Progress Toward Transformative Collaboration: Evolution of Effective University-Industry-School Partnerships

Elizabeth J. Oyer, EvalSolutions Inc.

Gilbert A. Downey, Illinois State Board of Education

Debra Greaney, Area V Learning Technology Center

Tania Jarosewich, Censeo Group LLC

Yuan Hong, Rutgers University

Jimmy de la Torre, Rutgers University

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Abstract

The Illinois Mathematics and Science Partnership (IMSP) state level evaluation investigates the complex ecology of formal and informal collaborative relationships between universities, schools, and industry partners. The program is designed to improve the performance of students by encouraging universities and schools to collaborate in programs that improve mathematics and science teaching. The meta-analyses support that the IMSP produced non-zero effect sizes for all of the models tested. The IMSP effect sizes were moderate to large across all of the models. Overall, survey respondents across partner types (industry, school, higher education, and teacher) were positive about their experiences in terms of the vision, leadership, communication, technical assistance, progress toward goals, and sustainability of their local IMSP. In the first year of implementation, the strongest area of partnership development was in the evidence of outcomes or capacity of the partners. Evaluation Implementation is the area indicating the most development is needed across more grants. In site profile reports, successful collaboration and the development of solid Master's Programs were consistent themes across projects. In survey narrative data, partners as well as participants valued the knowledge they had gained through the process and collaboration developed as part of the IMSP activities. To a lesser degree, teachers valued the outcomes in their instructional.

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Objectives

The Illinois Mathematics and Science Partnership (IMSP) state level evaluation investigates the complex ecology of formal and informal collaborative relationships between universities, schools, and industry partners. The program is designed to improve the performance of students by encouraging universities and schools to collaborate in programs that improve mathematics and science teaching. The IMSP programs in this report are evaluated not only in terms of the progress toward teacher and student outcomes, but also the nature and effectiveness of the partnerships across several dimensions, including the mutuality and trust between partners and quality of the leadership, resources, and communication. This report summarizes the progress of IMSP toward transformative partnerships across six dimensions of collaboration: Partnership Composition, Organizational Structure, Action Plan & Operational Guidelines, Partnership Quality, Performance and Outcomes, Sustainability, and Evaluation Implementation.

Theoretical Framework

Evaluating the effectiveness of these collaborations includes analyses of how partners leverage their individual resources and expertise to accomplish the collective goals of the partnership. The work of defining Mathematics and Science Partnerships (MSP) has revealed key elements for successful collaboration. In a recent examination of the benefits of engaging faculty in MSP programs, Zang et al. (2009) presented a comprehensive history of the articulation of the nature of partnerships. Most commonly, partnerships are described in terms of the function of separate entities working toward common goals (Kingsley and Waschak, 2005).

A long history of attention to important elements of MSP relationships provides guidance on creating and maintaining sustainable collaboration. For example, the attention to community context, learner-diversity, knowledge needs, and the use of assessment to provide feedback have been noted as keys to increasing the recruitment and retention in STEM education programs (Scott, Milam, Stuessy, Blount, & Bentz, 2006). However, even well-conceived, thoughtfully planned partnerships must endeavor to overcome obstacles to success, including issues related to communication, diminishing resources, and conflict in values between partners (Kochan, 1999). Cultural and theoretical differences can occur not just between school and academic partners, but also between academic partners who may not have experience collaborating across departments or colleges (Knight, Wiseman, and Smith, 1992; Bohen and Stiles, 1998; Peters, 2002). The pivotal role of context, respect, communication, and cooperation recur in various accounts of partnerships between organizations (Miller, Williamson McDiarmid, Luttrell-Montes, 2006).

One of the guiding principles of the Illinois MSP is that the program funds partnerships, not individual institutions, to accomplish project goals. The IMSP evaluation framework is grounded in the research that has identified a number of factors that contribute to successful collaborations, including an environment that brings together partners with common needs; membership characterized by diversity and respect; a structure that reflects flexibility, collaborative decision-making and clearly defined roles; group members with a stake in outcomes; open and frequent communication; a vision that is shared and developed collaboratively; and resources including in-kind contributions from all stakeholders in addition to outside resources (Mattessich & Monsey, 1992, Hays, Hays, DeVille, & Mulhall (2000), Lewis (2000), Mattessich, Murray-Close, & Monsey (2001), HUD (2002a, 2002b), Mattessich (2003), Metzler (2003), Scherer (2004).

The current report summarizes the work in the Implementation Phase. In this "implementation stage" evaluation, the development and progress of the partnerships were assessed. Results from qualitative case study analyses were combined with quantitative survey results to provide a more complete picture of the nature and progression of the collaboration across sites. Using a conceptual rubric derived from literature, partnerships were rated as beginning, emerging, developing, or transformational across seven dimensions: Partnership Composition, Organizational Structure, Action Plan & Operational Guidelines, Partnership Quality, Performance & Outcomes, Sustainability, and Evaluation Implementation. Survey results from industry, higher education, school partners, and teacher participants were also summarized.

The Illinois Mathematics and Science Partnership (IMSP) program represents an important response to a very critical need in students' mathematics and science achievement. The IMSP program is designed to improve the performance of students in the areas of mathematics and science by encouraging states, IHEs, LEAs, and elementary and secondary schools to participate in programs that improve and upgrade the status and stature of mathematics and science teaching, focus on the education of mathematics and science teachers as a career-long process; bring mathematics and science teachers together with STEM professionals, and develop more rigorous mathematics and science curricula aligned with state and local standards.

The IMSP program was initiated by the Illinois State Board of Education (ISBE) as a response to achievement needs for Illinois students in mathematics and science as well as to increase the percentage of high school math and science teachers certified in their field

Addressing the Need

Model 1:

The ISBE has developed two MSP programs to address the need for improved mathematics and science instruction in Illinois. The first model currently funded in the IMSP program centers around Master's Degree programs that represent partnerships across colleges of Arts and Science and Education with school districts to provide degree programs uniquely tailored to the needs of the IMSP.

Model 2:

In 2008-2009, the ISBE launched a second model, the Workshop Institute MSP program. This model focused on two week intensive training sessions complemented by shorter training and mentoring sessions throughout the year. The first round of intensive training was conducted in June 2009.

Methodology

Participants

The ISBE has developed two MSP programs to address the need for improved mathematics and science instruction in Illinois. The first model currently funded in the IMSP program centers around Master's Degree programs that represent partnerships across colleges of Arts and Science and Education with school districts to provide degree programs uniquely tailored to the needs of the IMSP. There are eleven universities partnered with school districts across twenty-three grants. (Some university partners have multiple grants). Grants encompass elementary, life sciences, earth and space science, environmental science, secondary math,

physics, chemistry, and IT/pre-engineering. In 2008-2009, 16 partnerships began the implementation phase of the grant, serving 551 participant teachers.

In 2008-2009, the ISBE launched a second model, the Workshop Institute MSP program (WIP). This model focused on two week intensive training sessions complemented by shorter training and mentoring sessions throughout the year. Grants represent secondary mathematics with connections to physical sciences, secondary physical sciences with connections to math, high school Nanotechnology, secondary science (primarily Geology), secondary math and science and secondary biotechnology. The first round of intensive training was conducted in June 2009, serving 216 participant teachers.

State-Level MSP Evaluation Data Sources for Quality of Partnerships

Partner Interviews

Site visits were completed for thirteen grants in Fall2008 and Spring 2009 (see Appendix A for protocol).Site evaluators summarized interview field notes and project artifacts, creating detailed Partnership Profiles for each IMSP grant. Interviews focused on Partnership Composition, Organizational Structure, Action Plan & Operational Guidelines, Partnership Quality, Performance & Outcomes, and Evaluation Implementation. Grant profiles were coded using QSR N6 software. Principal Investigators for each grant reviewed the profiles and submitted clarifications and comments through an online survey (see Appendix B).

Partner Surveys

Surveys were adapted from studies of university - community coalitions (Wolff, 2003). The surveys incorporated questions related to partners' satisfaction with the collaboration in

terms of vision, leadership, communication, technical assistance, progress and outcomes, and sustainability (see Appendix C). Surveys were completed online by university, school, and industry partners as well as teacher participants. Response rate was 85% with 1162 out of 1375 partners and participants responding across both programs. Descriptive analyses indicated the internal consistency for each survey type (higher education, industry, school, and teacher participant) was strong withα_{IHE} = .972 (n=109), $\alpha_{Industry}$= .931 (n=45), α_{School}= .971 (n=50), and $\alpha_{Teacher}$= .971 (n=479). The mean replacement method (Afifi & Elashoff, 1966) was employed to control for attrition in responses due to the "not applicable" response choice, replacing the "not applicable" code with the subscale mean. Statistical analyses were conducted using SPSS 18.

Extant Data

State documents were used to establish successful transition to the implementation phase of the program. Data from these records included start dates for implementation. Relevant extant data were also collected during site visits, including meeting organizational charts, member lists, logic models, evaluation frameworks, data analysis plans, budget summaries, agendas and minutes

Results

In 2008-2009, the state-level evaluation efforts focused on teacher and student outcomes for Master's Program grants that began implementation as well as teacher outcomes for Workshop-Institute grants. Site visits were completed in spring 2009 for the thirteen grants in the Master's Program model that began implementation in the fall semester. Site evaluators summarized interview field notes and project artifacts in program profiles for each IMSP grant.

Analyses of the partnerships focused on Partnership Composition, Organizational Structure, Action Plan and Operational Guidelines, Qualities of the Partnering Relationship, and Evaluation Implementation. Grant profiles and narrative survey responses were coded using QSR N6 software. Statistical analyses were conducted using SPSS 18.

Qualities of the partnering relationship: To what extent is there a mutual need, trust, equality in decision-making, resource exchange, transparency, respect, representation, enthusiasm, and sustained understanding between partners and stakeholders across this IMSP grant? To what extent is leadership collaborative and transformational? Who are the leaders? Have the IMSP resources been sufficient to reach implementation goals?

Partnership profiles and partner survey results were analyzed in terms of the characteristics associated with quality partnerships, including mutuality & trust, leadership, resources, and collaboration and mechanisms of communication. Detailed profiles of grants in the implementation stages were developed based on interviews and review of extant data conducted by the state evaluation team. Based on these profiles, projects were described in terms of the degree to which they were in the beginning, emerging, developing, or transformative stages.

Partnership Composition was considered in terms of the degree to which IMSP staffing, collaboration between colleges, as well as the context for implementing the MSP shows effective coordination for achieving outcomes. Organizational Structure indicated the extent to which governance and decision-making bodies of the MSP were stable and effective. Action Plan & Operational Guidelines described the nature of the program elements and the extent to which formal or informal agreements define, establish and support effective collaboration. Partnership

Quality was represented as the degree that the IMSP partnership meets mutual needs. The level of trust, respect, and mutual accountability between partners, shared leadership between partners and sufficient resources to accomplish goals are also elements of partnership quality. Finally, Evaluation Implementation indicated the degree to which the evaluation framework was executed as planned.

Beginning stages are represented by articulated plans but no actions. The element is "on the radar" but there is no substantive progress toward effective implementation. The quality of the plans is inconsistent. Outcomes are not possible because no plans have been put into action. Plans may not provide adequate foundation for full implementation.

Emerging stages are represented by clear and articulated plans with some initial actions setting the stage for implementation, but not enough substantive activity to establish implementation. The quality of the articulated plan may be very strong or may have some apparent weaknesses amidst other strengths. Outcomes are not imminent or predictable because high quality implementation has not reached a minimum threshold.

Developing stages show clear, strong implementation is in place, although corrections for barriers, changes to plans, or consistency/satisfaction across stakeholders might be mixed. Positive outcomes are evident but all goals are not fully realized or not on track.

Transformative stages show such a clear, strong enacted plan. It can be considered a model for others to use. Positive outcomes associated with the partnership seem inevitable or highly predictable.

In the first year of implementation, the strongest area of development was in the partnership compositions, or the coordination and collaboration of the partners (see

). Partnership Quality, operationalized as shared leadership, mutual need, mutual accountability, and adequate resources, is the area indicating the most development is needed across more grants.

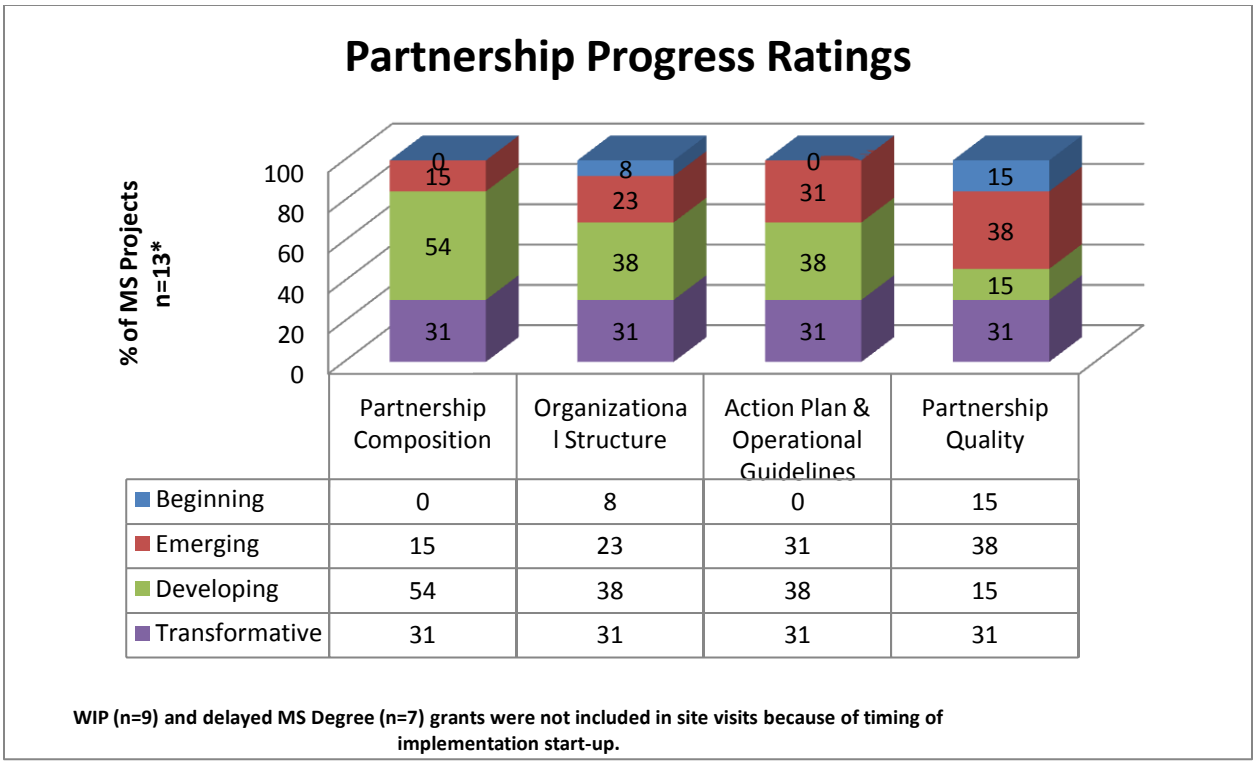

Figure 1. Partnership Progress Chart 1

Mutual Need and Trust

In site visits, participants across partnerships consistently reported a shared need, enthusiasm, and trust with between partners.

> *School district participants stated, "You know, I go to a lot of meetings. Our meetings are actually enjoyable. There's a synergy that grows every time we get together. And we get into discussions about things that we wouldn't normally be discussing"* (Partnership Profile).

> *Community Partner: "But I think our role as a partner, you know, have felt very much that this was a team that we did come to consensus in our discussions. It's very interesting all the things (Project Staff Member) has brought to the group that can be discussed and that we have discussed. And quite easily seem to reach consensus and move along or come up with ideas and solutions. It's been a pretty painless procedure. I mean, it works and it's been going very smoothly. So I think our role has been as a co-contributor and advisor and try to help find faculty when we need faculty"* (Partnership Profile).

Some partnerships are characterized by a more limited sense of need between partners.

> "*According to the PI, the grant is meeting (School District's) needs – to have teachers with advanced skills and meeting highly qualified status. (School District) has not contributed the funds for tuition reimbursement*

that they had promised, but they reportedly are pleased about what this program can do for their students" (Partnership Profile).

In narrative survey results, respondents overwhelmingly reported positive experiences across the IMSP grants. The dedication of the partners and participants was noted by all partner types and was one of two dominant themes in the narrative data that were coded as "positive" in the analyses.

"I love that this is a cohort program. Knowing that I will be following the people in my group for the next couple of years is reassuring and it creates a good support system. Also, (Professors) were very enthusiastic and helpful....they were great additions to the program!" (MS Grant Teacher 680, State Partnership Survey).

"I have found it very professional fulfilling to be involved in the MSP. I am impressed by the dedication of the teachers participating in the program -- both from the schools and the university" (MS Grant IHE Partner 276, State Partnership Survey).

"(Project Director) from the ROE is wonderful at helping us access grants to provide technology to our students. We have been able to work with wonderful professors and consultants to learn how to study rivers, build geodesic domes, perform water samples, identify trees, and use technology such as GIS/GPS, TI-Navigator in the classroom. Our program so far has been ambitious and well conceived" (WIP Grant Teacher 857, State Partnership Survey).

"The IMSP faculty members were excellent at meeting the needs of their students. Many students were having difficulty in a class, and the faculty arranged for a tutor to help us" (MS Grant Teacher 465, State Partnership Survey).

"I have gained much from the collaboration with other teachers from my district and the university professors and instructors along with the professional development opportunities such as attending the ICTM conference" (MS Grant Teacher 596, State Partnership Survey).

"(Project Directors) have been a tremendous help. I feel that they want me to succeed in this program" (MS Grant Teacher 343, State Partnership Survey).

"The instructors have been very supportive of all participants in IMSP" (MS Grant Teacher 411, State Partnership Survey).

Leadership & Decision-Making

There was a mix of leadership styles represented in the profiles. Some projects had a leadership approach that was transformational with diffuse processes for incorporating many stakeholders formally into the process. Decisions were made in a collaborative, consensus-building way, although consensus was not always possible.

"I suspect there are more than one (leader) because there are decisions that need to be made at different levels. We talk about that in class with

the teachers too. They want to make decisions that they are not able to make. It would be the same thing for me to try and make decisions for (Project Director) or other people here. But I think there are probably several leaders in this group that are functioning very well. Again, that's an outsider's view" (Partnership Profile).

Instructor stated, "I can talk to this. I think he (referring to Project Director) bends over backwards to try to please everyone. And you know what happens a lot of times is you always have the unhappy group. So I think I can sense as best as you can. And then you know something has to be finally made and somebody's not happy and poor (Project Director) takes the brunt of it" (Partnership Profile).

PI stated, "Fifty percent of the time we have consensus and then fifty percent of the time I bite the bullet and make the decision" (Partnership Profile).

Many grants were characterized by a collaborative leadership style in which one partner (the Project Director) holds a dominant leader role, but input is actively included for key decisions. This style was mostly associated with a more centralized decision-making process, although frequently information and input was collected from the partners.

"The co-PIs have developed the project guidelines and budgets. They solicit input from the school district partners and from the evaluation

consultant but the PIs make the final decisions about the project" (Partnership Profile).

"The co-PIs have developed the guidelines and budgets for the project. They solicit input from the school district partners and from faculty in other departments who are involved with the grant. Associated faculty have developed courses with input from the co-PIs. The faculty who are teaching courses are interested in meeting the goals of the grant and open to discussions with the PIs about content of courses and organization of the program in order to improve the program and student outcomes" (Partnership Profile).

Finally, some grants have a heavily centralized leadership style. One role, the Project Director, is almost exclusively charged with making decisions and this role decides when input is needed from other partners.

"Per PI statements. University faculty and school district input is sought to help inform some decisions" (Partnership Profile).

"The PI is leading grant implementation. She consults with others when needed but for the most part, appears to be leading the program on her own" (Partnership Profile)

The strong, positive impact of the IMSP leaders was noted by all partner types and was one of two dominant themes in the narrative data that were coded as "positive" in the analyses.

"(Project Director) has been consistently supportive and prompt in replying to requests" (MS Grant IHE Partner 490, State Partner Survey)

"This was an OUTSTANDING PROGRAM. I was AMAZED at everything Amy was able to give us and do for us!" (WIP Grant Teacher 490, State Partner Survey).

"(Project Directors) are wonderful - they get the job done while demonstrating respect and high expectations. The conversations are always professional" (MS Grant Industry Partner 389, State Partner Survey).

"(Project Director) is an absolute joy to work with on this project. She has incredible respect of program participants and the entire community" (WIP Grant Industry Partner 912, State Partner Survey)

"The leadership of the IMSP Grant has been outstanding. I enjoy working with them" (MS Grant School Partner 348, State Partner Survey).

"The leadership not only showed academic strength but allowed outside partnership to actively participate in planning and implementation" (MS Grant School Partner 518, State Partner Survey).

"Leaders in our project are very competent, effective, inclusive and extremely active and busy" (MS Grant IHE Partner 334, State Partner Survey).

"Excellent team with members from schools and university departments" (MS Grant IHE Partner 368, State Partner Survey).

"(Project Directors) are models of great leadership for this program" (MS Grant IHE Partner 571, State Partner Survey)

"(Project Staff) are wonderful to work with. They are approachable and communicate well. They have a passion for this program" (WIP Grant Teacher 289, State Partner Survey).

*"I am honored to work with the leadership of the IMSP and have learned a so much from them" (*MS Grant Teacher 567, State Partner Survey).

Partnership qualities are also evident from the partners each grant named to complete state partnership surveys. For the implementation phase of the IMSP, all MS Degree projects named higher education, 94% (n=15) named school partners, and 38% (n=6) named industry partners to complete state surveys. WIP projects all named IHE partners to participate in surveys, 75% (n=6) named school partners, and 50% (n=4) named industry partners to participate in the state survey.

Adequacy of Resources

Resource needs were evident for several projects. These needs were primarily related to resources needed for extra staff or for evaluation activities, although some grants reported their resources were sufficient to get the work done.

The PI stated that "we really need one more body to sort of pull us all a little more together. We need a glue person." There is a need for a "half time or administrating

assistant to provide that glue. We don't really have that. We have a diffuse leadership and actually a diffuse administrative network. And we need glue. That's what we need" (Partnership Profile).

The PI stated, "if more resources could be needed for evaluation purposes…for data entry and analysis. And for this upcoming year we plan to have an evaluation team. The three of us here plus maybe two more. We will be discussing the process as well as doing the analysis. And staff members are helping us with the entry of data. And maybe we could have some students help out with entry of data too. So that could be…I think it's reasonable" (Partnership Profile).

Team Leader stated, "Yes, definitely. There were resources that were acquired specifically for the purposes of this grant. Books that are now in the (University) library that were not before hand and they're there because they will be useful to the students in this program, and they're not limited to the use of the students in this program" (Partnership Profile).

In survey narrative data, respondents were appreciative of the resources they had received, but were equally vocal about the need for more resources.

"In regards to the working relationship, I would have to address the issue of the technology that we have been trained on. To be able to use these things in our classrooms there will need to be more and the district is not going to address this issue. It will be very frustrating this year because I will want all my students to get the benefit of it but the number of units will not match the number of students that I have" (WIP Grant Teacher 843, State Partner Survey).

"I work in a high-poverty/high-minority school and district, and the resources for STEM technology, resources, supplies, etc. are negligible and decreasing. My district does not have the money to buy materials related to IMSP or STEM in general, so my ability to incorporate what I'm learning is quite limited" (MS Grant Teacher 309, State Partner Survey).

Performance and Outcomes: What areas did the IMSP address most successfully? In what areas was the IMSP not successful in addressing?

Meta-Analysis Results

There were four phases of the meta-analyses conducted for 2008-2009 projects.

Phase 1: Obtaining Project-Level Effect Sizes for Teacher and Student Outcomes

The formulas selected to calculate the project level effect sizes, standard errors and weights are based on the assumption that the design is single-group pretest-posttest design. The effect size estimates were obtained using Equation (4) (see Morris & DeShon, 2002, p. 107). These formulas are reproduced below.

$$d_{RM} = \frac{M_{D,E}}{SD_{D,E}} = \frac{M_{post,E} - M_{pre,E}}{SD_{D,E}}$$

Here, $M_{D,E}$ is the sample mean change, or the mean difference between pre- and posttest scores, in the experimental group ($M_{pre,E}$ and $M_{post,E}$) and $SD_{D,E}$ represents the sample standard deviation of change scores. In this case, $SD_{D,E}$ is calculated as follows.

$$SD_{D,E} = \sqrt{SD_{pre}^2 + SD_{post}^2 - 2 \times SD_{pre} \times SD_{post} \times \rho_{pre,post}}$$

where SD_{pre} and SD_{post} are sample standard deviations of the pre- and posttest scores, respectively, and $\rho_{pre,post}$ is the Pearson correlation between the pre- and posttest scores.

The sampling variance estimates were obtained using the first formula in Table 2 (see Morris & DeShon, 2002, p. 117)

$$Var(d_{RM}) = \left(\frac{1}{n}\right)\left(\frac{n-1}{n-3}\right)\left(1+n\delta_{RM}^2\right) - \frac{\delta_{RM}^2}{[c(n-1)]^2}$$

Here, n is the number of paired observations in a single-group pretest-posttest design; δ_{RM} is the population effect size in the change-score metrics; $c(df)$ is the bias function defined as $c(df) = 1 - \frac{3}{4df - 1}$.

The standard errors of the site level effect size estimates and the weights are calculated based on the above estimates.

Due to missing data, the numbers of pre- and posttest observations were not the same. To obtain an estimate of the number of paired observations, n, in this single-group pretest-posttest design that can be used in computing the necessary statistics, the harmonic mean of the pretest and posttest sample sizes (i.e., n_{pre} and n_{post}) was computed. The harmonic mean was selected because it is more conservative compared to the arithmetic mean and the geometric mean, but not as conservative as the $\min(n_{pre}, n_{post})$.

Several estimates of the Pearson correlation were missing or considered missing. Specifically, values of or close to zero and negative values were treated as missing. To impute the missing values of these missing correlation coefficients, the pretest reliability and posttest

reliability were used as predictors. Specifically, the following models were used for the teacher and student data, respectively.

$$\ln(\hat{\rho}) = -0.31 - 0.146\ln(R_{pre}) - 0.548\ln(R_{post}) + 0.491\ln(R_{pre} \times R_{post}), \text{ and}$$

$$\ln(\hat{\rho}) = -0.058 + 1.959\ln(R_{pre}) - 0.268\ln(R_{post})$$

Phase 2: Obtaining Overall Effect Sizes for Content Knowledge

Because some projects utilized more than one measure for teacher knowledge outcomes, observations were combined within a single project (see Appendix D for a list of measures by project). The combined effect size is the weighted average across the effect sizes within each project. Therefore, 28 observations for teachers, with one effect size measure for each project, were created. In addition to the weighted effect sizes, the within project variances were also computed for each project using the following formula:

$$\sigma^2_{within} = \frac{1}{\sum_{i=1}^{n} 1/\sigma_i^2} + \frac{\sum_i^n w_i (d_i - \bar{d})^2}{\sum_i^n w_i}$$

where n is the number of observations within one project. σ_i^2 is the sampling variance, w_i is the weight, d_i is the effect size of the i^{th} observation; $\bar{d}$ is the weighted effect size across the observations within one project. The multi-level analysis was based on the combined teacher data. The covariates of interest for the teacher data, "content" (1-math, 2-science, 3-engineering) and "type" (1-MS, 2-WIP), were dummy coded.

Using the same method, observations for students were also combined within a single project. There were seven observations for students.

Dependency Relationship Between Variables

The association between the effect size, content and type was investigated. For the teacher data, the results showed that the "type of grant" variable (MS vs. WIP) had no association with the effect size. Although the "content" variable had a relatively larger association with the effect size (the mean effect size for "science" and "engineer" was higher than the mean effect size for "math"), the impact of content area was still not significant (p=0.13). The model used here is

$$d_{weighted} = \mu + Type + \varepsilon$$

$$d_{weighted} = \mu + Content + \varepsilon$$

For the student data, content was the only available predictor. The analysis shows that there was also no significant association between the effect size and the content area (p=0.3451).

Multi-level Meta-analysis Model

To test for the predictors of effect size magnitude, a multi-level meta-analysis model was used. The first multi-level model used was:

$$Y = \mu + \gamma + e$$

where Y is the weighted effect size, μ is the average population effect, γ is the random effect, which was assumed to have a normal distribution with a mean of zero and a common variance parameter τ. For this model, τ measures the between-study variation (in this analysis, it actually

measures the between-project variation), whereas e measures the within-study variation, which is the project-specific chance error.

This model was used to conduct the multi-level analysis for the teacher data and student data, respectively. For both data sets, we aimed to assess the average IMSP effect and to gauge the amount of variability among these projects. In other words, we wanted to estimate the parameters μ and τ.

The second multi-level model built here is

$$Y = \mu + \beta_1 X_1 + \gamma + e$$

where μ is the average population effect conditional on the covariates. X_1 represents the covariate of interest, β_1 is the coefficient associated with the covariates. The remaining components of the model (i.e., Y, γ, τ and e) have the same interpretation as above. Using this model, the relationship between the effect size and other possible explanatory variables were also investigated. None of the tested background variables were significant predictors of the effect size for teacher content knowledge (see

Table 1).

Table 1. Predictors for Multi-level Meta-Analysis

Effect	Estimate	Standard Error	DF	t value	Pr>t
Hours of PD	0.00	0.00	26.00	0.12	0.91
Quality of PD	0.00	0.01	26.00	0.22	0.83
% of Participants with BA	0.00	0.01	26.00	0.00	1.00
% of Participants with BS	0.00	0.01	26.00	-0.07	0.95
% of Participants with Teaching Assignment in Core Content Area	0.01	0.01	26.00	0.90	0.37
% of Participants with Undergraduate degree in Content Area	-0.01	0.01	26.00	-1.25	0.22
% of Participants with Initial Certification	-0.01	0.01	24.00	-1.13	0.27
% of Participants with Standard Certification	0.00	0.01	24.00	0.07	0.95
% of Participants with Master Certification	0.00	0.03	24.00	0.08	0.94
% of Participants with Endorsements in STEM areas	0.00	0.01	24.00	0.52	0.61
% of Participants with Baseline HQ status	0.00	0.01	23.00	-0.71	0.48
% of Participants with Current HQ status	0.00	0.01	23.00	-0.71	0.48

Effect	Estimate	Standard Error	DF	t value	Pr>t
% of Participants teaching at magnet or charter school type	-0.01	0.01	26.00	-0.45	0.66
% of Participants teaching in non-traditional (e.g., multi-age, block) classroom organization	-0.01	0.01	26.00	-0.91	0.37

Phase 3: Test of Multi-Level Meta-Analyses

SAS Proc Mixed procedure was used for the multi-level meta-analysis. For the teacher data, the results based on the first model show that the estimated average IMSP effect ($\hat{\mu}$) across 28 projects was 0.90, with standard error 0.18. It is significantly different from zero ($p<0.0001$; see

Table 2 and

).

Table 2. Teacher and Student Models

Teacher Model*	**Estimated Average ES**	**Standard Error**	**Significance**
Overall (n=28**)	.90	.18	.0007
MS Degree (n= 14)	.90	.25	.0002
WIP (n= 9)	.91	.28	.009
Math (n= 13)	.68	.23	.01
Science (n= 12)	1.19	.35	.05
Student Model	**Estimated Average ES**	**Standard Error**	**Significance**
Overall (n=7)	.74	.19	.01

*Engineering-only model not produced because of small n (n=3).

**Some projects provided a math and science ES and are counted separately.

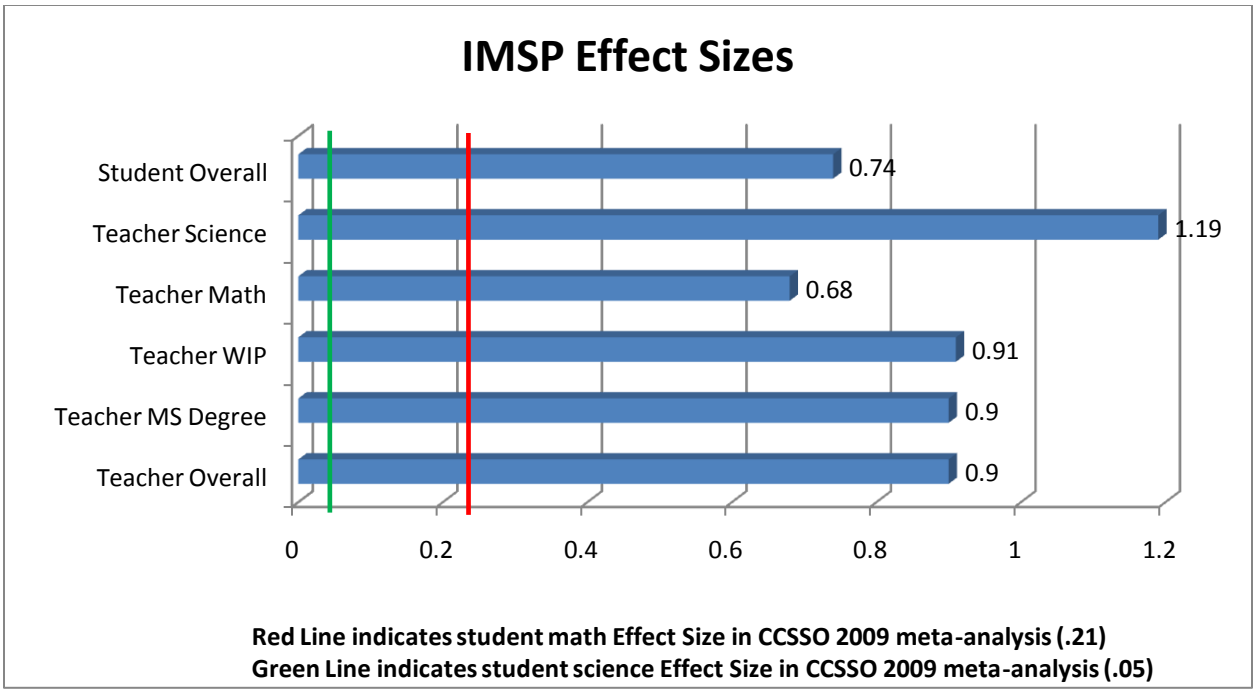

Figure 2. IMSP Effect Sizes

The total variance of the IMSP effect across the projects was 6.41. Furthermore, the estimated between-study variance ($\hat{\tau}$) was 0.77 with standard error 0.28. The between-study variance was significant ($p<0.005$) and it was almost four times the average within-study variance. These results support the existence of the between-study variation; therefore, the mixed-effect model is preferable to the fixed-effect model for this analysis.

Only the first (overall) model was built for the student data. The results showed that the estimated average IMSP effect ($\hat{\mu}$) across 7 projects was 0.73, with a standard error of 0.16. It was also significantly different from zero ($p<0.005$).

The estimated average effect of the student model IMSP was 0.74, with standard error 0.19 ($p=0.01$). There were no science data for the meta-analyses; there were six math and one engineering effect size included in the model.

The total variance of the IMSP effects among the seven projects was 0.68. The estimated between-study variance ($\hat{\tau}$) was 0.12, which accounted for almost 18% of the total variation. The standard error of between-study variance estimate was 0.10.

Phase 4: Interpreting the Effect Sizes

In this evaluation report, the multi-level meta-analysis was conducted to measure the average effect size and the total variation across projects. Meta-analysis has often been restricted to estimating (fixed) covariates effects based on fixed-effects linear models. However, in this analysis, non-negligible between-study (or between-project) variation was observed. Therefore, a random-effect component was incorporated into the model to conceptualize the current set of projects under consideration as a random sample selected from a population of projects. That is, each project-specific effect is sampled from a larger population of effects. Therefore, for each

project, there are two sources of variability in the random-effect framework: one is the variability of the effect parameters, and the other is the sampling variability associated with each project.

Clearly, the analyses support that the effect sizes were not zero for all of the models tested (Teacher Content Knowledge Overall, Teacher Science Knowledge, Teacher Math Knowledge, and Student Content Knowledge). For this first year of implementation, one reference point for interpreting the effect sizes produced here is the CCSSO meta-analysis of national MSP trends (Blank & de la Alas, 2009). In this study, the pre-post mean effect size for student math was .21 (standard error=.08) with the 95% confidence interval (.06, .36) and for student science was .05 (standard error=.08) with the 95% confidence interval (-.11, .20). In this context, the IMSP effect sizes for mathematics and science are moderate to large. This is similar to the interpretation that would be generated by the traditional heuristic provided by Cohen (1988).

These effect sizes will be used as barometers to interpret the impact in future years. Caution is warranted in interpreting these initial effect sizes for 2008-2009. There were missing data from two projects for the teacher meta-analysis model and eight projects for the student meta-analysis model. In addition, important data related to implementation was not available this year to include as important explanatory variables in the models. Also, data were not available for all the grants, only those entering implementation on time. Most importantly, without control groups, it is not clear how these gains compare to progress made under different models of professional development and learning conditions.

Survey Results

Partners were surveyed for feedback on their experiences in the IMSP for 2008-2009. The surveys asked for satisfaction ratings in four categories: vision, leadership, communication, and technical assistance.

Overall, survey respondents across partner types (industry, school, higher education, and teacher) were positive about their experiences in terms of the vision, leadership, communication, technical assistance, progress toward goals, and sustainability of their local IMSP (see

Table 3).

Table 3. Survey Results

	Industry		IHE		School		Teacher	
	WIP Total	MS Total	WIP Total	MS Total	WIP Total	MS Total	WIP Total	MS Total
Vision	96.54	94.44	97.47	86.13	87.01	85.97	87.90	80.69
Leadership	100.00	95.95	98.14	91.58	87.99	90.00	89.45	87.64
Communication	82.82	84.69	91.53	79.69	80.02	77.43	81.05	72.34
Technical Support	98.15	99.12	100.00	88.23	90.98	85.27	92.05	86.54
Progress Toward Objectives	75.08	74.72	89.93	81.37	82.45	79.73	90.27	77.81
Sustainability	38.53	83.00	68.20	70.52	67.89	66.27	85.14	80.53
Total	10	20	22	87	14	36	177	302

Vision was operationalized in terms of clarity of IMSP goals, planning process used to prepare objectives, follow-through on activities, efforts to promote collaboration, planned collaborative action between STEM professionals and teachers, processes used to assess needs, participation of representatives with a variety of interests, diversity of partners, respect for partner contributions, and shared resources. Partners for both MS Degree and WIP programs rated the vision highly, with industry and IHE partners generally rating the vision the highest for both (see

). MS Degree teachers rated the vision elements somewhat lower overall than the school, IHE, and industry partners in their projects.

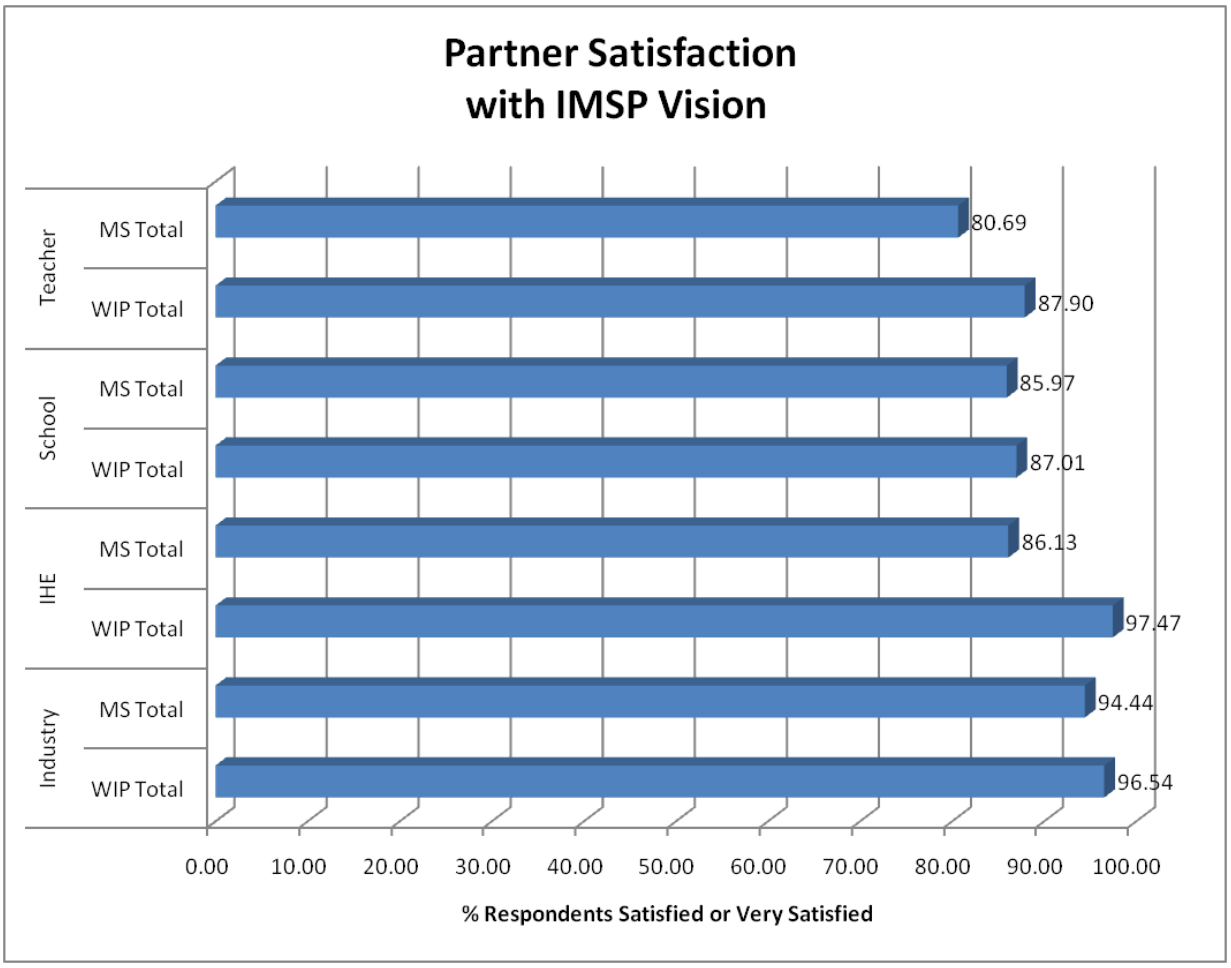

Figure 3. Partner Satisfaction with Vision

Leadership was defined in terms of the competence of the IMSP leader, sensitivity to cultural issues, opportunities for taking a leadership role, trust that partners afforded each other, and transparency of decision-making. Again, most partners for both MS Degree and WIP programs rated the project leadership highly, with industry and IHE partners generally rating the vision the highest for both (see

). Similar to vision, MS Degree teachers rated leadership elements somewhat lower overall than the school, IHE, and industry partners in their projects. WIP teacher and school respondents were similar (around 88% average satisfied or very satisfied) and somewhat fewer were satisfied as compared with WIP IHE and industry partners.

Figure 4. Partner Satisfaction with Leadership

Communication was rated in terms of media use to promote IMSP, communication among partnership members, communication between IMSP and broader community, extent to with partners are listened to and heard, working relationships with school officials, and information on issues and available resources. While a majority of partners for both MS Degree and WIP programs rated the project communication highly, the average percent who were satisfied was somewhat lower than other areas Again, MS Degree teachers rated communication elements somewhat lower overall than the school, IHE, and industry partners in their projects. WIP teacher and school respondents were similar (around 81% average satisfied or very satisfied) and somewhat fewer were satisfied as compared with WIP IHE (see

).

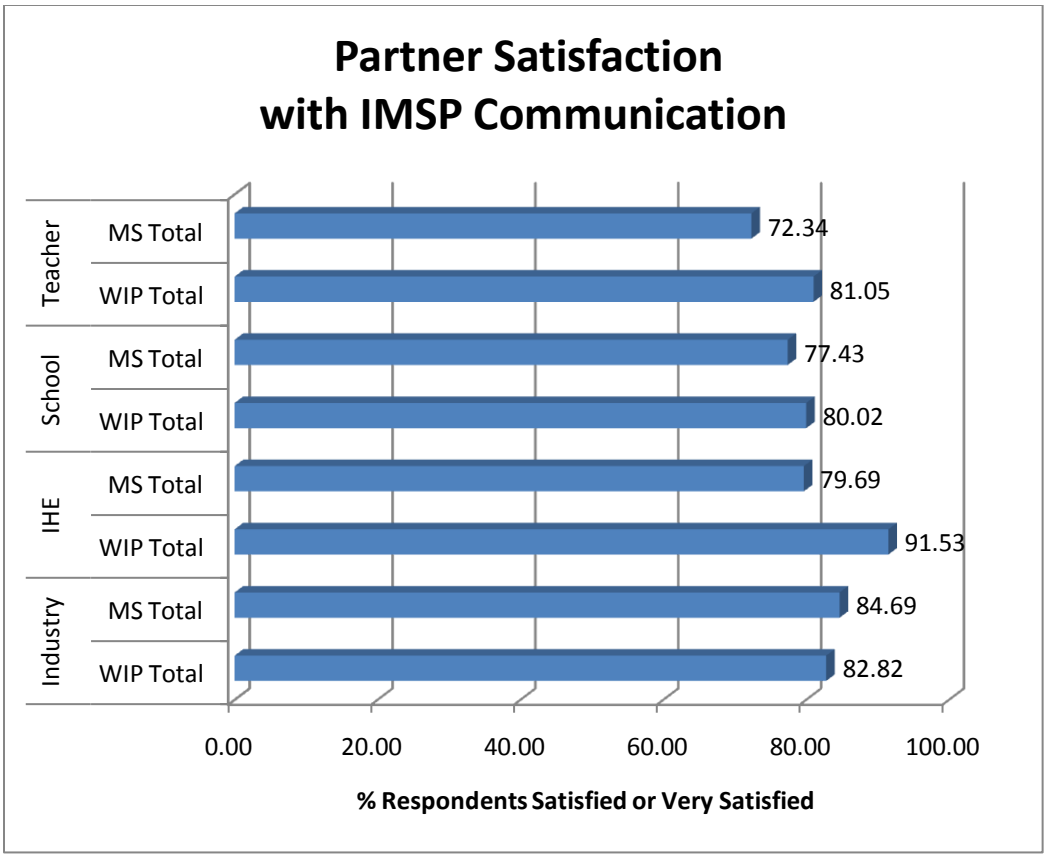

Figure 5. Partner Satisfaction with Communication

Respondents rated technical assistance in terms of training and technical assistance provided by IMSP faculty and staff, help given in understanding IMSP requirements, help given to address concerns, working relationships with industry and school partners, and information on issues and available. Here, MS Degree teachers, school, and IHE respondents rated the technical support similarly (about 85-88%) which was noticeably lower than the industry respondents (99%). WIP teacher and school respondents were similar (around 91% average satisfied or very satisfied) and somewhat fewer were satisfied as compared with WIP IHE and industry respondents (see

).

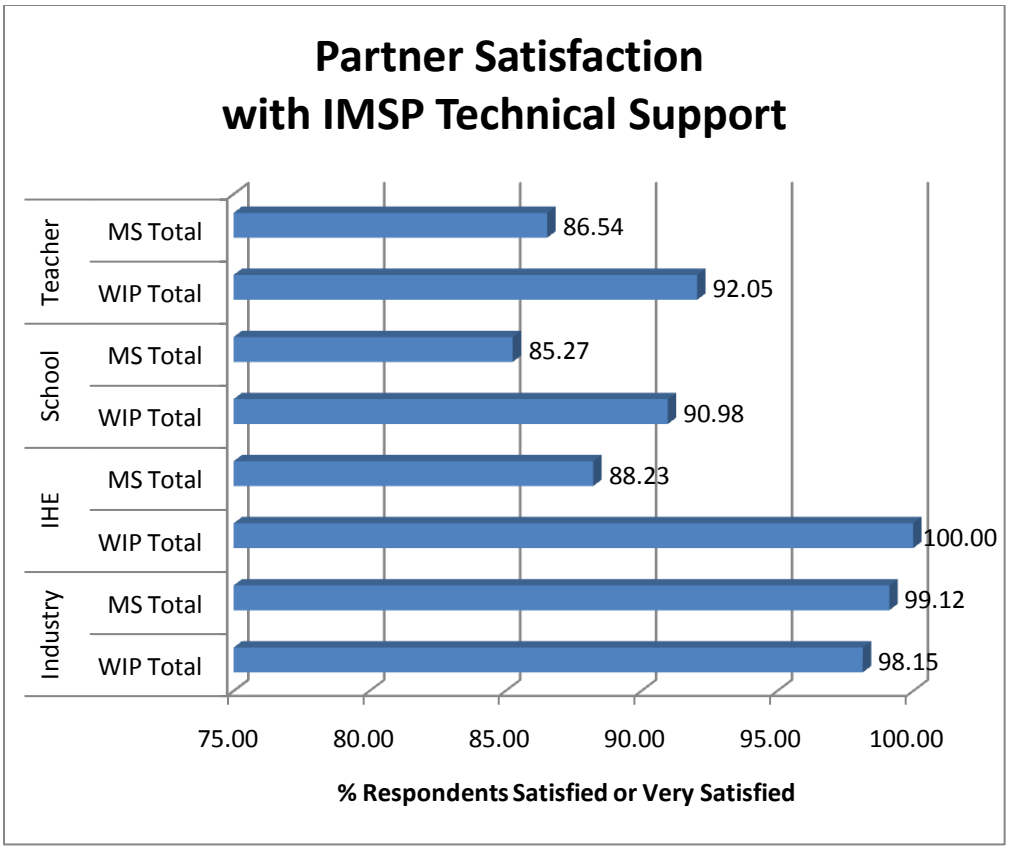

Figure 6. Partner Satisfaction with Technical Support

Progress toward objectives Improvement in teachers' content knowledge, access and use of new instructional resources and STEM technologies , progress toward meeting endorsement or certification requirements, effective collaboration between STEM industry experts and teachers, access to mentors, fairness with which resources and opportunities are distributed, capacity of the local IMSP teachers to give support to each other, and improvement in science and/or mathematics instruction in partner schools. For progress elements, MS Degree teachers, school, and IHE respondents rated the progress similarly (about 78-81%) which was slightly higher than the industry respondents (75%). WIP teacher and IHE respondents were similar (around 90% average satisfied or very satisfied) and somewhat more were satisfied as compared with WIP school (82%) and industry (75%) respondents (see

).

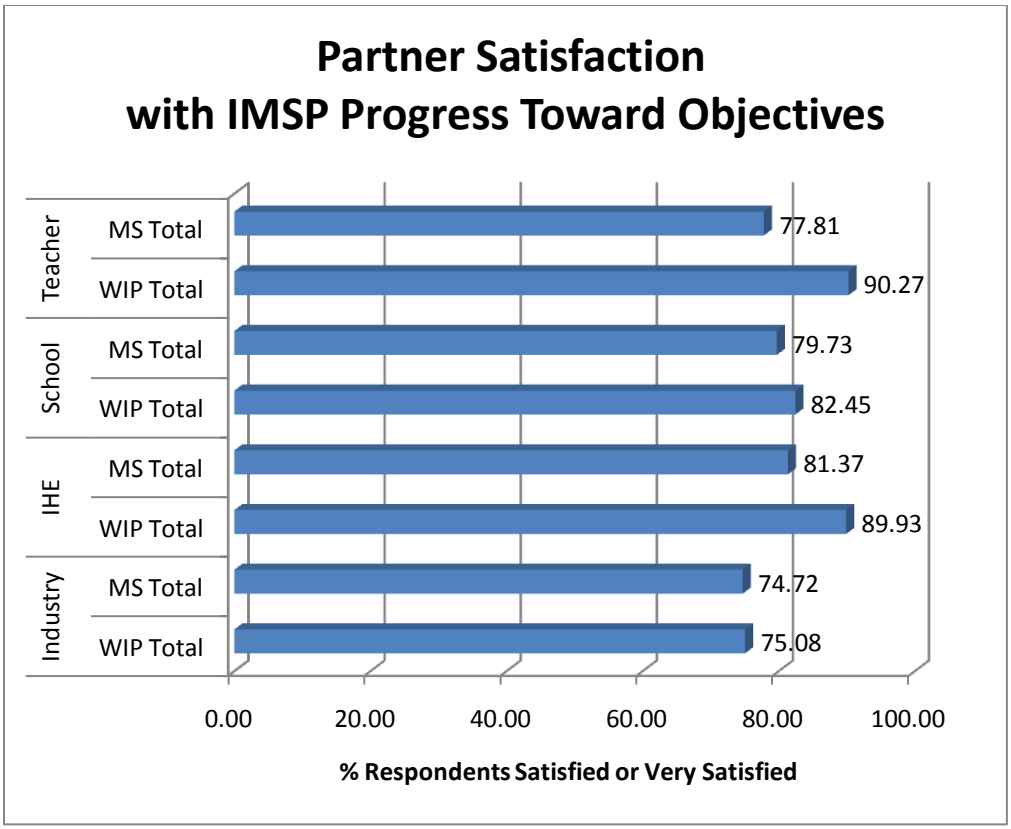

Figure 7. Partner Satisfaction with Progress Toward Objectives

Finally, sustainability was rated in terms of the extent to which the partners believed they had received important professional benefits from participation in the IMSP, that benefits received were worth the time, effort, and cost invested in the IMSP, and that benefits were commensurate with the contributions made to the IMSP. Respondents also described their belief in whether the IMSP should be continued, whether they will participate fully in this IMSP's activities in the future, whether the IMSP activities need to be dramatically improved to make it worth their investment, and whether the composition of their IMSP needs to be expanded or changed to be more effective. They rated if there were changes in structure, policies, or functions to institutionalize the IMSP goals and activities and whether alternative funds to sustain IMSP activities after the expiration of grant were being actively sought. For sustainability, MS Degree teachers and industry respondents rated the technical support similarly (about 81-83%) which was higher than the school (66%) and IHE (71%) respondents. WIP teacher and industry respondents were similar (around 83% average satisfied or very satisfied) and markedly more were satisfied with sustainability as compared with WIP school (68%) and industry (39%) respondents (see

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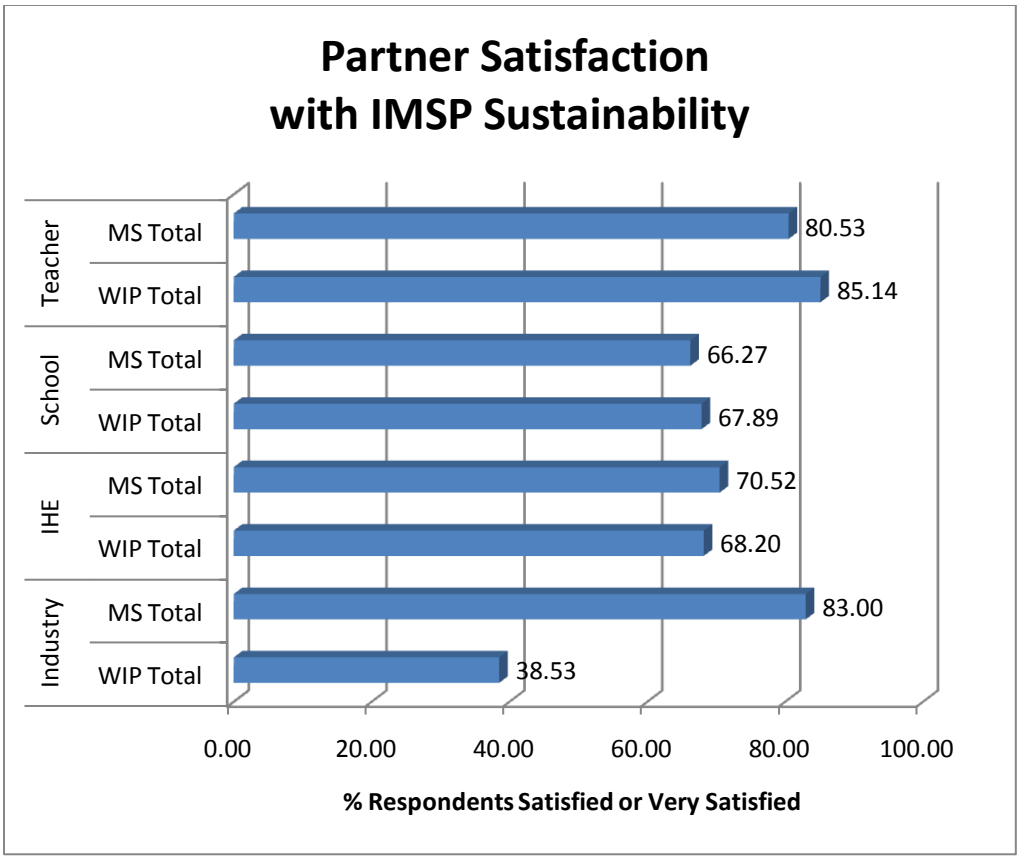

Figure 8. Partner Satisfaction with Sustainability

Profile Reports Summary

Detailed profiles of grants in the implementation stages were developed based on interviews and review of extant data conducted by the state evaluation team. Based on these profiles, projects were described in terms of the degree to which they were in the beginning, emerging, developing, or transformative stages.

Performance & Outcomes were judged for evidence of major outcomes or benefits for institutions, schools, or community in capacity, knowledge, or knowledge dissemination. The IMSP has pursued major strategies originally planned. There has been positive performance of the collaboration between partners. The capacity of the IMSP has increased. Evaluation Implementation indicates the degree to which evaluation activities provided data needed to fulfill state and federal reporting requirements.

Beginning stages are represented by articulated plans but no actions. The element is "on the radar" but there is no substantive progress toward effective implementation. The quality of the plans is inconsistent. Outcomes are not possible because no plans have been put into action. Plans may not provide adequate foundation for full implementation.

Emerging stages are represented by clear and articulated plans with some initial actions setting the stage for implementation, but not enough substantive activity to establish implementation. The quality of the articulated plan may be very strong or may have some apparent weaknesses amidst other strengths. Outcomes are not imminent or predictable because high quality implementation has not reached a minimum threshold.

Developing stages show clear, strong implementation is in place, although corrections for barriers, changes to plans, or consistency/satisfaction across stakeholders might be mixed. Positive outcomes are evident but all goals are not fully realized or not on track.

Transformative stages show such a clear, strong enacted plan. It can be considered a model for others to use. Positive outcomes associated with the partnership seem inevitable or highly predictable.

In the first year of implementation, the strongest area of development was in the performance and outcomes, or in the evidence of outcomes or capacity of the partners (see

). Evaluation Implementation, operationalized as providing needed data for state and federal reporting, is the area indicating the most development is needed across more grants.

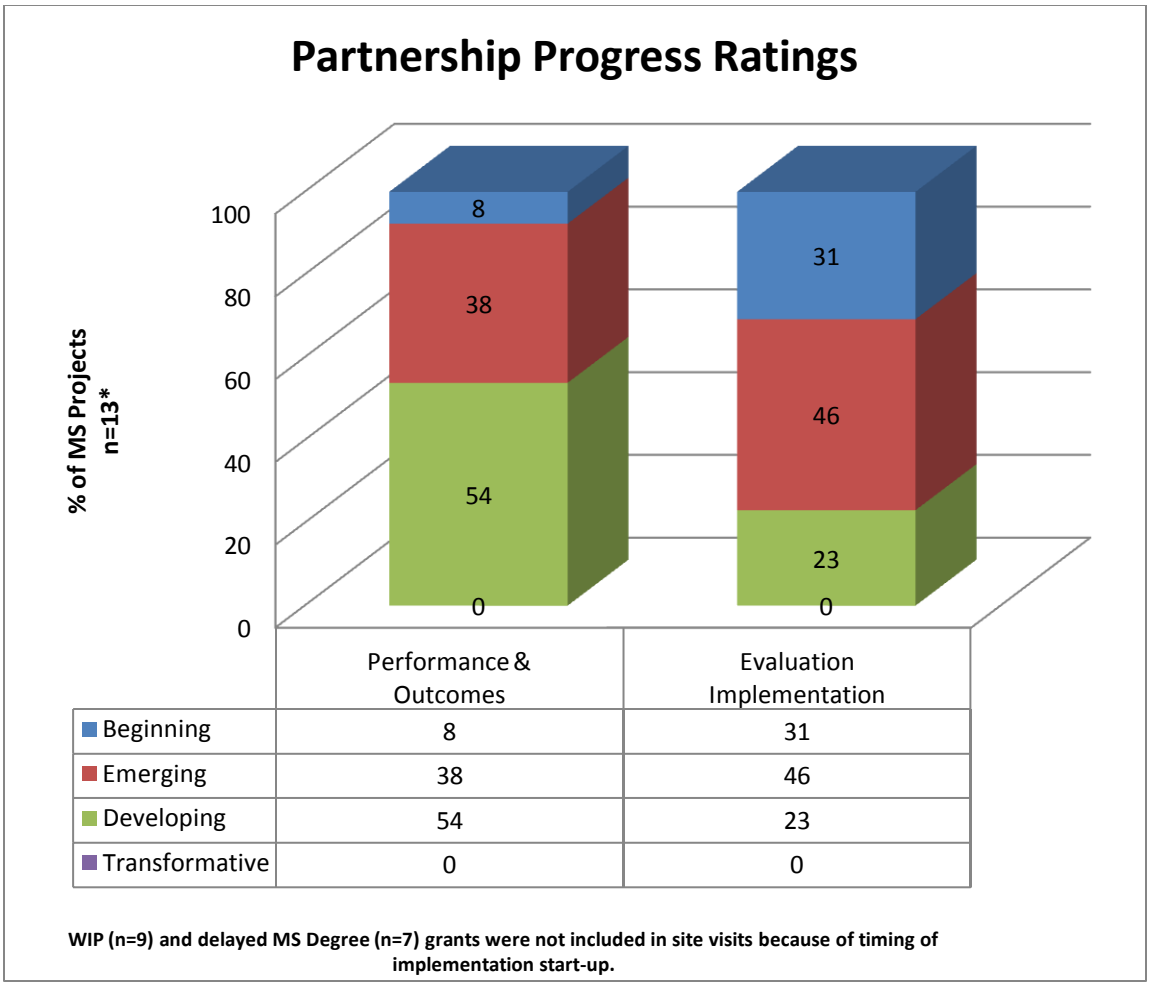

Figure 9. Partnership Progress Chart 2

Most Successful

In site profile reports, successful collaboration and the development of solid Master's Programs were consistent themes across projects.

> I*nstructor: "There was a lot of collaboration and a lot of sharing of ideas. It seemed like there was an attitude of camaraderie that they were special and it was rigorous and demanding and they were just going to have to survive it. I think that level of connection forms teachers from different schools and districts but I think if the district can leverage a sense of connection between teachers it's a very powerful thing. I'm not sure how that can be done but they made connection"* (Partnership Profile)

> *Another benefit cited by those interviewed was increased interactions within and across colleges and improved relationships among faculty.* (Partnership Profile)

> *At the university level a big success is just look around the table at all the different departments represented the other ones not here, and all working together, you know. There's no silos there anymore per se.* (Partnership Profile)

> *PI stated, 'We think we've been very effective in engaging faculty from a variety of departments on campus. That's been really kind of good. Getting people to participate in professional development. New people working with teachers. They'd never worked with teachers before."* (Partnership Profile)

> *Well we will very soon have over 80 people that will be I think very strong protagonists to saying I can have a content area master's degree. It's: I have a choice and that will be my choice. That's very important. That's an option now that just hasn't been around.* (Partnership Profile)

The partners indicated an increased capacity in terms of their program as well as new partnerships, in spite of the financial constraints faced by some partners.

> *Team Leader, "Again this (capacity building) would come at different levels, I think the first would be from what you heard from Arlene this morning in terms of our growth and faculty members and what we have been doing in our own field. I think that's the first one. Second I think we've been getting more faculty involved and I think that's the second round of benefits to the university. And trickling down to the teachers themselves"* (Partnership Profile)

> *There is a waiting list of applicants for the program. Teacher capacity to integrate math and science into other content areas is being increased.* (Partnership Profile)

> *The PI reports that last year "many" of the teachers in the program had been pink-slipped and two schools had closed. She reported that the IMSP worked "very closely with some of the districts to make sure that they (teachers) were all—or if they weren't going to be called back what was going to happen."* (Partnership Profile)

Outcomes in information and knowledge

In survey narrative data, two themes clearly developed from the respondents' feedback. Partners (IHE, school, and industry) as well as participants and partners valued the knowledge they had gained through the process.

> *"I am re-learning math concepts that will help me if I ever become a math teacher, but I am a science teacher that was placed into the math program"* (MS Grant Teacher 610, State Partner Survey)

"My content knowledge in science has increased and I am so much more interested in current topics of discussion" (MS Grant Teacher 671, State Partner Survey)

"I am very excited about the knowledge obtained (WIP Grant Teacher 835, State Partner Survey).

"I feel this program has greatly increased my knowledge and ability to convey that knowledge to my students. I will recommend it to the other teachers at my school/district" (WIP Grant Teacher 887, State Partner Survey).

"Most Positive Aspect: Seeing the students (the middle school teachers) gain a better knowledge of the discipline of mathematics, and seeing them start to feel more positive about their own abilities, and more confident in working with higher-level mathematics, such as proofs, non-Euclidean geometry, etc." (MS Grant IHE Partner 408, State Partner Survey).

To a lesser degree, teachers valued the outcomes in their instructional practice and the teaching strategies they gained. While some teachers had positive implementation experiences, others were clear that the connection with their classroom practice needed improvement.

"I really enjoyed working with Dr. Rahn to further my knowledge of statistical analysis in the manufacturing setting. I used my new knowledge to develop a lesson for my remedial group, and it went very well" (MS Grant Teacher 360, State Partner Survey).

"I have been able to immediately implement a large portion of material in our classes into my own classroom" (MS Grant Teacher 360, State Partner Survey).

"The most positive aspect has been developing inquiry science in my classroom" (MS Grant Teacher 474, State Partner Survey).

"I've learned or re-learned a number of ways to significantly improve my instruction" (WIP Grant Teacher 903, State Partner Survey).

"I thought the math classes would help me more with my math instruction (teaching us about different curriculum, new strategies, and teaching trends, etc" (MS Grant Teacher 669, State Partner Survey).

"I think the teachers taking classes in the program would like to see more of a connection between what they're learning in the high-level mathematics classes and how they can use that knowledge in teaching their middle school students, when much of what they're learning in math 526 (for example) is beyond the scope of what they teach"(MS Grant IHE Partner 408, State Partner Survey).

"Perhaps a better connection between the engineering content and the school curriculum"(MS Grant IHE Partner 454, State Partner Survey).

"Require assignments that require the use of ideas in the classroom. Give us ideas to use in teaching, have us try some ideas then have us turn something in related to that attempt" (MS Grant Teacher 279, State Partner Survey)

Changes in attitudes, values or behaviors of the participating organizations?

For some participants, there was a renewed enthusiasm for their content areas.

"I have learned so many new ways to teach my students math and science concepts that I think are more current and interesting that the material we presently use. With the

background I am receiving, I can use current events to teach my students and help them to understand the connections in their daily lives to math and science. The things I learn naturally flow to my students. My excitement from learning also stimulates my actions in the classroom, making my teaching more interesting and exciting for my students" (MS Grant Teacher 363, State Partner Survey).

"Being taught new technology and ideas helps to inspire me with fresh ideas. Even if some of the concepts are ones that do not necessarily apply to my classroom, I came back with motivation to do more. It was like a vitamin shot of b12 or something" (WIP Grant Teacher 843, State Partner Survey).

"I am more motivated to engage students in science as a result of this program and the background knowledge that I have gained from it" (WIP Grant Teacher 985, State Partner Survey).

"Seeing the students (the middle school teachers) gain a better knowledge of the discipline of mathematics, and seeing them start to feel more positive about their own abilities, and more confident in working with higher-level mathematics, such as proofs, non-Euclidean geometry, etc." (MS Grant IHE Partner 408, State Partner Survey).

<u>In what areas was the IMSP not successful in addressing?</u>

In survey narrative data, several themes emerged in respondents' feedback in their first year of implementation. The clearest recommendations were related to changes in the specific course or program where they were partners or participants.

"More science concepts being taught and more assignments that we can implement into our classroom, for example, apply what we've learned to develop a lesson or find one in various resources. These could all be shared with the others participating in the course as well as tested in the classrooms" (MS Grant Teacher 328, State Partner Survey).

"More group activities" (MS Grant Teacher 358, State Partner Survey).

"More computer training for the first math class. I didn't have all the computer skills needed to show pictorials on my computer" (MS Grant Teacher 375, State Partner Survey).

"As a life science teacher, I would like to see more life science applications" (WIP Grant Teacher 794, State Partner Survey).

"A focus on the pre-knowledge base of the individual participants and perhaps extra training for those not as knowledgeable and want to know more before they come. I would have been willing to 'read up' before participating" (WIP Grant Teacher 797, State Partner Survey).

"It could have been stretched over a little more time" (WIP Grant Teacher 805, State Partner Survey).

"We focused on GPS for a week and I really learned how to use it. I needed more time with the calculator and navigator system. Perhaps spending more quality time with those topics around the same time that we receive the navigators" (WIP Grant Teacher 847, State Partner Survey).

"I would have like more time to work on the action research project and determine how we can tie that together with our PBL activity" (WIP Grant Teacher 851, State Partner Survey).

Second, respondents expressed a consistent need for improved communication by the local IMSP.

"I feel that the communication between IMSP and the community could be improved by using print media resources" (MS Grant School Partner 467, State Partner Survey).

"Give us advanced warning on meetings" (MS Grant School Partner 560, State Partner Survey).

"Requirements were not always spelled out" (MS Grant Teacher 579, State Partner Survey).

"I feel that this program will improve as time goes on. As a pilot program there are some expectations that need to be completed and communication needs to improve in order to benefit everyone that is involved in the program. Once the kinks are ironed out and a set curriculum is created this program can be very beneficial" (MS Grant Teacher 610, State Partner Survey).

"Academically, everything went well. There needed to be more communication so that students were not panicking about the financial aid aspect" (MS Grant Teacher 326, State Partner Survey).

"Clearly communicate to participants the expectations of the program" (MS Grant Teacher 338, State Partner Survey).

"Better communication between instructors and participants. Logistically there were a few incidence" (WIP Grant Teacher 806, State Partner Survey).

"More communication from the staff" (WIP Grant Teacher 911, State Partner Survey).

"More effective communication" (MS Grant IHE Partner 713, State Partner Survey).

Fiscal and time constraints were also a noted trend in the feedback.

"This program continues to be one of the best at supporting work between content and pedagogy specialists and teachers. The ability to implement the vision is sometimes hampered by necessity of fiscal timing and constraints" (WIP Grant IHE Partner 890, State Partner Survey).

"With the unstable state government system in Illinois the districts are just looking to maintain balanced budget - promised money is not received. First the education budget needs to stabilize before the local districts can look to sustaining additional programs" (MS Grant Industry Partner 280, State Partner Survey).

"I am dissatisfied with the conditions at my school, due to complete lack of support for growth and experimentation due to financial restrictions and poor administrative leadership. I'm not sure I would choose a career in teaching, if anything this program has made me want to be a research scientist in a STEM field, I've learned a lot about what is out there in terms of study and opportunity, which are exciting and rewarding in completely different way. I attempt to pass that to my students in hopes that they will pursue STEM careers" (MS Grant Teacher 520, State Partner Survey).

Finally, there was a strong theme indicating that the district level support for the IMSP initiative was not sufficient for meeting the goals of the grant effectively.

"My principal was unwilling to allow me the professional leave to attend a conference funded by the grant. I felt that I had no recourse in the district to help me with this unfortunate situation" (MS Grant Teacher 567, State Partner Survey).

"Very little support from own school" (WIP Grant Teacher 886, State Partner Survey)

"Within the district there is very little support for the program. For example I heard about the program by word of mouth versus official information sent throughout the district" (WIP Grant Teacher 922, State Partner Survey).

"Again, the school districts are absent on the student/participant level" (MS Grant Teacher 538, State Partner Survey).

"I don't believe our principal is aware of the training and changes we are trying to make to improve math instruction by implementing science and technology. It's also disappointing that our science teachers chose not to be involved" (WIP Grant Teacher 857, State Partner Survey).

"Do not have a good working relationship with school officials. Nearly impossible to communicate with" (WIP Grant Teacher 886, State Partner Survey).

Partnership profile reports indicated that partners desired to be more effective and timely in their responses to participants' needs.

"That threw me off a little too. I was under the assumption they would all be math teachers and many didn't have a hardcore math background." (Partnership Profile)

> *It (remediation) was in the original plans but they did not take full advantage of what was offered. And part of that was our problem because we were a little slower on the trigger than we needed to be. And we didn't have as much ready for them before they started the program as they needed but even so there was enough in the program to help them as they were going through. And they did not take advantage of it. So we learned a lesson about what they would and wouldn't do and how proactive we needed to be.* (Partnership Profile).

In the first year of implementation, missing data or incomplete data were evident across the grants in two major areas. Missing data for student outcomes in science (there were no valid pre and posttest data for science for the MS grants) as well as implementation data across all grants were evident and areas needing improvement.

Conclusions and Discussion

Evaluation Framework

There are several key guidelines for effective STEM evaluations (Lawrenz & Huffman, 2006). The incorporation of qualitative and quantitative methodologies, performed according the relevant rigorous standards for each, provides a more complete understanding of outcomes. Mixing philosophies, designs, and devices are all important ways that quantitative and qualitative approaches are combined in STEM educational evaluation.

There are other considerations in addition to methodology that are key in an effective STEM evaluation. In the evaluation of recruitment and retention in one Texas MSP program (Scott, Milam, Stuessy, Blount, & Bentz, 2006), the fruits of close collaboration between colleges in a university and the learning communities in which their students had field

experiences were explored. The attention to the community context, learner-diversity, knowledge needs, and the use of assessment to provide feedback were key to increasing the recruitment and retention in STEM education programs.

The pivotal role of context, respect, communication, and cooperation recur in various accounts of partnerships between organizations focused on STEM initiatives (Miller, Williamson McDiarmid, Luttrell-Montes, 2006). Further, STEM evaluations must examine both the implementation and outcomes of program work in order to describe the context of each program (Miller, Williamson McDiarmid, Luttrell-Montes, 2006) and help to connect outcomes to project activities. Similarly, evaluation of professional development, be it in STEM projects or other school-based evaluations must examine not only perceptions of the professional development, but also its outcomes and impact on instruction (Guskey, 2000).

Quality of the Partnerships

One of the guiding principles of the IMSP is that the program funds partnerships, not individual institutions, to accomplish project goals. Research has identified a number of factors that contribute to successful collaborations, including an environment that provides a context for bringing together partners with common needs; membership characterized by diversity and respect; a process/structure that reflects flexibility, collaborative decision-making and clearly defined roles; group members with a stake in outcomes; open and frequent communication; a vision that is shared and developed collaboratively; and resources including in-kind contributions from all stakeholders in addition to outside resources (Mattessich & Monsey, 1992).

Clearly, mutual need, respect, trust, and enthusiasm are strengths consistently across these IMSP grants. This foundation characterizes both the spirit of the federal program as well as

the promise of positive results from the resources ISBE has provided to promote collaboration between higher education faculty, industry STEM professionals, and K-12 school stakeholders.

Progress Toward Outcomes

The analyses support good progress for the IMSP based on the statistically significant (non-zero) effect sizes for all of the models tested (Teacher Content Knowledge Overall, Teacher Science Knowledge, Teacher Math Knowledge, and Student Content Knowledge). The IMSP effect sizes were moderate to large across all of the models.

Survey respondents across partner types were positive about their experiences in terms of the vision, leadership, communication, technical assistance, progress toward goals, and sustainability of their local IMSP. In the first year of implementation, the strongest area of partnership development was in the evidence of outcomes or capacity of the partners. Evaluation Implementation is the area indicating the most development is needed across more grants. In site profile reports, successful collaboration and the development of solid Master's Programs were consistent themes across projects.

For some participants, there was a renewed enthusiasm for their content areas. To a lesser degree, teachers valued the outcomes in their instructional.

Recommendations for Improvement

Grants should continue to revise their programs and PD based on the feedback from participants to make the experience as responsive as possible to teachers' needs. Based on the feedback of some participants, improved communication at the initial stages of the program are needed to clarify expectations and commitments. Resource needs should be considered both locally and at the state level to determine what or if the resources are being leveraged as effectively as possible. In response to the multiple indicators that there is somewhat of a disconnect between IMSP goals and activities and district level support for the IMSP initiative, both local and state level policies for the partnerships should be articulated to support the development of transformative partnerships through the IMSP program.

Finally, in the second year of implementation, missing data issues need to be eliminated. Local grant evaluation frameworks need to be monitored by the state to ensure an effective alignment with the state and federal evaluation reporting needs is evident. Central to the state evaluation needs are the formal articulation of specific, measurable implementation goals at the local grant level accompanied by properly validated and aligned student outcome measures. The state evaluation team needs to provide support to develop and revise local evaluation frameworks as needed to ensure high quality evaluation implementation in Year 2.

Significance

As researchers continue to investigate and articulate the complexities of the inter-relationships between distinct organizations working toward common goals, they will build an understanding of how these partnerships foster benefits to all participants as well as the intricacies of transitioning to overcome barriers within and outside the partnership. In addition,

models of collaboration that incorporate new partnerships, like those between colleges in universities as well as industry and schools, will expand the learning opportunities in important ways to lead education theory and practice in new directions. Understanding the nature of effective relationships is an integral part of realizing these goals of "expanding repertoires for learning."

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Appendix A

Protocol for Implementation Phase

1. Partnership Composition.

History: What is history of the university in the community or with the partners? Did the university (or parts of it) have experience with or a record of engagement in community outreach, community service or applied research in the past? [Were these efforts coordinated? Was there a pre-existing partnership/program within the University that preceded the IMSP? If so, what role does that office have on the work of the IMSP? What is the relation between the IMSP and the program? Is there a University unit that oversees the work of this center? What was the relationship between the university and the community partners in the IMSP prior to the ISBE application?]

For collaboration between colleges within IHE: What was the relationship among the colleges prior to the IMSP? Were their prior relationships with each other similar or different? In what way?

Process. What was the process for creating the IMSP? [How did the IMSP partners develop the application to ISBE? Did community or school partners contribute to the application, review the draft, etc.? How did the IMSP partners refine the partnership relationships after receiving the grant? Are there any groups that should have been included that were not part of the IMSP?]

For collaboration between colleges within IHE:: Did both/all schools participate in developing the IMSP proposal? How were the roles defined? How were responsibilities assigned?

Staffing. How is the IMSP staffed? [Have new staff been hired to conduct the work of the IMSP? What positions were filled? Where did the candidates come from? How many staff members work (will work) for the IMSP? What policies are in place for the replacement of staff as needed?]

For collaboration between colleges within IHE: Are IMSP staff drawn from both/all institutions? Are faculty and students from both/all institutions involved in IMSP?

Context. What is the school environment for IMSP reform? [What are the major educational initiatives in the city/region/state? How has the IMSP related to these efforts? Can the IMSP have improved coordination with other programs to achieve greater outcomes? Are there resources for and attention to these issues? What is the context for university funding? What other programs are competing for university resources and attention?]

For collaboration between colleges within IHE: How does the institutional context for the IMSP differ among the schools?

2. Organizational Structure of Partnership.

Structure. What is the structure of this IMSP? Does the IMSP have an advisory board(s) and what is its role? Is there a sense of equity among the partners? [Who are the board members and what are their respective affiliations? What is the governance of the IMSP? How are decisions made? By whom? Are community / school perspectives valued and respected? What are the roles of the university, community/ school in the IMSP? To what degree have university-community/school relationships constituted a partnership? (Not at all, somewhat, to a moderate degree, to a great degree)]

For collaboration between colleges within IHE: What are the respective roles of the colleges in the IMSP? Do all schools participate equally in governance and decision-

making? How is accountability by each school to the partnership determined? How are imbalances in institutional resources compensated for? Is the IMSP seen as an opportunity for faculty and student collaboration among the schools, or as individual efforts under a single banner?

Location within the University. Is there a specific space designated for the IMSP within the university? What parts of the university are involved with the IMSP? What structures, policies and/or practices of the university support community outreach or hinder outreach activities? [Where is the IMSP physically housed? What was the rationale for its placement? Is the IMSP embraced by the leadership of the university? If so, how?]

For collaboration between colleges within IHE: Where is the IMSP located in the consortium? Why?

Artifacts: IMSP Membership list, IMSP/ IHE organizational chart

3. Action Plan and Operational Guidelines

IMSP Program Areas. What is the nature of the IMSP program and how ambitious is it? [What program areas does the IMSP address? What is the scope and sequence of the new program?]

For collaboration between colleges within IHE: Are program areas divided by schools? If so how? Or do the schools work jointly on the same project areas?

Operational Guidelines. What formal agreements are in place to define, establish, and support communication and collaboration between partners? Who established these guidelines?

Artifacts: Logic Model, Evaluation Framework, Data Analysis Plans, IBHE proposal

4. Quality of Partnerships

Mutuality & Trust. Do the goals and objectives of the IMSP address mutual needs across partners? What are the perceptions of trust across partners? Is there a sense of safety for sharing

of information and resources? What steps have partners taken to build trust? What is the nature of most interactions between partners? Face-to-face? Email? What was the nature of relationships between partners before the IMSP? How respectful is the IMSP to differences in cultural and organizational norms, values, and beliefs? How transparent are the IMSP operations? Is their equality in decision-making? Is there reciprocal accountability? Is there a balance in the representation of all partners in the IMSP? Does leadership across partners work closely together? Is there enthusiasm surrounding IMSP goals and activities?

For collaboration between colleges within IHE: What is the nature of relationships between colleges? Is there a sense of equality in decision-making and resources? Is there a respect for differences in cultures? Is there shared enthusiasm for the IMSP?

Artifacts: Meeting agendas, minutes

Leadership. Who are the leaders of the IMSP? [Who led the development of the IMSP application? Are there one or more persons taking leadership? What is their role in the institution? What is their continuing role in the IMSP? Was there participation from the top levels of the institution?]

For collaboration between colleges within IHE: Is leadership for the IMSP shared among the colleges? Is there a key person at each school leading the IMSP? Is there participation from top levels at both/all schools?

Resources. Has the IMSP received matching funds? [From what sources? How does this compare with the initial proposal? Are there adequate resources to accomplish IMSP goals? Are resources sufficient for all partners?] limited not just to financial resources but extending to managerial and technical skills, contacts, information and the like;

For collaboration between colleges within IHE: How will resources be divided among the institutions? Did all/both schools provide matching funds?

Artifacts: Budget summary/narrative

Communication. What are the guiding principles for your IMSP? Is there shared decision-making between partners? What are the primary vehicles for communication? Is there a formal management and communication plan? How are conflicts resolved in the partnership?

Artifacts: Meeting agendas, meeting minutes, newsletters, websites, other forms/policy statements

Appendix C

Member Check Survey

Each grant has been sent a .pdf representing the profile written by your state site evaluator focusing on four specific areas: Partnership Composition, Organizational Structure, Action Plan and Operational Guidelines, and Qualities of the Partnering Relationship.

The profiles across all grants will be analyzed to report on trends across the state in terms of the funded IMSP partnerships. Individual profiles will be submitted to the ISBE in an Appendix as part of year end report. A redacted version will be submitted as needed using pseudonyms for partners as indicated by individual grants. The redacted version will be disseminated as appropriate at the discretion of the ISBE.

The purpose of this survey is to provide grantees an opportunity to clarify or provide alternative perspectives on the profiles being submitted to the ISBE in the year-end report. If you are comfortable with the content of the profile as written by the site evaluator, no response is needed. All responses submitted on this form will be appended to your site evaluator profile unedited.

Comments about your IMSP **Partnership Composition** profile summary:

Comments about your IMSP **Organizational Structure** profile summary:

Comments about your IMSP **Action Plan and Operational Guidelines** profile summary:

Comments about your IMSP Qualities of the **Partnering Relationships** profile summary:

Identification in redacted report:	**Yes**	**No**
Would you like the redacted report to use a pseudonym for university partners?	○	○
Would you like the redacted report to use a pseudonym for school partners?	○	○
Would you like the redacted report to use a pseudonym for industry partners?	○	○

Appendix C

IMSP Teacher Satisfaction Survey[1]

(This Survey Omitted for Year One Planning Phase)

Please indicate your level of satisfaction with each aspect of your MSP participation.

(Likert scale: Very Satisfied – Very Dissatisfied)

Vision and Mutuality

1. Clarity of the vision for IMSP goals and objectives
2. Planning process used to prepare the IMSP objectives
3. Follow-through on IMSP activities
4. Efforts to promote collaborative action with other educators
5. Efforts to promote collaborative action with STEM professionals outside the university
6. Processes used to assess teachers' needs
7. Processes used to assess my students' needs
8. Participation of influential people in the IMSP that represent teachers' interests
9. Diversity of partners and participants
10. Respect, acceptance and recognition of my contributions to reaching the IMSP goals
11. Resources provided by my district and/or school to support my commitment to the IMSP grant

Leadership

12. Strength and competence of IMSP leadership
13. Sensitivity to cultural issues
14. Opportunities for me to take leadership roles

[1] Adapted from Annual Satisfaction Survey for Community Coalitions. Wolff,T (2003).. A practical approach to evaluating coalitions. In T.Backer(Ed.) Evaluating Community Collaborations. Springer Publishing

15. Trust that partners and participants afford each other

Communication

16. Use of the media to promote awareness of the IMSP goals, actions, and accomplishments

17. Communication among members of the partnership

18. Communication between the IMSP and the broader community

19. Extent to which IMSP participants are listened to and heard

20. Working relationships established with school officials

21. Information provided on issues and available resources

Comments:

Technical Assistance:

22. Strength and competence of IMSP faculty and staff

23. Training and technical assistance provided by faculty and staff

24. Help given the participants in meeting IMSP requirements

25. Help given the participants to become better able to address and resolve their concerns

Progress and Outcomes:

26. My progress in learning new content through the IMSP grant.

27. My progress in using new instructional resources through the IMSP grant.

28. My progress in using new STEM technologies through the IMSP grant.

29. My progress toward meeting endorsement or certification requirements.

30. My access to STEM industry experts through the IMSP grant.

31. My access to mentors because of the IMSP grant.

32. Fairness with which resources and opportunities are distributed

33. Capacity of IMSP teachers to give support to each other

34. IMSP grant's contribution to improving science and/or mathematics instruction in my school.

Please indicate how much you agree or disagree with the following statements.

(Likert scale: Strongly Agree – Strongly Disagree)

Job Satisfaction

35. In most ways, being a STEM teacher is close to my ideal.

36. My conditions of being a STEM teacher are excellent.

37. I am satisfied with being a STEM teacher.

38. So far I have gotten the important things I want to be a STEM teacher.

39. If I could choose my career over, I would change almost nothing.

Sustainability

40. I received important professional benefits from my participation in the IMSP.

41. The benefits I received were worth the time, effort, and cost I invested in the IMSP.

42. The benefits I received were commensurate with the contributions I made to the IMSP.

43. I strongly believe the IMSP should be continued.

44. I will participate fully in IMSP activities in the future.

45. The IMSP activities need to be dramatically improved to make it worth my investment.

46. I will continue to integrate IMSP strategies and materials into my classroom instruction.

47. I have access to the resources I need to continue to integrate IMSP strategies and materials into my classroom instruction.

48. My district will support my continued integration of IMSP strategies and materials into my classroom instruction.

IMSP School Partner Satisfaction Survey[2]

Please indicate your level of satisfaction with each aspect of your IMSP partnership.

(Likert scale: Very Satisfied – Very Dissatisfied)

Vision and Mutuality

1. Clarity of the vision for the IMSP goals and objectives

2. Planning process used to prepare the IMSP objectives

3. Follow-through on IMSP activities

4. Efforts to promote collaborative action

5. Efforts to promote collaborative action between STEM professionals and teachers

6. Processes used to assess teachers' needs

7. Processes used to assess students' needs

8. Participation of influential people in the IMSP that represent a variety of interests

9. Diversity of partners and participants

10. Respect, acceptance and recognition of my contributions to reaching the IMSP goals

11. Resources provided by the partner districts and/or school to support the IMSP grant

Leadership

12. Strength and competence of IMSP leadership

13. Sensitivity to cultural issues

14. Opportunities for me to take a leadership role

15. Trust that partners and participants afford each other

16. Transparency of decision-making.

[2] Adapted from Annual Satisfaction Survey for Community Coalitions. Wolff,T. (2003). A practical approach to evaluating coalitions. In T.Backer(Ed.) Evaluating Community Collaborations. Springer Publishing

Communication

17. Use of the media to promote awareness of the IMSP goals, actions, and accomplishments
18. Communication among members of the partnership
19. Communication between the IMSP and the broader community
20. Extent to which IMSP participants are listened to and heard
21. Working relationships established with school officials
22. Information provided on issues and available resources

Technical Assistance:

23. Strength and competence of IMSP faculty and staff
24. Training and technical assistance provided by faculty and staff
25. Help given the participants in meeting IMSP requirements
26. Help given the participants to become better able to address and resolve their concerns

Progress and Outcomes:

27. Progress in improving teachers' content knowledge through the IMSP grant
28. Progress in teachers' access and use of new instructional resources through the IMSP grant
29. Progress in teachers' access and use of new STEM technologies through the IMSP grant
30. Teachers' progress toward meeting endorsement or certification requirements

31. Effective collaboration between STEM industry experts and teachers' through the IMSP grant

32. Teachers' access to mentors through the IMSP grant

33. Fairness with which resources and opportunities are distributed

34. Capacity of IMSP teachers to give support to each other

35. IMSP grant's contribution to improving science and/or mathematics instruction in schools

Please indicate how much you agree or disagree with the following statements.

(Likert scale: Strongly Agree – Strongly Disagree)

Sustainability:

36. My district received important professional benefits from participation in the IMSP.

37. The benefits my district received were worth the time, effort, and cost invested in the IMSP.

38. The benefits my district received were commensurate with the contributions made to the IMSP.

39. I strongly believe the IMSP should be continued.

40. I will participate fully in IMSP activities in the future.

41. The IMSP activities need to be dramatically improved to make it worth my district's investment.

42. The composition of the IMSP needs to be expanded or changed to be more effective.

43. My district has changed the structure, policies, or functions to institutionalize the IMSP goals and activities.

44. My district intends to sustain IMSP activities after the expiration of grant funds.

45. My district is actively seeking alternative funds to sustain IMSP activities after the expiration of grant funds.

IMSP Industry Partner Satisfaction Survey[3]

Please indicate your level of satisfaction with each aspect of your IMSP partnership.

(Likert scale: Very Satisfied – Very Dissatisfied)

Vision and Mutuality:

1. Clarity of the vision for the IMSP goals and objectives
2. Planning process used to prepare the IMSP objectives
3. Follow-through on IMSP activities
4. Efforts to promote collaborative action between partners
5. Efforts to promote collaborative action between STEM professionals and teachers
6. Participation of influential people in the IMSP that represent a variety of interests
7. Diversity of partners and participants
8. Respect, acceptance and recognition of my contributions to reaching the IMSP goals
9. Resources provided by the partner organizations to support the IMSP grant

Leadership:

10. Strength and competence of IMSP leadership
11. Sensitivity to cultural issues
12. Opportunities for me to take a leadership role
13. Trust that partners and participants afford each other
14. Transparency of decision-making.

Communication:

[3] Adapted from Annual Satisfaction Survey for Community Coalitions. Wolff,T. (2003). A practical approach to evaluating coalitions. In T.Backer(Ed.) Evaluating Community Collaborations. Springer Publishing

15. Use of the media to promote awareness of the IMSP goals, actions, and accomplishments

16. Communication among members of the partnership

17. Communication between the IMSP and the broader community

18. Extent to which IMSP participants are listened to and heard

19. Working relationships established with school officials

20. Information provided on issues and available resources

Technical Assistance:

21. Strength and competence of IMSP faculty and staff

22. Training and technical assistance provided by faculty and staff

23. Help given the participants in meeting IMSP requirements

24. Help given the participants to become better able to address and resolve their concerns

Progress and Outcomes:

25. Progress in improving teachers' content knowledge through the IMSP grant

26. Progress in teachers' access and use of new instructional resources through the IMSP grant

27. Progress in teachers' access and use of new STEM technologies through the IMSP grant

28. Teachers' progress toward meeting endorsement or certification requirements

29. Effective collaboration between STEM industry experts and teachers' through the IMSP grant

30. Teachers' access to mentors through the IMSP grant

31. Fairness with which resources and opportunities are distributed

32. Capacity of IMSP teachers to give support to each other

33. IMSP grant's contribution to improving science and/or mathematics instruction in schools

Please indicate how much you agree or disagree with the following statements.

(Likert scale: Strongly Agree – Strongly Disagree)

Sustainability:

34. My organization received important professional benefits from participation in the IMSP.

35. The benefits my organization received were worth the time, effort, and cost invested in the IMSP.

36. The benefits my organization received were commensurate with the contributions made to the IMSP.

37. I strongly believe the IMSP should be continued.

38. I will participate fully in IMSP activities in the future.

39. The IMSP activities need to be dramatically improved to make it worth my organization's investment.

40. The composition of the IMSP needs to be expanded or changed to be more effective.

41. My organization has changed the structure, policies, or functions to institutionalize the IMSP goals and activities.

42. My organization intends to sustain IMSP activities after the expiration of grant funds.

43. My organization is actively seeking alternative funds to sustain IMSP activities after the expiration of grant funds.

Appendix D

Tests Used by Sites for Content Knowledge

Project	**Content**	**Teacher Test Name**
Master's Aurora Biology	Science	TDLR local
Master's Aurora Biology	Science	BIO5010 local
Master's Aurora Earth Space	Science	MOSART Space
Master's Aurora Earth Space	Science	MOSART Earth
Master's Aurora Elementary	Science	DTAMS Life Science
Master's Aurora Secondary Math	Math	DTAMS MS Number Computation
Master's Aurora Secondary Math	Math	DTAMS MS Algebraic Ideas
Master's Bradley Elementary	Math	LMT elementary number concepts 2004A
Master's Bradley Elementary	Math	LMT probability and ratios 2008B
Master's Bradley Elementary	Math	LMT rational numbers 2008A
Master's Bradley Elementary	Math	LMT middle school geometry 2007A
Master's Bradley Elementary	Math	LMT middle school algebra 2006A
Master's Bradley Elementary	Science	DTAMS Earth/space diagnostic

Project	**Content**	**Teacher Test Name**
		assesment Version 1.2
Master's Bradley Elementary	Science	DTAMSLife science diagnostic assesment Version 3.2
Master's Bradley Elementary	Science	DTAMS Physical science diagnostic assesment Version 3.2
Master's ISU Chemistry	Science	Inorganic Chemistry Exam for Graduate Students
Master's ISU IT / Pre-Engineering	Engineering	Integrated Curriculum
Master's ISU Secondary Math	Math	DTAMS Number and Computation
Master's ISU Secondary Math	Science	DTAMS Physical Science
Master's Loyola Chemistry	Math	Advanced Algebra Test Form 2F
Master's Loyola Secondary Math	Math	DTAMS
Master's NIU IT / Pre-Engineering	Engineering	Locally constructed test from released items of Graduate Record Exam
IMSP - Master's NIU Sec Math	Math	NCO
IMSP - Master's NIU Sec Math	Math	GEO
IMSP - Master's NIU Sec Math	Math	PFA
Master's SIU-C Elementary	Math	Math
Master's SIU-C Elementary	Science	Science

Project	**Content**	**Teacher Test Name**
Master's SIU-C Elementary	Science	Chem
Master's SIU-C Elementary	Science	Biology
IMSP - Master's UIUC Elementary	Math	LMT_Total
IMSP - Master's UIUC Elementary	Math	LMT_Number
IMSP - Master's UIUC Elementary	Math	LMT_Algebra
IMSP - Master's UIUC Elementary	Math	LMT_Geometry
Workshop/Institute Aurora University MS / HS Mathematics	Math	DTAMS
Workshop/Institute Aurora University MS / HS Physical Sciences	Math	DTAMS
Workshop/Institute Board of Trustees of the University of Illinois HS STEM - Nanotechnology	Engineering	Nanotechnology
Workshop/Institute Illinois State University MS / HS Science / Geology	Science	EarthScope
Workshop/Institute Lee/Ogle Counties ROE 47 6th - 9th grade Math & Science	Math	Learning Mathematics for Teaching
Workshop/Institute Lee/Ogle Counties ROE 47 6th - 9th grade Math & Science	Science	Science Content Test
Workshop/Institute Monroe-Randolph ROE 45 MS / HS Science - Biotechnology	Science	Ibiotech

Project	**Content**	**Teacher Test Name**
Workshop/Institute Rock Island County ROE 49 4th - 9th grade Math & Science	Math	Algebra Content
Workshop/Institute Rock Island County ROE 49 4th - 9th grade Math & Science	Math	Learning Mathematics for Teaching
Workshop/Institute Rock Island County ROE 49 4th - 9th grade Math & Science	Science	Science Content
Workshop/Institute St. Clair ROE 50 HS Math & Science	Math	Math Test to Math Teachers
Workshop/Institute St. Clair ROE 50 HS Math & Science	Math	Math Test to Science Teachers
Workshop/Institute St. Clair ROE 50 HS Math & Science	Science	Science Test to Math Teachers
Workshop/Institute St. Clair ROE 50 HS Math & Science	Science	Science Test to Science Teachers