Report 2014-08

I-STEM

INDIANA Science • Technology • Engineering • Mathematics
RESOURCE NETWORK

Indiana Science Initiative Update: An Analysis of the Integrating Science, Engineering and Mathematics to Improve Student Learning

November 2014

The I-STEM vision is for Indiana to be a national leader in student achievement and to demonstratively improve college and career readiness in the STEM disciplines.

AN ANALYSIS OF THE **INTEGRATING SCIENCE, ENGINEERING AND MATHEMATICS TO IMPROVE STUDENT LEARNING** PROFESSIONAL DEVELOPMENT PROGRAM:

A RICHMOND COMMUNITY SCHOOLS – PURDUE UNIVERSITY PARTNERSHIP

2014 – 2015 Academic Year

Provided in Partial Fulfillment of Requirements for the Indiana MSP Grant

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PROGRAM NARRATIVE

NEEDS ASSESSMENT:

The Schools. The Richmond Community Schools (RCS) is located in Central Indiana and includes 6 elementary schools, 3 intermediate schools, and 1 high school. RCS is the largest school system in Wayne County, Indiana. With this size come economies of scale in terms of the number and diversity of opportunities they can afford with their student body. Their mission emphasizes the strength is in their professionalism, their partnerships with parents and local business, the diversity of their facilities and special programs, and their commitment to excellence. In performing a needs assessment, Purdue University examined criteria that would advance the needs of students in the corporation.

Mathematics Teaching Efficacy Beliefs Instrument (MTEBI)

The program used the Mathematics Teaching Efficacy Beliefs instrument to obtain a baseline measurement of teacher's confidence in teaching mathematics. The MTEBI is a 21-item scale designed to measure mathematics teaching efficacy beliefs (Enochs, Smith, and Huinker, 2000). These items are divided into two subscales: Personal Mathematics Teaching Efficacy (PMTE) and Mathematics Teaching Outcome Expectancy (MTOE). Previous research conducted by Enochs, Smith, and Huinker (2000) suggests that, of the 21 items, 13 items contribute to the measurement of PMTE and 8 items load onto MTOE.

Fifty teachers from Richmond participated in the current MTEBI assessment. Appropriate recoding was completed on negatively scored items to create composite scores for each subscale. Possible scores on PMTE range from 13 to 65 and, for MTOE, from 8 to 40. Descriptive analyses reveal that, on average, teachers scored a 52.92 on the PMTE (*SD* = 5.58, Minimum = 42, Maximum = 64) and 28.68 on the MTOE (*SD* = 3.40, Minimum = 20, Maximum = 37). Below, histograms for each of the subscales show the distribution of teacher scores. In sum, the available evidence suggests that teachers have room for improvement on MTEBI scores following professional development. Our goal would be that teachers would increase both their personal confidence in teaching mathematics and their more global opinions about whether teachers can affect mathematics learning and thereby increase their scores on this assessment for each year of professional development in mathematics.

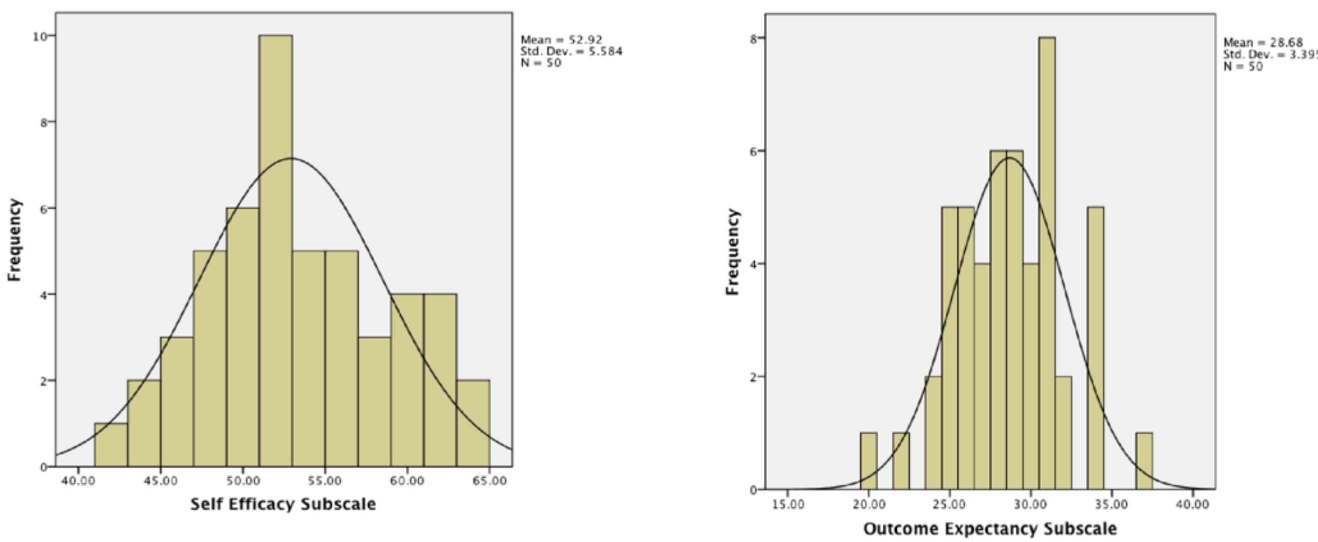

Figure 1: MTEBI results for Richmond Community Schools Teachers

The team also examined teacher's efficacy towards teaching the engineering design process. Figure 2 shows teacher beliefs towards their preparedness for implementing the engineering design standards and integrating the design process into mathematics and science. This self-reported data was collected with questions using a scale of 0 to 5, where 5 is the highest in understanding or preparedness and 0 is the lowest. The average score was 1.85 for feeling prepared to integrate engineering design in science and only 1.69 for integrating engineering design in mathematics. The average score of teacher's enthusiasm towards teaching engineering was also low at 2.25. Teachers did recognize to a greater extent the importance of the alignment of the engineering design process to the math and science standards, with average scores of 2.59 and 2.73, respectively. The data represented in Figure 2 shows the need to better inform and train teachers in the engineering design process and help them better understand its integration into science and mathematics.

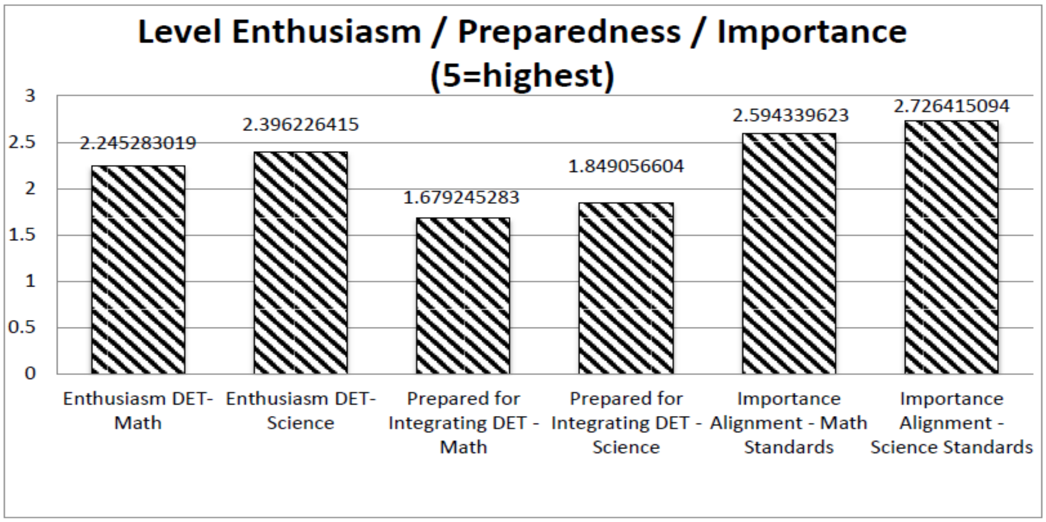

Figure 2. Teacher's efficacy towards teaching the engineering design process.

Teacher survey results Finally, teachers were interviewed to determine their willingness to participate in the proposed professional development and their perception of the challenges and opportunities in mathematics when taught in a science context. Of the teachers that responded, 74% said they were likely or very likely to participate in the summer professional development. The teachers expressed willingness and a definite need to re-align the mathematics and science curriculum. They recognize that since the district has begun mandating the time allotted for mathematics and English/Language Arts, they feel that there is not an opportunity to integrate and children do not see the connections between the different subjects. They commented that they feel the school day has become "chopped up" and that there is not a flow between subjects like there used to be. They expressed difficulty in seeing where the natural points of integration are between mathematics and science and said they found it much easier to integrate literacy and science. A common theme was finding time to teach science and they expressed concerned that the integration might take time away from either science or mathematics instruction. They were open to learning about the mathematics extensions and working to integrate them. They liked the idea of having the summer camp as a way to practice the lessons that they would implement during the school year.

According to the report summary, and in line with advancing the STEM initiatives of the corporation, the Integrating Science, Engineering, and Mathematics ISEM professional development program would address:

- Goal 1 – develop teacher's conceptual understandings of mathematics and of the engineering design process;
- Goal 2 – align science, mathematics and engineering instruction at the lesson level;
- Goal 3 – develop mathematics extensions from science and engineering modules as applications of the science content

In order to meet these goals, we would have an 80-hour summer institute each year, monthly grade level meetings, ongoing support from STEM resource teachers and the district science coach, and an online professional development resource site.

The Teachers. In assessing the credentials of elementary, middle, and high school teachers within RCS, "on paper," teachers appear to have the qualifications necessary to provide effective science education experiences for students. However, math and science is oftentimes listed as teachers' least favorite subject to teach, they struggle to determine effective pedagogical practices to teach it, and they are often unaware of their limitations in the knowledge base (Baseline review with potential teachers, Spring 2014).

Related to goal 5 of the ESS program (students would show improved understanding and achievement in math and science), student scores on ISTEP mathematics have consistently dropped during middle school by an average of 6.67 percent for the past three years (2009-2012). Further, the achievement gap between overall scores and scores of students with free and reduced lunch status averages 11 percent in middle schools; with English language learners the gap extends to 23 percent. End of course assessments for first time Algebra I testers shows an unacceptable 63 percent pass rate. Science test scores for middle schoolers currently are 9 percent below the state 2012-2013 average. Clearly, STEM related initiatives would provide the Richmond Community Schools with strong opportunities for growth.

Summary of Needs Assessment. RCS demonstrates the need for this Mathematics and Science Partnership (MSP) program grant by having each of their schools meet the qualifying criteria established in the RFP. In addition, when assessing their own skills, RCS teachers identify as lacking the skills set required to teach science as a form of inquiry-based practice.

RESEARCH BASE

Research in mathematics and science education exploring the use of science context or integrated contexts (those that demand the application of theory or knowledge from more than one discipline) (Ng & Stillman, 2009; Venville, Leonie, & Wallace, 2004) has suggested that more research is needed to explore how curriculum can be used to support the learning of concepts from more than one discipline. Research has uncovered several factors that impact learning from “real-world” context that demand the application of science and mathematics (Venville, Sheffield, Leonie, & Wallace, 2008) including the openness of problems involved. While students might be deeply engaged in generating solutions to problems set in a scientific context, the application of mathematics and ultimately what can be learned from the posed problems is mediated by students attention to mathematics and its use (Ng & Stillman, 2009). In other words, in order to learn mathematics from the problems set in context, it seems that students' attention must be drawn to the mathematics.

In an analysis of a collection of studies exploring students engaged in integrated mathematics and science lessons, Hurley (2001) defined several different models of integration including sequencing mathematics and science. Findings from the analysis revealed that "Student achievement effects were greatest for mathematics when taught in sequence with science; i.e., when they were planned conceptually together, but when the students learned first one and then the other" (p. 265). Hurley further suggested that more research on learning with existing curricula is needed.

Finally, the teaching of engineering and the design process has received significant attention in the past few years in the U.S., particularly with the release of the *Framework for Science Education* (National Research Council, 2011), the Next Generation Science Standards, and the addition of a Science, Technology and Engineering standard to our own Indiana Academic Standards for Science -- 2010. Providing education in the design process and engineering has been shown to enhance student learning in science and mathematics and support the development of skills such as problem solving. When teachers use a design-based learning approach in the classroom, students develop problem-solving skills that are critical in dealing with solving open-ended and ill-defined problems (Eshach, 2006). Additional studies have shown that engineering design projects not only improve problem-solving skills, but also enhance students' science content knowledge (Fortus et al., 2004; Mehalik, Doppelt, & Schunn, 2008; Wendell & Lee, 2010). A focus on engineering design has also been shown to improve knowledge and skills in mathematics (Hjalmarson, Diefes-Dux, & Moore, 2008). In survey research using the Design, Engineering and Technology (DET) survey of 192 teachers from 18 states, Hsu et.al (2011) found that elementary teachers believe that design, engineering and technology was important and should be integrated into the K-12 curriculum. However, these same teachers reported having low familiarity with design, engineering and technology and exhibited neutral confidence in their ability to teach this content. These teachers also identified lack of time, training and teacher knowledge as barriers to teaching. These results give us strong support for the work that the team plan to do with our teachers in this project.

OUTLINE OF THE ISEM PROGRAM – 2014-2015

Integrating Science, Engineering, and Mathematics ISEM was developed following ongoing discussions between the Richmond Community Schools and Purdue University. Using needs assessment data gathered during the 2013-2014 academic year, an intervention program was designed to ensure that ESS would provide advancement opportunities for area students, teachers, and schools. The ESS program reorganizes math and science curriculum, teaching pedagogy, professional development opportunities, and expectations of student performance into a coherent and systematic plan to improve science instruction in our community.

ESS was developed to include a four-phase process toward re-aligning RCS math and science curriculum in grades 1-6 through a system of teacher training, curricular reorganization, and program implementation. The emphasis of ESS was to develop scientifically-based professional development and verify student learning following intensive teacher training and curriculum redevelopment.

TEACHER EVALUATIONS – 2014.2015 ACADEMIC YEAR

The evaluation of teachers included a (1) baseline of teacher knowledge about math and science curriculum, and (2) qualitative analysis of reflections gathered as the STEM initiative began, (3) ESS teacher demonstration of pedagogical learning during the ESS summer professional development sequence (2014).

Teacher Content Knowledge

Four forms of content knowledge were identified by the pre-tests taken by cooperating model and ESS teachers during the Spring of 2014: declarative procedural knowledge (content knowledge of what teachers "know"), inquiry knowledge (content knowledge of what teachers "the skills and habits of mind of doing science"), strategic knowledge (content knowledge of what teachers "knowledge of when, where, and how to use certain types of knowledge in a new situation and knowledge of assembling cognitive operations."), and pedagogical knowledge (skill-based knowledge of what teachers "teach: knowing when, where, and how to use knowledge in teaching situations").

Teachers involved in the program believed that they would have the most difficulty with strategic knowledge, or content knowledge of when, where, and how to use certain types of knowledge in new situations and ways of assembling cognitive operations (minimum score on 8-item scale = 1, maximum score on scale = 7, mean = 4.12). However, these scores were closely tied to normed groups who had taken the tests previously. Instead, teachers showed the greatest issue with pedagogical knowledge, or when, where, and how to use knowledge in teaching situations (minimum score on 10-item scale = 0, maximum score on scale = 9, mean = 2.58). Teachers should work with faculty at the Purdue University over two weeks during the Summer of 2014 to work on these skills. Faculty from the sciences (chemistry and life sciences in particular) should work with faculty on ways that they might address student inquiry questions and prepare lessons for implementation in their classrooms. Teacher educators were instrumental in helping faculty to design lesson plans that could be practiced during summer professional development, then implemented in their classrooms. Because pedagogical content knowledge is of such critical concern, the observation forms gathered throughout the year would be of immeasurable assistance in clarifying the improvement of teachers (and are believed to demonstrate improvement, to be confirmed with post-test scores).

Generalist Science. A preliminary review of teachers' science content knowledge was reviewed during summer professional development. Most of these teachers taught in classrooms grades 1-6. All participants had backgrounds in generalist education, but only one participant had a significant background in the sciences. The average participant took one course in earth science and physical science ($\underline{x}$ = 2.41 hours earth, $\underline{x}$ = 3.19 hours physical) as an undergraduate, and one or two life science courses. Teachers at this level also show a wide disparity in teaching experience. While the average participant shows 11 years experience ($\underline{x}$ = 11.71 years), there is a disparity, with the median experience being 7 years with four teachers having more than 20 years experience. These data show that while advanced teachers may be able to provide pedagogical support to those with less classroom experience, none have much in the way of strong backgrounds in science content.

Procedural knowledge. As stated previously, an analysis of procedural knowledge, inquiry knowledge, strategic knowledge, and pedagogical knowledge would be reviewed based on pre-test scores. In general, teachers show adequate procedural content knowledge. Generally, life science content from biology coursework is the strongest reviewed (knowledge of habitats, biomes, weather patterns, cells, using data in tables and charts to make inferences). Information that might require additional discussion would include basic knowledge of chemical reactions, properties of matter, and different forms of circuits and the exchange of energy, and how lunar phases relate to weather patterns (as well as differences between rotation and revolution).

Inquiry knowledge. Few issues with inquiry knowledge were determined based on pre-test scores of participants. Responses showed adequate ability to work with students on clarifying what they know, and how questioning can be used to illicit deeper understanding of knowledge of science content. It may be that as deeper conceptual understandings of content are required (such as those detailed in the Indiana academic standards), generalist teachers may require more tools on how questioning ties to hypothesis testing and the reflection that comes from lab experiences. While general knowledge and application knowledge could be analyzed in the results, it is unclear if higher order thinking skills currently are being used as a strong component of pedagogy in use.

Strategic knowledge. As with the other participants currently involved in the ESS program, generalist teachers need further training in when and how to use knowledge in teaching situations. General connections between content areas can be made, but because of limitations with efficacy around the content area, teachers appear to be hesitant to make the "leaps" required to compare and contrast how content ties to other areas of science. Similarly, the formal process of inquiry should be reviewed, in particular around the concepts of using hypothesis testing, steps of inquiry, and in using journaling and writing as strategies for reflection.

Pedagogical knowledge. Generalist science teachers participating in the ESS program showed strong knowledge of varied methods that could be used in their classrooms. While methods were clear and could be used effectively, teachers appear to lack the efficacy to believe in their approaches. Narrative often included questions about their skills, lack of effective previous experiences, or general difficulty in performing labs and "doing science." Little to no discussion included working with students in manners that paralleled what professional scientists do. Rather, much of methodology was designed to review information. Further connections should be made between inquiry, deep thinking about science, and "what scientists do." In other words, time should be spent with these teachers on clarifying that scientists often do not have all the answers and that methods are designed to be systematic so that mistakes can lead to deepening understandings.

Generalist Math. In comparison with generalist science skills, most teachers at this level shared a stronger background with mathematics.

Procedural knowledge. As stated previously, an analysis of procedural knowledge, inquiry knowledge, strategic knowledge, and pedagogical knowledge would be reviewed based on pre-test scores. In general, teachers show adequate excellent procedural math content knowledge. Generally, information on operations and algebraic thinking and number/operations in base ten were strongest reviewed. Measurement and data also showed good performance. Information that might require additional discussion would include advanced information about how to clarify fractions with unlike denominators and geometric principals (as they tie to the coordinate plane).

Inquiry knowledge. Few issues with inquiry knowledge were determined based on pre-test scores of participants. Responses showed adequate ability to work with students on clarifying what they know, and how questioning can be used to illicit deeper understanding of knowledge of math content. It may be that as deeper conceptual understandings of content are required (such as those detailed in advanced skills required in the Indiana academic standards), generalist teachers may require more tools on how helping students to understand the "whys" of operations rather than the "hows." Teachers seemed to struggle most when explaining their reasoning for how the drew conclusions to problem solving. While teacher knowledge of problems and students' responses were accurate, difficulty in how to explain responses so that students might better understand solutions was shown.

Strategic knowledge. As with the other participants currently involved in the ESS program, generalist teachers need further training in when and how to use knowledge in teaching situations. Almost all teachers reported lecturing through material, showing example items, and modeling "how to solve." Virtually no use of technology, inquiry-based methods, or use of manipulatives was discussed. It would be good to include a discussion of how journaling and reflective writing in mathematics can be used as strategies for deeper reflection in content.

Pedagogical knowledge. Generalist math teachers participating in the ESS program need a greater repertoire of varied methods that could be used in their classrooms. While methods documented were clear and could be used effectively, teachers lack a variety of strategies. Teachers were often traditional in their approaches. They know how to model the deconstruction of problems through board work, and the use of dry erase boards. Little discussion of writing or reflecting on "why" stepped procedures worked was documented. Further, some greater clarification about student mis-responding should occur – teachers tended to not adequately be able to clarify the incorrect thinking that led to student errors in procedures, especially in complex ordered algebraic operations and geometry using the coordinate plane.

Reflections from 2014

By the end of the Summer 2014 activities, students, teachers, and university faculty had developed a strong and powerful professional learning community. Students would be able to see teachers and university faculty working together to clarify scientific knowledge and skills during the 2014-2015 academic year. Teachers were provided mentoring and advanced content development to better instill the motivation that they could successfully teach a science curriculum. Faculty from teacher education, mathematics, and the sciences were able to work together to model authentic science methods while deepening the content knowledge of students and teachers in STEM content areas.

Preliminary results for the year show that pairing effective literacy instruction (use of vocabulary, use of diverse fiction and non-fiction texts, use of scientific journals) can assist teachers in advancing science content and skills. Further, teachers were able to gain improved pedagogical skills in teaching math and science by linking familiar literacy skills with newly-developed declarative, procedural, and inferential knowledge. It is believed that when teacher post-test scores and student ISTEP+ scores for math and science are reviewed, improvements would be evidenced.

According to the report summary, and in line with advancing the STEM initiatives of the corporation, the Integrating Science, Engineering, and Mathematics ISEM professional development program would address:

- Goal 1 – develop teacher's conceptual understandings of mathematics and of the engineering design process; *Teachers at the elementary and intermediate levels have a greater understanding of how to incorporate math and science into engineering-based units. They share greater efficacy for program implementation and the ability to effectively use inquiry-based methods.*
- Goal 2 – align science, mathematics and engineering instruction at the lesson level; *Teachers at the elementary and intermediate levels shared a stronger ability to use their declarative knowledge to implement curriculum in a strategic manner. Teachers report feeling better prepared to discuss "how to solve" engineering processes and how to help students better reflect on their own learning.*

- Goal 3 – develop mathematics extensions from science and engineering modules as applications of the science content. *Teachers worked diligently for 10 days to develop materials that could be taught in a STEM camp, as well as develop materials for use with the classroom. The teachers especially valued the chance to work together and plan with Purdue faculty in developing inquiry-based engineering curriculum.*

More emphasis on backward design and effective assessment techniques also were suggested by Richmond teachers; these suggestions would be implemented as well. Further, the Implementation of the MSP grant has been an extremely powerful and positive experience for the teacher and students in Richmond Community Schools. The professional development aligned fully with our implementation of the Indiana Science Initiative which allowed for a more robust execution. The first major success was the acceptance of our Purdue facilitators. The teachers respected the expertise of these professionals and felt comfortable having them in their classrooms to observe and give constructive feedback concerning math and science content, classroom management and inquiry and journaling strategies that would improve student achievement. At our professional development meetings our teachers were able to share concerns and needs in a productive discourse in vertical and grade levels across the district. This has led to a partnership across schools where teachers have banded together to write grants and create projects that have led to funding of projects.

The MSP project has been an important impetus for additional professional growth opportunities. A critical success of the project was having work time where the teachers collaborated with like grade levels from throughout the district. The teachers were able to share classroom management tips, pedagogy and create resources and curriculum maps that relate to Indiana's

Academic Standards for Mathematics and Science. Materials were gathered and developed with the assistance of the Purdue faculty, which greatly benefitted the professional growth of the participants.

The program has revealed a committed team of professionals who relish time to work with their colleagues and create a nurturing environment for students. Because of this commitment, the district has grown both professionally and academically because of this opportunity.

Throughout the process of implementation of the MSP grant the team has grown. RCS have not only implemented the updated Indiana State Standards for Mathematics but have implemented the Indiana Standards for English Language Arts into the math and science curriculum. RCS also has been able to create and implement pre and post assessments for the four categories of standards in math and science and have a central recording point where RCS can track the progress of student learning and identify gaps in instructional pedagogy that might be impeding the progress of students and are able to give guidance to teachers who are struggling.

RCS have created a cohesive group of teachers who are passionate about math and science education and moving our students to become scientifically literate. Through our last workshop, the teachers created a leadership team that is projected to meet throughout the school year to evaluate our district's progress toward improving math and science education.

Teachers were involved in inquiry activities throughout the summer professional development. The school corporation has strongly advocated improved performance and incorporation of math and science standards by teachers across grade levels. Teachers within the corporation have been state partners in supporting growth of STEM initiatives; as such, their involvement in a train-the-trainer type program also has supported the corporation.

For example, teachers this summer worked closely with strategies to improve inquiry skills. One such technique learned was "I see ... I think ... I wonder ...". The strategy provides a chance for students to be hands on and active in thinking about their environment. Students look at items in middle of table, review with their eyes, think with associations, and then ask questions about wondering. Then, students individually interact with items, then discuss as a small group, then can interact with items. Such experiences allow kids to be involved, support their innate curiosity, as well evening of the playing field for different levels. Teachers would then consider how they could include this in their curriculum.

Teachers also spent time in professional development working on developing materials and content studies that could teach content inquiry skills. Teachers worked with faculty from Purdue University to explore how mathematicians and scientists use writing in their professional practices. Content was investigated as a part of this process, but teachers spent time reflecting on writing and thinking skills as well. Content knowledge was supported, but so was the development of critical thinking skills. The side-by-side approach to developing curriculum and materials that teachers could readily implement this fall in their classrooms was valued by teachers.

Teachers worked with administrators and content faculty from Purdue to explore investigative techniques and the importance of emphasizing student questioning skills. Inquiry was a cornerstone of this process. Though teachers were aware of and had used backward design qualities and Bloom's taxonomy to support higher order thinking skills, time was spent exploring how to ask questions and engage in scientific processing skills. From simple class activities, to examining content texts, to engaging in weeklong experiments; curriculum was advanced to meet high student thinking skills.

Evidence from the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) evaluations and a preliminary test of content knowledge in mathematics demonstrated that teachers felt less strong in mathematics and engineering areas than in other curricula that they teach. These results were used to directly target content, practices, and materials that could advance teacher efficacy and improve use of inquiry in classrooms. Results from the STEM institute show that teachers felt an improved sense of effectiveness in incorporating mathematics into the sciences through use of curriculum developed during the institute.

One of our goals was to improve instructional delivery and our teachers have been working on the scientific process and how students make their own meaning and check understandings through end of lesson discussions.

Teachers also commented on how they appreciate the partnership with Purdue. “The partnership with the Purdue faculty has been very helpful. I was able to see how inquiry-based learning works with my students. The Purdue faculty worked in my classroom with my students, and now I have a better understanding of how it can work with them. RCS are doing more inquiry learning in my classroom than in the past. The Purdue faculty also provided great resources.”

The grant has also helped our teachers collaborate and share ideas and resources. “The collaboration was Amazing! It is so nice to have time to work with others that know the age level and have ideas to share. It’s so nice to share lessons, highs, lows, create book lists and website lists to assist with the teaching of the kits.” Another teacher writes, “The collaboration during the summer was so beneficial! RCS came up with ways to get more accomplished and shared ideas.”

The final unforeseen benefit has been the cohesion of all the teachers of math and science from Kindergarten through middle school. Our teachers really never knew who the teachers were at the different levels nor did they know how they taught math and science. It has been a great experience having teachers work together across levels.

Evaluation for P-12 schools is an ongoing dilemma. It required strong communication between the off-site evaluator and the program coordinator. Coordination and evaluation of teacher improvement was much more easily facilitated than evaluation of students. Part of this was brought on by the significant difficulties with the Spring 2014 statewide issues with ISTEP+. The transition to computerized testing made for significant challenges, which delayed return of results.

While these difficulties occurred, the ability to incorporate standardized and non-standardized measures made for a stronger evaluation system. The reporting process benefited by the use of multiple measures.

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Appendix: MTEBI Form

Mathematics Teaching Efficacy Belief Instrument (MTEBI)

Inservice Teachers

Developed by Larry G. Enochs and Iris M. Riggs, used with permission

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Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.	A	B	C	D	E
2. I will continually find better ways to teach mathematics.	A	B	C	D	E
3. Even if I try very hard, I do not teach mathematics as well as I do most subjects.	A	B	C	D	E
4. When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.	A	B	C	D	E
5. I know the steps necessary to teach mathematics concepts effectively.	A	B	C	D	E
6. I am not very effective in monitoring mathematics activities.	A	B	C	D	E
7. If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.	A	B	C	D	E
8. I generally teach mathematics ineffectively.	A	B	C	D	E

	Agree				Disagree
9. The inadequacy of a student's mathematics background can be overcome by good teaching.	A	B	C	D	E
10. The low mathematics achievement of some students cannot generally be blames on their teachers.	A	B	C	D	E
11. When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.	A	B	C	D	E
12. I understand mathematics concepts well enough to be effective in teaching mathematics.	A	B	C	D	E
13. Increased effort in mathematics teaching produces little change in some students' mathematics achievement.	A	B	C	D	E
14. The teacher is generally responsible for the achievement of students in mathematics.	A	B	C	D	E
15. Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.	A	B	C	D	E
16. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.	A	B	C	D	E
17. I find it difficult to use manipulatives to explain to students why mathematics works.	A	B	C	D	E
18. I am typically able to answer students' mathematics questions.	A	B	C	D	E

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
19. I wonder if I have the necessary skills to teach mathematics.	A	B	C	D	E
20. Given a choice, I would not invite the principal to evaluate my mathematics teaching.	A	B	C	D	E
21. When a student has difficulty understanding a mathematics concept, I am usually at a loss as to how to help the student understand it better.	A	B	C	D	E
22. When teaching mathematics, I usually welcome student questions.	A	B	C	D	E
23. I do not know what to do to turn students on to mathematics.	A	B	C	D	E

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