evidence regarding one central critique of their measures: that multiple-choice assessments cannot validly represent the knowledge, skills, and judgment involved in actual teaching practice. To the extent that there is a relationship between the test domain and practice domain, it strengthens their claim that they can measure knowledge for teaching in this format. In this article the authors describe the aims, methods, and preliminary findings from a large-scale statistical study of teacher knowledge and student achievement and a videotape study of teachers' classroom mathematics instruction. If a teacher knowledge/student achievement relationship is found in the former, the latter will help identify the mechanisms through which this relationship is realized. Finally, as a means for informing the debate about why test validation is often better conceptualized than practiced, they consider the cost and obstacles to this type of work."
52	Hill, H.C., D.L. Ball, and S.G. Schilling, "Unpacking 'Pedagogical Content Knowledge': Conceptualizing and Measuring Teachers' Topic-Specific Knowledge of Students," *Journal for Research in Mathematics Education*, Vol. 39, No. 4, July 2008, pp. 372-400.	"There is widespread agreement that effective teachers have unique knowledge of students' mathematical ideas and thinking. However, few scholars have focused on conceptualizing this domain, and even fewer have focused on measuring this knowledge. In this article, we describe an effort to conceptualize and develop measures of teachers' combined knowledge of content and students by writing, piloting, and analyzing results from multiple-choice items."
53	Hill, H.C., M. Blunk, C. Charalambous, J. Lewis, G.C. Phelps, L. Sleep, and D.L. Ball, "Mathematical Knowledge for Teaching and the Mathematical Quality of Instruction: An Exploratory Study," *Cognition and Instruction*, Vol. 26, No. 4, October 2008, pp. 430-511.	"This study illuminates claims that teachers' mathematical knowledge plays an important role in their teaching of this subject matter. In particular, we focus on teachers' mathematical knowledge for teaching (MKT), which includes both the mathematical knowledge that is common to individuals working in diverse professions and the mathematical knowledge that is specialized to teaching."
54	Hill, H.C., C. Dean, and I.M. Goffney, "Assessing Elemental and Structural Validity: Data from Teachers, Non-teachers, and Mathematicians," *Measurement: Interdisciplinary Research and Perspectives*, Vol. 5, No. 2-3, August 2007, pp. 81-92.	"Validation efforts typically focus around what, exactly, is measured by an instrument(s), and whether what is measured corresponds to the theoretical domain(s) originally specified. In this paper, we conduct a first analysis into these issues. Our goal is building instruments focused around measuring the mathematical knowledge used in teaching: not only the content that teachers teach to students directly, but also the professional knowledge that helps support the teaching of that content. Following Kane (2001; 2004a) and as reported in Schilling & Hill (this issue), we developed two assumptions and related inferences to represent this thinking, Elemental assumption and Structural assumption. In this paper we describe and address the Elemental assumption of the LMT measures."
55	Hill, H.C., and S.T. Lubienski, "Teachers' Mathematics Knowledge for Teaching and School Context: A Study of California Teachers," *Educational Policy,* Vol. 21, No. 5, 2007, pp. 747-768.	"This article examines the relationship between the mathematical knowledge of 438 K-8 California teachers and the demographics of the schools in which they work. To measure mathematical knowledge, we used a series of multiple-choice problems meant to represent both the content teachers teach and the specialized knowledge of mathematics that teachers might possess. Teachers in schools with higher proportions of low-SES and Hispanic students performed more poorly on these measures than did teachers from other schools. Implications for policy and for further research are discussed."
56	Hill, H., B. Rowan, and D.L. Ball, "Effects of Teachers' Mathematical Knowledge for Teaching on Student Achievement," *American Educational Research Journal*, Vol. 42, No. 2, Summer 2005, pp. 371-406. Retrieved November 10, 2008 from MSPnet Web site.	"This study explored whether and how teachers' mathematical knowledge for teaching contributes to gains in students' mathematics achievement. The authors used a linear mixed-model methodology in which first and third graders' mathematical achievement gains over a year were nested within teachers, who in turn were nested within schools. They found that teachers' mathematical knowledge was significantly related to student achievement gains in both first and third grades after controlling for key student- and teacher-level covariates. This result, while consonant with findings from the educational production function literature, was obtained via a measure focusing on the specialized mathematical knowledge and skills used in teaching mathematics. This finding provides support for policy initiatives designed to improve students' mathematics achievement by improving teachers' mathematical knowledge."
57	Hill, H.C., S.G. Schilling, and D.L. Ball, "Developing Measures of Teachers' Mathematics Knowledge for Teaching," *The Elementary School Journal*, Vol. 105, No. 1, September 2004, pp. 11-30. Note: This is also available on MSPnet.	"In this article we discuss efforts to design and empirically test measures of teachers' content knowledge for teaching elementary mathematics. We begin by reviewing the literature on teacher knowledge, noting how scholars have organized such knowledge. Next we describe survey items we wrote to represent knowledge for teaching mathematics and results from factor analysis and scaling work with these items."
58	Holdan, E. G., and M. M. Maxwell, "From Lecturer to Facilitator: The Impact of a Collaborative Effort," *International Journal of Learning*, Vol. 11, 2004, p. 761.	No abstract available.

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(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
59	Hsu, E., J. Kysh, K. Ramage, and D. Resek, "Seeking Big Ideas in Algebra: The Evolution of a Task," *Journal of Mathematics Teacher Education*, Vol. 10, No. 4-6, December 2007, pp. 325-332. Retrieved December 4, 2008 from SpringerLink Web site.	"In this paper we describe a strand of activities for teachers of mathematics that we used with two cohorts of participants in a professional development program called Revitalizing Algebra (REAL). We first discuss our goals and describe the participants, and then we describe the construction and selection of the tasks followed by teacher responses."
60	Hulen, T., "Breaking the Cycle: Integrating the Mathematics Specialist," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 41-43.	Abstract not available.
61	Inge, V., "Leadership Progress in Stafford County Schools," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 73-76.	Abstract not available.
62	Iverson, N.R., "Mathematics Professional Development That Focuses on Student Achievement: A Parallel Case Example," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 119-141.	Abstract not available.
63	Justice, G.W., "Motivating University Faculty Participation in the Training and Professional Development of P-12 Teachers," *Journal of Higher Education Outreach and Engagement*, paper submitted for publication. [This item was included as a pending publication within a specified peer-reviewed journal.]	No abstract available.
64	Khourey-Bowers, C., R.L. Dinko, and R.G. Hart, "Influence of a Shared Leadership Model in Creating a School Culture of Inquiry, and Collegiality," *Journal of Research in Science Teaching*, Vol. 42, No. 1, January 2005, pp. 3-24. Retrieved December 3, 2008 from Wiley InterScience Web site.	"The purpose of this study was to assess the effectiveness of a Local Systemic Change (LSC) initiative (N = 216) at Year 2 in a 5-year plan. Key questions were: What is the extent of school and teacher involvement?; What is the impact on teacher preparedness, attitudes, and beliefs?; and What is the extent of institutionalization? The model of professional development used shared leadership (Lead Teachers & Study Groups) along with workshops in inquiry, content, and assessment. All teachers averaged 81 hours of participation by the end of Year 2; LTs averaged 161 hours. Longitudinal and episodic data were collected using multiple instruments, including Horizon Research Teacher Survey (Baseline and Year 2), SG and Lead Teacher surveys (Year 1 and Year 2), Context Beliefs About Teaching Science and Classroom Observation Protocol (Year 2). Gains in teachers' practices, beliefs, and professional culture (collegiality and department chair support) were measured at significance levels of .05. The results indicate that sustained and intensive professional development influences individuals and school culture."
65	Knofczynski, G., P. Hadavas, and L. Hoffman, "Effects of Implementing Projects in an Elementary Statistics Class," *Journal of Mathematical Sciences and Mathematics Education*, Vol. 2, No. 2, September 2007, pp. 44-49.	"In hopes of reducing the percent of students receiving non-passing grades in elementary statistics classes, interactive hands-on projects were implemented in the classes. These projects gave students the opportunity to use personal data, discuss statistical concepts with each other, and strengthen the students' understanding, mastery and appreciation of the material covered in an elementary statistics class."
66	Krall, R. M., K. H. Lott, and C.L. Wymer, "Inservice Elementary and Middle School Teachers' Conceptions of Photosynthesis and Respiration," *Journal of Science Teacher Education*, in press.	"The purpose of this descriptive study was to investigate inservice elementary and middle school teachers' conceptions of photosynthesis and respiration, basic concepts they are expected to teach. A forced-choice instrument, assessing selected, standards-based life science concepts with non-scientific conceptions embedded in distracter options, was utilized to assess 76 inservice elementary and middle school teachers from the central Appalachian region. Outcomes from four tasks assessing photosynthesis and respiration concepts are discussed."
67	Krause, S., V. Burrows, J. Sutor, and M. Carlson, "Addressing Gender Equity Pipeline Issues with a Workshop for High School Math and Science Teachers," *Frontiers in Education Annual Conference Proceedings*, Milwaukee, WI, October 10-13, 2007.	"A gender gap in science, a foundational subject area for engineering, begins to emerge in middle and early high school. This gap can negatively impact females' education and career decisions about science and engineering due to environmental and affective factors in the classroom. In order to identify, strategize, and address these gender equity issues, a workshop was held for high school math and science teachers in an NSF math science partnership project. Interactive, team-based discussions and reports were made after short presentations on gender issues of environmental factors of stereotypes and "chilly learning climates" and affective factors of self-efficacy and societal relevance of engineering. Teachers' recorded their reflections based on the factors of awareness, personal experience, literature findings, underlying causes, and possible ameliorative strategies and actions."

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(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
68	Krause, S., V. Burrows, J. Sutor, and M. Carlson, "High School Math and Science Teachers' Awareness of Gender-Equity Issues from a Research-based Workshop," *American Society for Engineering Education Annual Conference Proceedings*, Honolulu, HI, June 26, 2007.	"Over the past decade the first-time enrollment of females in undergraduate engineering has not increased and remains at about 20%, in spite of ongoing K-12 engineering gender diversity programs. The underlying cause for the decline is not cognitive ability or academic performance. Instead, the cause has sociocultural roots that create barriers to female participation in science and engineering education and careers… This work presents the results of a research-based workshop on issues that inhibit females from enrolling in college curricula that lead to STEM degrees and careers."
69	Krause, S., R. Culbertson, M. Carlson, and M. Oehrtman, "High School Teacher Change, Strategies, and Actions in a Professional Development Project Connecting Mathematics, Science, and Engineering," *Proceedings of the 38th ASEE/IEEE Frontiers in Education Conference*, Saratoga Springs, NY, October 22-25, 2008.	"Project Pathways, an NSF Math Science Partnership professional development project, uses four semester-long courses and professional learning communities (PLCs) with the goal of enhancing teacher knowledge, skills and practice. The unifying concept of function is applied to promote conceptual competence in core content subjects and key problem solving processes. Modules integrating math, science, and engineering are delivered in team-based studio labs complemented by associated PLCs."
70	Landge, S. M., V. Atanassova, M. Thimmaiah, and B. Török, "Microwave-Assisted Oxidative Coupling of Amines to Imines on Solid Acid Catalysts," *Tetrahedron Letters*, Vol. 48, Issue 29, July 16, 2007, p. 5161-5164.*****	"A K-10 montmorillonite catalyzed microwave-assisted oxidative coupling of amines is described. Substituted benzylamines readily undergo self-coupling reactions to produce benzylidene–benzylamines, while aliphatic amines and anilines cannot form self-coupled products. A mixture of a benzylamine and an aniline or aliphatic amine, respectively, effectively, and selectively produces mixed imines, such as benzylidene–anilines and benzylidene–alkylamines."
71	Landge, S. M., M. Berryman, and B Török., "Microwave-Assisted Solid Acide-Catalyzed One-Pot Synthesis of Isobenzofuran-1 (3*H*)-ones," *Tetrahedron Letters*, Vol. 49, Issues 29-30, July 31, 2008, pp. 4505-4508.*****	"A new, solid acid-catalyzed microwave-assisted environmentally benign synthesis of isobenzofuran-1(3*H*)-ones is described. Montmorillonite K-10 appeared to be an excellent catalyst for the condensation and successive lactonization reactions. Reaction of phthalaldehydic acid (2-carboxybenzaldehyde) with methylaryl and cyclic ketones was initiated by microwave irradiation and occurred in one step. The reactions were complete in 10–30 minutes providing excellent yields (90–98%)."
72	Landge, S. M., D. A. Borkin, and B. Török, "Microwave-Assisted Preparation of Trifluoroacetaldehyde (Fluoral): Isolation and Applications," *Tetrahedron Letters*, Vol. 48, Issue 36, September 3, 2007, pp. 6372-6376.*****	"A novel method for the preparation of trifluoroacetaldehyde (fluoral, TFAc, CF3CHO) from commercially available trifluoroacetaldehyde ethylhemiacetal (TFAE) by microwave irradiation is described. The isolation, characterization and reaction of fluoral with various nucleophiles were studied to verify the diverse applicability of this new method."
73	Landge, S. M., A. Schmidt, V. Outerbridge, and B. Török, "Synthesis of Pyrazoles by a One-Pot Tandem Cyclization-Dehydrogenation Approach on Pd/C/K-10 Catalyst," *Synlett*, Issue 10, 2007, pp. 1600-1604.*****	"A novel one-pot synthesis of substituted pyrazoles from chalcones and hydrazines via a tandem cyclization-dehydrogenation approach is described. This process is based on the use of a bifunctional noble-metal/solid-acid catalyst, Pd/C/K-10 montmorillonite and microwave irradiation under solvent-free conditions. The cyclization of chalcones with hydrazines readily takes place on the strong solid acid while the presence of the metal ensures the formation of the aromatic product through dehydrogenation. The reactions are complete in 30 minutes providing good yields and high selectivities."
74	Landge, S. M., and B. Török, "Synthesis of Condensed Benzo[N,N]-Heterocycles by Microwave-Assisted Solid Acid Catalysis," *Catalysis Letters*, Vol. 122, No. 3-4, May 2008, pp. 338-343.*****	"The synthesis of several types of condensed benzo[N,N]-heterocycles such as benzimidazoles, benzodiazepines, quinoxalinones by a microwave-assisted solvent-free solid acid catalyzed method is described. The commercially available, inexpensive K-10 montmorillonite is an excellent catalyst for the synthesis of the target compounds. Our approach is based on the reactions of a wide variety of o-phenylenediamines, with ketones, aldehydes and bifunctional reagents, respectively. The cyclization reactions were initiated by microwave irradiation."
75	LaRue-Davis, A., "The Role of the Mathematics Specialist in Albemarle County Public Schools, Virginia," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 27-31.	Abstract not available.
76	Lawson, A.E., "How Many Scientific Methods Exist?," *The American Biology Teacher*, undated. [No further details available.]	No abstract available.

*****An asterisk denotes any of the 10 STEM discipline-focused academic articles produced by *MSP-funded* interns, graduate students, or other supported participants who are newly contributing to the STEM workforce, and are therefore included in this review. These articles generally produced low ratings because they did not draw data from, or reflect the main activities of, a specific MSP or RETA.

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(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
77	Lawson, A.E, "On the Hypothetico-Deductive Nature of Science? Darwin's Finches," *Science & Education*, Vol. 18, No. 1, January 2009, pp. 119-124.	"Allchin (2006) has misinterpreted a classic case of hypothetico-deductive (HD) science in terms of his preferred "let's-gather-some-data-and-see-what-emerges" view. The misrepresentation concerns the research program of Peter and Rosemary Grant on Darwin's finches. The present essay argues that the Grants' research is HD in nature and includes a statement by Peter Grant to that effect."
78	Lawson, A.E., "On the Implications of Neuroscience Research for Science Teaching and Learning: Are there any?," *CBE – Life Sciences Education*, Vol. 5, No. 2, Summer 2006, pp. 111-117.	"What, if anything, do teachers need to know about how the brain works to improve teaching and learning? After all, a plumber needs to know how to stop leaks--not the molecular structure of water. And one can learn how to use a computer without knowing how a computer chip works. Likewise, teachers need to know how to help students develop intellectually and learn--not necessarily how their brains work. Nevertheless, it is important for teachers to understand that what is being discovered about how brains work supports constructivist learning theory, which in turn supports inquiry-based teaching. The goal of the present article is to explicate why this is so. The author starts with some of the basics of brain development. The author then discusses the implications of neuroscience research for science teaching and learning."
79	Lawson, A.E., J. Jensen, and M. Oehrtman, "Using a Learning Cycle and Mendelian Genetics to Teach Scientific and Statistical Hypothesis Testing," *Journal of Statistics Education*, Vol. 18, No. 1, January 2009.	No abstract available.
80	Lawson, A.E., and M. Oerhtman, "Connecting Science and Mathematics: The Nature of Proof and Disproof in Science and Mathematics," *International Journal of Science and Mathematics Education*, Vol. 6, No. 2, June 2008, pp. 377-403.	"Disagreements exist among textbook authors, curriculum developers, and even among science and mathematics educators/researchers regarding the meanings and roles of several key nature-of-science (NOS) and nature-of-mathematics (NOM) terms such as proof, disproof, hypotheses, predictions, theories, laws, conjectures, axioms, theorems, and postulates. To assess the extent to which these disagreements may exist among high school science and mathematics teachers, a 14-item survey of the meanings and roles of the above terms was constructed and administered to a sample of science and mathematics teachers."
81	Lawson, A.E., M. Oehrtman, and J. Jensen, "The Nature of Scientific Hypothesis Testing," *The American Biology Teacher*, undated.	No abstract available.
82	Leege, L., M. Schriver, and K. Chassereau, "Under the Mistletoe," *The Science Teacher*, Vol. 75, No. 2, February 2008, pp. 48-52.	"The "Under the Mistletoe" project was developed to capitalize on student curiosity about the American Christmas Mistletoe plant and draw learners into an engaging, inquiry-based exercise that incorporates numerous life science standards and collaborative research. By collecting data on host and nonhost tree size, location, and number of mistletoe present during the winter months—after the trees have lost their leaves—students investigate the host-parasite relationships of mistletoe. Students gain experience developing research questions, using scientific equipment to collect data, and drawing conclusions based on the integration of math and science."
83	Lehner, E., "Creating Collaborative Third-Space Discourse to Address Coteaching Contradictions," *Forum: Qualitative Social Research*, Vol. 7, No. 4, September 2006, Article 19.	"This article examines how coteaching can be wrought with contradictions without employing its recursive counterpart, cogenerative dialogue. To help avoid dualistic tendencies while coteaching, participants can use cogenerative dialogue to help create collaborative third-space discourse where plans of cooperative action can be cogenerated. This work also shares how the extension of the cosmopolitan ethic can be used in tandem with one-on-one cogenerative dialogues to navigate ideological differences in coteachers and create fruitful working partnerships."
84	Lehner, E., "Using Cogenerative Dialogue to Advance Urban High School Science Achievement," *AERA Online Yearbook of Urban Learning, Teaching, and Research,* paper accepted for publication.	No abstract available.
85	Levendis, Y.A., C. Zahopoulos, C. Hall, and J. McLaughlin, "A Vertically-Aligned Contextualized Pre-Engineering Design Course for Middle- and High-School Science Teachers?", *Proceedings of the ASEE New England Section Meeting*, CD-ROM, University of Rhode Island, Kingston, 2007.	No abstract available.

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(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
86	Li, X., E.J. Collins, and J.J. Evans, "Examining the Collision-Induced Decomposition Spectra of Ammoniated Triglycerides as a Function of Fatty Acid Chain Length and Degree of Unsaturation. II. The PXP/YPY series," *Rapid Communications in Mass Spectrometry*, Vol. 20, No. 2, December 6, 2006, pp. 171-177.*	"A series of positionally pure triglycerides (TAGs) of the form PXP and YPY, where P is the palmitate moiety and X and Y are large arrays of different fatty acid moieties, is synthesized and analyzed by reversed-phase high-performance liquid chromatography/tandem mass spectrometry. The intensities of the collision-induced decomposition (CID) products of ammoniated TAGs were examined as a function of chain length, degree of unsaturation, double-bond position, and cis/trans configuration of X and Y. The major CID products, the diglyceride (DAG) fragment ions and the MH^+ ions, are plotted as functions of chain length for the saturated and monounsaturated series of X and Y…The collection of PXP/YPY data produced in this work is used to test the mechanisms of the formation and decomposition of ammoniated TAGs that were previously presented. The YPY data are used to predict the intensities of the fragment ions in the CID spectra of YPX-type TAGs. The limitations of the mathematical approach used in these predictions are discussed in context of a broader plan to develop a software platform for comprehensive analysis of complex TAG mixtures."
87	Lias, A. R., S. K. Fowler, E. G. Holdan, and M. M. Maxwell, "Developing a Deep Understanding of Elementary School Mathematics: A Staff Development Partnership," *International Journal of Learning*, Vol. 12, 2006, p. 73.	"How do elementary school students gain an understanding of the big ideas in mathematics? Often elementary teachers lack the depth of understanding of these big ideas and perceive themselves as not being "good at math." How can teachers gain this depth of mathematical content knowledge and the pedagogical skills needed to make this happen? In a concerted effort to systematically change the teaching and learning of mathematics in southwestern Pennsylvania, elementary schools, middle schools, high schools, intermediate units, and universities have joined in a Mathematics and Science Partnership…The focus of this paper is on the partnership's work with elementary school Teacher-Leaders. We summarize how our partnership is helping teachers develop a deeper mathematical understanding of elementary school mathematics and the pedagogical skills necessary to bring about a deeper understanding in their students through the use of exemplary professional development materials."
88	Little, L., "The Computational Science Major at SUNY Brockport," *Future Generation Computer Systems*, Vol. 19, Issue 8, November 2003, pp. 1285-1292.	"The field of computational science is a recent addition to academic study. While the content of such an education is generally agreed upon, effective methods for imparting this knowledge are still being investigated. This paper describes the current state of the computational science degree programs at SUNY Brockport and the successes that have been obtained."
89	Lucas, D., B. Broderick, R. Lehrer, and R. Bohanan, "Making the Grounds of Scientific Inquiry Visible in the Classroom," *Science Scope*, Vol. 29, Issue 3, November-December 2005, pp. 39-42.	"As every parent knows, children are no slouches at generating questions. But the scientific potential in a child's spontaneous question can easily be lost; children often fail to take the step beyond casual curiosity into systematic inquiry. Questioning is indeed robustly rooted in children's everyday ways of thinking about the world, but serious classroom support is required if these children's questions are to become productive guides to scientific inquiry. Similarly, children are apt at generating justifications to support their actions or points of view in an argument. However, they often regard their actions or beliefs as unproblematic, even self-evident. In contrast, scientific inquiry demands a separation between belief and evidence, so that each can be considered apart and their relations made explicit. Thus, question posing and evidence-generating go beyond common sense, and so must be nurtured explicitly in science education" [first paragraph of article].
90	Mahoney, J., "Teacher to Teacher: What is the Name of This Game?," *Mathematics Teaching in the Middle School*, Vol. 11, Issue 3, October 2005, p. 150.	"This article introduces an easy-to-learn game which, surprisingly, is similar to a well-known game. Variations of this game are also described."
91	Mason, B., D.A. Mason, M. Mendez, G. Nelsen, and R. Orwig, "Effects of Top-Down and Bottom-Up Elementary School Standards Reform in an Underperforming California District," *The Elementary School Journal*, Vol. 105, Issue 4, March 2005, p. 353. Retrieved November 10, 2008 from MSPnet Web site.	"In this article we describe how an underperforming school district used research and theory on curriculum, assessment, implementation, and school and classroom organization to develop and implement district standards and improve the achievement of elementary school students. Key reforms included: teachers developing essential curriculum standards, standards-based criterion-referenced tests, and standards-based extended-learning opportunities. Teachers rated the reform efforts positively and reported a high likelihood of implementation. Using California Department of Education data, we employed econometric analyses to estimate program effects for the district's elementary schools from 1999 to 2002."
92	Mathematics Specialists School and University Partners, "Mathematics Specialists Definition," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 1-2.	Abstract not available.

*An asterisk denotes any of the 10 STEM discipline-focused academic articles produced by *MSP-funded* interns, graduate students, or other supported participants who are newly contributing to the STEM workforce, and are therefore included in this review. These articles generally produced low ratings because they did not draw data from, or reflect the main activities of, a specific MSP or RETA.

(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
93	McClain, A., D. Feldman, L. Meadows, "Engineering Applications for Middle School Mathematics Education: Supporting an Inquiry-Based Classroom Environment," *Proceedings of the 2007 ASEE Annual Conference and Exposition*, Honolulu, Hawaii, June 24-27, 2007. Retrieved November 5, 2008 from MSPnet Web site.	"Although many wonderful resources are available that provide educators with a connection between engineering, science, mathematics, and real world applications, there is a need for development in support of inquiry-based engineering application tasks for the middle school mathematics classroom. In this paper, available resources for engineering applications in middle school classrooms, inquiry-based pedagogy, and the need for engineering applications supporting inquiry-based mathematics education are presented."
94	McLeod, K., and D. Huinker, "University of Wisconsin-Milwaukee Mathematics Focus Courses: Mathematics Content for Elementary and Middle Grades Teachers," *Journal of Mathematical Education in Science and Technology*, Vol. 38, Issue 7, October 2007, pp. 949-962.	"There has been much debate in recent years as to the amount and type of mathematical knowledge that teachers need to acquire. One set of recommendations is provided by the Mathematical Education of Teachers (MET) report, produced jointly by the American Mathematical Society and the Mathematical Association of America. This paper reports on efforts at the University of Wisconsin-Milwaukee to implement the MET report recommendations for pre-service elementary and middle grades teachers, in the contexts of teacher education programmes and the teacher licensing structure of the state of Wisconsin."
95	Mills, P., and W. Sweeney, "Bond Breaking Misconception," *Journal of College Science Teaching*, (letters to the Editor), Vol. 37, September 1, 2007, p. 11.	"We write to discuss an important clarification in the article 'Combustion and Energy Transfer Experiments,' which appeared in the January/February 2007 issue. The thesis of the article, that core concepts in science can be linked across courses and disciplines in the laboratory is an important idea. The authors identified a critical core concept, namely energy transfer in chemical reactions, and have presented ways in which this concept can be integrated into biology, chemistry, and physics laboratories" [first paragraph of article].
96	Morton, F., "Approaching Mathematics Utopia," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp.45-52.	Abstract not available.
97	Pagni, D., "Building Buildings with Triangular Numbers," *The AMATYC Review*, Vol. 27, No. 2, Spring 2006, p. 56.	"Triangular numbers are used to unravel a new sequence of natural numbers here-to-fore not appearing on the Encyclopedia of Integer Sequences website. Insight is provided on the construction of the sequence using "buildings" as a viewable model of the sequence entries. A step-by-step analysis of the sequence pattern reveals a method for generating the function. Graphing calculator programs are provided for generating the sequence both recursively and explicitly for different initial "building" sizes. Finally, an explicit formula for the sequence that makes use of the "ceiling" function generalizes the results."
98	Pagni, D., "Card Folding: An Investigation with Limits", *Mathematics Teacher*, Vol. 100, Issue 1, August 2006, p. 60.	"This article covers an activity that involves geometry and second-year algebra concepts, graphing, and limits (vertical and horizontal asymptotes)…students can verify their mathematical conclusions with actual measurements of the cards."
99	Pagni, D., "Finding Areas on Dot Paper," *Mathematics Teaching in the Middle School*, Vol. 12, Issue 5, January 2007, pp. 274-282.	"This article contains investigative activities to assist students in constructing formulas out of an understanding of the area of geometric shapes."
100	Pagni, D., "The Coat Check Problem: A S(t)imulating Lesson", *Mathematics Teaching in the Middle School*, Vol. 13, Issue 3, October 2007, pp. 182-187.	"Article describes a simulation of the Coat Check problem, in which four women check their coats only to have them returned at random. Students examine the experimental and theoretical probability of at least one woman getting her own coat back."
101	Paruszkiewicz, M., "Trickle-down Inspiration: From Mathematics Specialist to Teacher to Students," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 11-13.	Abstract not available.
102	Pecore, J. L., B.A. Christensen, H. Mobley, and N.R. Hanna, "Earth Core: Enhancing Delivery of Geoscience Content in a Diverse School System During Times of Changing State Standards," *Journal of Geoscience Education*, Vol. 55, No. 5, December 2007, pp. 589-595.	"The Earth Core program provided a one week earth science content workshop to urban public school sixth grade teachers who lacked geoscience training with the goal of increasing participants' pedagogical content knowledge (PCK) and confidence in teaching earth science. The workshop evolved from a concern that teachers would not have the training or experience required to engage students with earth science material due to new state standards switching geoscience instruction from 8th to 6th grade."
103	Pitt, L.D., "Mathematics Teacher Specialists in Virginia: A History," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 23-31.	Abstract not available.

(Continued)

(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
104	Pitts, V.M., and J.P. Spillane, "Using Social Network Methods to Study School Leadership," *International Journal of Research & Method in Education*, Vol. 32, Issue 2, July 2009, pp. 185-207.	"Social network analysis is increasingly used in the study of policy implementation and school leadership. A key question that remains is that of instrument validity - that is, the question of whether these social network survey instruments actually measure what they purport to measure. In this paper, we describe our work to examine the validity of the School Staff Social Network Questionnaire (SSSNQ), an instrument designed to study school leadership practice related to instruction. To examine the validity of the survey, we conducted two studies. The first involved administration of the SSSNQ in 22 schools and interviews with a sub-sample of school staff in six of these schools. The second study involved cognitive interviews in which interviewees were asked to "think aloud" as they completed a revised version of the SSSNQ."
105	Pustejovsky, J.E., J.P. Spillane, R. Heaton, and W.J. Lewis, "Understanding Teacher Leadership in Middle School Mathematics: A Collaborative Research Effort," *The Journal of Math and Science: Collaborative Explorations*, 2008. [No further details available.]	"We report findings from a collaborative research effort designed to examine how teachers act as leaders in their schools. We find that teachers educated by the Math in the Middle Institute act as key sources of advice for colleagues within their schools while drawing support from a network consisting of other teachers in the program and University-level advisors. In addition to reporting on our findings, we reflect on our research process, noting some of the practical challenges involved as well as some of the benefits of collaboration."
106	Race, K., "Beyond the Textbook: Lessons Learned From Two Years as a Mathematics Specialist," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 15-20.	Abstract not available.
107	Richard, P.R., J.M. Fortuny, M. Hohenwarter, and M. Gagnon, "GeogebraTUTOR: Une Nouvelle Approche pour la Recherche sur L'apprentissage Compétentiel et Instrumenté de la Géométrie à L'écôle Secondaire," *Proceedings of the World Conference on E-Learning in Corporate, Government, Healthcare & Higher Education*, Québec, Canada, 2007.	"Le but de notre exposé est de montrer une nouvelle approche pour la recherche sur l'apprentissage de la géométrie à l'école secondaire à partir d'un environnement informatique d'apprentissage humain conçu par notre équipe de recherche (geogebraTUTOR). Le texte présente les objectifs de notre projet, le contexte de réalisation, dont les axes de références du cadre théorique, ainsi que la méthode de recherche avec ses fondements, la population à qui s'adresse la recherche et son développement. Nous concluons brièvement avec les retombées attendues dans le milieu scolaire."
108	Robertson, P., "Mathematics Specialists in the Elementary Schools: The Arlington Story," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, p. 39-42.	Abstract not available.
109	Rodriguez, B., and S. Garthwaite, "A Day in the Life of Two Mathematics Specialists: Bringing Math to the Forefront in Elementary Schools," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 61-67.	Abstract not available.
110	Rodriguez-Lopez, M., and A. Carrasquillo, "Improving Conceptions in Analytical Chemistry: The Central Limit Theorem," *Journal of Chemical Education*, Vol. 83, Issue 11, November 2006, pp. 1645-1648.*****	"This article describes the central limit theorem (CLT) and its relation to analytical chemistry. The pedagogic rational, which argues for teaching the CLT in the analytical chemistry classroom, is discussed. Some analytical chemistry concepts that could be improved through an understanding of the CLT are also described."
111	Rosenberg, S., M. Spillane, and D. Wulf, "Heron Triangles and Moduli Spaces," *Mathematics Teacher*, Vol. 101, No. 9, May 2008, pp. 656-663.	"The "Delving Deeper" department provides a forum that allows classroom teachers to share the mathematics from their work with students, their classroom investigations and projects, and their other experiences. This month, the question, "Are triangles with same area and perimeter congruent?" is discussed."
112	Rosenberg, S., M. Spillane, and D. Wulf, "Inscribing Chords in a Circle," *Mathematics Teacher,* in press.	No abstract available.
113	Rowan, T., "Mathematics Teacher Specialists - Making a Difference for Student Learning," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 43-61.	Abstract not available.

*****An asterisk denotes any of the 10 STEM discipline-focused academic articles produced by *MSP-funded* interns, graduate students, or other supported participants who are newly contributing to the STEM workforce, and are therefore included in this review. These articles generally produced low ratings because they did not draw data from, or reflect the main activities of, a specific MSP or RETA.

(Continued)

(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
114	Sack, J.J., "Commonplace Intersections within a High School Mathematics Leadership Institute," *Journal of Teacher Education*, Vol. 59, No. 2, 2008, pp. 189-199. Retrieved December 4, 2008 from SAGE Publications Web site.	"This narrative inquiry weaves Schwab's commonplaces of curriculum and Clandinin, Pushor, and Murray Orr's narrative commonplaces through stories of conflict between a professional developer and 30 high school lead teachers. In her role as manager of a mathematics leadership institute situated between two urban public school districts and a partnering university in the mid-Southwestern United States, the inquirer describes how she and the professional developer learned how to deal with commonplace disconnections through reflective discourse around these experiences."
115	Schifter, D., and J.B Lester, "Active Facilitation: What do Specialists Need to Know and How Might They Learn It?," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, p. 97-118.	Abstract not available.
116	Schilling, S.G., "The Role of Psychometric Modeling in Test Validation for the MKT Measures: An Application of Multidimensional Item Response Theory," *Measurement: Interdisciplinary Research and Perspectives*, Vol. 5, No. 2-3, August 2007, pp. 93-106.	"One of the key challenges facing psychometrics as a discipline is demonstrating its relevance with regards to substantive issues in educational and psychological research. One problem is that psychometric modeling has long been considered part of reliability analysis, which has traditionally been considered separately from test validation. However, this separation can be viewed as artificial (Marcoulides, 2004) and we believe that test validation must necessarily employ psychometric modeling to investigate key assumptions and inferences. Such an investigation intimately connects psychometric modeling to substantive concerns and provides a gateway for the relevance of psycho-metrics in educational and psychological research. In this paper we examine the role of item response theory (IRT), particularly multidimensional item response theory (MIRT) in test validation from a validity argument perspective."
117	Schilling, S.G., and H.C. Hill, "Assessing Measures of Mathematical Knowledge for Teaching: A Validity Argument Approach," *Measurement: Interdisciplinary Research and Perspectives*, Vol. 5, No. 2-3, August 2007, pp.70-80.	"In assessing the utility of a test, two issues stand out: whether it provides information of interest to test consumers, and whether scores generated by the test assist in making good decisions. Validity addresses these two issues, making an assessment of test validity the single most important product provided by test developers. Unfortunately, despite its importance, test validation is almost universally viewed as the most unsatisfactory aspect of test development. As Messick (1988) noted, there has been a consistent disjunction between validity conceptualization and validation practice. To start, the proliferation of many different kinds of validity evidence without clear prioritization presents test consumers with an enormous task, that of sifting through various methods, approaches, and empirical work to determine the usability of a test. At the same time, some test developers use evidence (and methods) selectively, choosing convenient means for test validation, and convenient results for reporting. Kane (2001, 2004a) developed an argument-based approach to validity as a means of addressing these difficulties. His approach consists of two stages, the Formative Stage and the Summative Stage."
118	Schmidt, W.H., R.S. Prawat, and R.T. Houang, "National Control of Education: What Does it Mean," *Educational Evaluation and Policy Analysis*, in press.	No abstract available.
119	Schurmeier, K., C.G. Shepler, C.H. Atwood, and G.J. Lautenschlager, "Using Item Response Theory to Assess Undergraduate General Chemistry Understanding," *Journal of Chemical Education*, 2007. [No further details available.]	No abstract available.
120	Semken, S., and C.B. Freeman, "Sense of Place in the Practice and Assessment of Place-based Science Teaching," *Science Education*, Vol. 92, No. 6, November 2008, pp. 1042-1057.	"We teach earth, ecological, and environmental sciences in and about "places" imbued with meaning by human experience. Scientific understanding is but one of the many types of meanings that can accrue to a given place. People develop emotional attachments to meaningful places. The "sense of place," encompassing the meanings and attachments that places hold for people, has been well characterized in environmental psychology. Its components, place attachment and place meaning, can be measured psychometrically. "Place-based" science teaching focuses on local and regional environments and synthesizes different ways of knowing them, leveraging the senses of place of students and teachers. Place-based teaching has been advocated for its relevance and potential to attract underrepresented groups to science. We posit that sense of place is a measurable learning outcome of place-based science teaching. We developed an Arizona-based, culturally inclusive, meaning-rich introductory geology course, and used published surveys to assess place attachment and meaning in students who took the course."

(Continued)

(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
121	Semken, S., C. Butler Freeman, N. Bueno Watts, J. Neakrase, R. Dial, and D. Baker, "Factors that Influence Sense of Place as a Learning Outcome of Place-based Geoscience Teaching," *International Journal of Science Education*, 2007. [No further details available.]	No abstract available.
122	Shapiro, N., J. Frank, and K. O'Meara, "Pouring New Wine into Old Bottles: P-20 Partnerships and the Promise of STEM Education," *Thought & Action*, 2008, in press.	No abstract available.
123	Shen, J., P.C. Gibbons, J.F. Wiegers, and A.P. McMahon, "Using Research Based Assessment Tools in Professional Development in Current Electricity," *Journal of Science Teacher Education*, Vol. 18, No. 3, June 2007, pp. 431-459.	"We present a practical way of adapting and using four research-based assessments for different purposes in an electricity and magnetism course for K-8 science teachers. The course is designed to accomplish conceptual change toward accepted scientific conceptions as well as introducing teachers to materials and activities appropriate for their classrooms."
124	Shepherd, J.M., J. Durkee, and R. Hill, "On the Integration of an Educational Climate Model into Physical Geography Curricula: Implementation and Evaluation Strategies," *Journal of Geography*, 2007. [No further details available.]	No abstract available.
125	Shepler, C., K. Schurmeier, and C. Atwood, "Examining First Semester General Chemistry Students Thought Processes via Post-Test Interviews," *International Journal of Science Education*, 2007. [No further details available.]	No abstract available.
126	Sinclair, E., "The Mathematics Specialist: A Personal View," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 57-60.	Abstract not available.
127	Sinwell, B., "The Chebyshev Polynomials: Patterns and Derivation," *Mathematics Teacher*, Vol. 98, No. 1, August 2004, pp. 20-25.	"This article shows a derivation of the Chebyshev polynomials and explores mathematically the patterns that they produce. The range of topics covered is relevant to the high school classroom and beyond."
128	Smith-Jones, Y., "Hopewell, Virginia: How do you 'Hook' Elementary Teachers into Enjoying and Seeing the Beauty of Mathematics?," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005. pp. 63-65.	Abstract not available.
129	Sofo, R., "Beyond NCLB and AYP: One Superintendent's Experience of School District Reform," *Harvard Educational Review*, Vol. 78, Issue 2, Summer 2008, pp. 391-409.	"In this Voices Inside Schools essay, Ron Sofo, a school district superintendent in western Pennsylvania, argues that schools need bottom-up solutions more than top-down mandates if they are to prepare all students to meet twenty-first-century workforce demands… His essay offers a window into the complex process of instructional reform at the classroom, school, and district levels."
130	Southwell, D., "The Characteristics Necessary for a Mathematics Specialist," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 9, Spring 2007, pp. 37-39.	Abstract not available.
131	Spillane, J., "Distributed Leadership," *The Educational Forum*, Vol. 69, No. 2, Winter 2005, pp. 143-150.	"Stories of leadership successes follow a familiar structure: A charismatic leader, often the CEO or school principal, takes over a struggling school, establishing new goals and expectations and challenging business as usual within the organization. This leader creates new organizational routines and structures that with time transform the school's culture, contributing in turn to greater teacher satisfaction, higher teacher expectations for students, and improved student achievement."
132	Spillane, J.P., "Primary School Leadership Practice: How the Subject Matters," *School Leadership and Management*, Vol. 25, No. 4, September 2005, pp. 383-397.	"Teaching is a critical consideration in investigations of primary school leadership and not just as an outcome variable. Factoring in instruction as an explanatory variable in scholarship on school leadership involves moving away from views of teaching as monolithic or unitary practice. When it comes to leadership in primary schools, the subject matters. More sophisticated constructions of teaching are necessary that take into account the subject matter (e.g., mathematics or literacy) and the dimension of teaching (e.g., content and teaching strategies). This paper explores how the practice of leadership in primary schools is structured differently depending on the school subject."
133	Spillane, J., E. Camburn, and A. Pareja, "Taking a Distributed Perspective to the School Principal's Workday," *Leadership and Policy in Schools*, Vol. 6, No. 1, February 2007, pp. 103-125.	"Focusing on the school principal's day-to-day work, we examine who leads curriculum and instruction- and administration-related activities when the school principal is not leading but participating in the activity. We also explore the prevalence of coperformance of management and leadership activities in the school principal's workday. Looking across a range of administration-related and curriculum and instruction-related activities school principals participate in, we show that who takes responsibility for leading and managing the schoolhouse varies considerably from activity to activity and from one school to the next."

(Continued)

(Exhibit A-2, Continued)

Article No.	Citation	Original Abstract (some may be lightly edited)
134	Spillane, J.P., L. Dorner, A. Pareja, and J. Huff, "What can They Possibly Tell Me That I Don't Already Know? Using Mixed Methods to Study Change in Principal Expertise," *Cognition and Instruction*, 2008. [No further details available.]	No abstract available.
135	Spillane, J., and E. Orlina, "Investigating Leadership Practice: Exploring the Entailments of Taking a Distributed Perspective," *Leadership and Policy in Schools*, Vol. 4, No. 3, September 2005, pp. 157-176.	"This paper examines two questions: What does it mean to take a distributed perspective on leadership in schools? What are the entailments of taking a distributed perspective for research on school leadership? Arguing that the practice of leadership should be a key concern in scholarship on school leadership, the authors explore the leader-plus and the practice aspects of taking a distributed perspective. Arguing that both aspects are essential when taking a distributed perspective, the authors review findings from recent research that dwells mostly on the leader-plus aspect. Turning to the second question, the authors explore the methodological challenges involved in taking a distributed perspective."
136	Spillane, J., A. Pareja, C. Barnes, E. Camburn, and J. Huff, "Mixed Methods in Randomized Trials: Potentials and Pitfalls," *Educational Evaluation and Policy Analysis*, 2008. [No further details available.]	No abstract available.
137	Spillane, J., K. White, and J. Stephan, "Principal Expertise: Testing Differences Between Experts and Novices," *School Leadership and Management*, 2008. [No further details available.]	No abstract available.
138	Spillane, J., and A. Zuberi, "Studying the Practice of Leadership for Instruction: Designing and Piloting A Leadership Daily Practice Log," *Educational Administration Quarterly*, 2008. [No further details available.]	No abstract available.
139	Stith, I., K. Scantlebury, S. LaVan, C. Emdin, E. Lehner, and M. Kim, "The Ethics of Cogenerative Dialogue: A Cogenerative Dialogue", *Forum: Qualitative Social Research*, Vol. 7, No. 2, March 2006, Article 44.	"In this cogenerative dialogue about cogenerative dialogue as qualitative research method and ethics, we move beyond our individual contributions in this special issue to begin a process that we hope will be carried further by our readers. We conclude that cogenerative dialoguing constitutes an excellent starting point towards enacting equity in practice."
140	Trevisan, B. and T.M. Poole, "Using a Theme-based Approach to Learn Introductory Biology Results in an Increase in Confidence and Interest in Biology in Female Students," *Journal of College Science Teaching*, submitted for publication. [This item was included as a pending publication within a specified peer-reviewed journal.]	No abstract available.
141	Virginia Mathematics and Science Coalition Task Force, "Mathematics Specialists Task Force Report," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 5-22.	Abstract not available.
142	Walston, D., "Mathematics Specialists in Norfolk Public Schools," *The Journal of Mathematics and Science: Collaborative Explorations*, Vol. 8, Spring 2005, pp. 67-72.	Abstract not available.
143	Yasar, O., J. Maliekal, L. Little, and D. Jones, "Computational Technology Approach to Education," *Computing in Science and Engineering*, Vol. 8, Issue 3, June 2006, pp. 76-81.	"As technology is increasingly used in most facets of the workplace, it is imperative that primary and secondary schools and colleges help create a workforce capable of turning technological advancements into societal benefits. Such a workforce should possess strong backgrounds in math, science, and technology, and its numbers should be sustainable. Educators should use technology as the catalyst to transform instruction into a learner-centered and inquiry-based education, one in which students construct knowledge through their own investigations."

Total = 143