Rio Connections:
Improving Mathematics and Science

A Math-Science Partnership

September 2009

Sponsored by University of Rio Grande, Gallia-Vinton Educational Service Center,
Gallia County Local School District, Vinton County Local School District,
and Wellston City Schools
Prepared by Ohio University's Voinovich School of Leadership and Public Affairs

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TABLE OF CONTENTS

LIST OF FIGURES

EXECUTIVE SUMMARY

Project Background

The University of Rio Grande, Gallia-Vinton Educational Service Center (ESC), Gallia County Local Schools, Vinton County Local Schools, and Wellston City Schools have enjoyed a strong collaborative relationship for several years. Representatives from each entity formed a partnership and first began meeting in 2003 to address the critical issue of math and science achievement scores in the partner districts. The three participating districts can be identified as high-needs local education agencies (LEAs) as a result of not achieving a 75 percent pass rate on statewide math and/or science assessments and serving high numbers of students from families with incomes below the poverty line. This report addresses the second year of the partnerships' math and science partnership project.

The Rio Connections Project's mission is "to provide high-quality, ongoing math and science professional development for teachers in grades three through eight in the three participating school districts so they, in turn, can become specialists in both content knowledge and pedagogical skills in order to improve student achievement". The project's vision is to establish a collaborative partnership among districts, regional providers, and higher education that supports the development and integration of math and science in the classroom so students can obtain high achievement in these content areas.

The partnership identified three objectives for the Rio Connections project. First, the project will improve student content knowledge in math and science as reflected by a ten percent increase in the number of students who score proficient on the math portion of the Ohio Achievement Tests (OAT) and a pass rate of at least 75 percent on district-developed, short-cycle assessments of science over the first 18 months of the project. Second, the project will increase the content knowledge of math and science teachers as measured by the Caliber pre-/post-test. Third, the project will increase the frequency of teachers using Ohio Mathematics Academy Program (OMAP) and Ohio Science Institute (OSCI) Modules and best practice, research-based pedagogies by 75 percent as measured by teacher pre-/post-surveys and qualitative data collected during site visits.

Evaluation Methodology

Members of the Planning, Evaluation, Education, and Research (PEER) team at Ohio University's Voinovich School of Leadership and Public Affairs serve as the evaluators for the Rio Connections project. As noted above, the partnership goals were to improve teacher content knowledge in math and science, improve teacher instructional methods, and substantially change student test scores. All of the areas are addressed in this report, which is guided by the following primary research questions:

> 1) Do the professional development workshops lead to an increase in teacher content knowledge, as compared to a similar group of teachers in the same district who are not participating in the program?
>
> 2) Do teachers who receive professional development implement new ideas and skills into their classrooms?
>
> 3) Do students of participating teachers show an increase in math and/or science achievement as compared to a similar group of students in the same district whose teachers did not participate?

Several strategies were used to address the research questions. Evaluators collected quantitative and qualitative data from key project personnel, participants, partnering districts, and students who attend those districts. Specific data sources that inform this report's findings include:

- teacher content knowledge assessments,
- instructional practices surveys,
- Ohio Achievement Test scores,
- teacher group interviews,
- coach interviews, and
- site visits/observations.

Pre-tests and post-tests of teacher content knowledge and instructional practices were administered to Rio Connections Cohort I and Cohort II math and science teachers. University of Rio Grande Science Technology Engineering and Math (STEM) faculty developed questions to supplement the Caliber math content pre- and post-test instruments. In regard to the science content pre- and post-test instruments, STEM faculty used components of the Ohio Science

Institute (OSCI) assessments and additional questions that reflect content from each area of concentration in the professional development curriculum. The assessment questions are linked to the Ohio Academic Content Standards for mathematics and science education. The instructional practices pre- and post-survey were used to measure prior and current frequency in the teachers' use of OMAP and OSCI Modules as well as best practice research-based pedagogies. The pre-test content knowledge and instructional practices instruments were collected by workshop facilitators from participants at their first professional development workshop day. Teachers in Science Cohort I and II completed the science-specific instructional practices instrument and one of four science content tests based on the workshop in which they participated. Teachers in Math Cohort I & II completed the math-specific instructional practices instrument and one of three math content tests based on their workshop. Evaluation team members collected the post-test content knowledge and instructional practices instruments from participants in each group on their last professional development workshop day or during a separate post- assessment session.

Pre- and post-instruments were collected for each workshop grouping. There were no collection issues with the math data. There is one issue related to the science pre-test data: for one group (grades 4-5), the pre-test was administered two to three months later than the remaining groups' pre-tests. The collection dates for math and science participants are listed below (Tables 1 and 2).

Table 1: Pre- and Post-Test Collection Dates for Math Participants

OMAP Workshop	Pre-Test Date	Number of PD Sessions Provided	Post-Test Date
Grades 3-5 (Gallia County)	Nov. 2008	5	May 14 2009
Grades 6-8 (Gallia County)	Nov. 2008	5	May 14 2009
Grades 3-4 (Wellston City Group A)	Nov. 2008	5	Mar. 24 2009
Grades 5-8 (Wellston City Group B)	Nov. 2008	5	Mar. 25 2009
Grades 6-8 (Vinton County)	Sept. 2008	4	May 4 2009

Table 2: Pre- and Post-Test Collection Dates for Science Participants			
OSCI Workshop	**Pre-Test Date**	**Number of Professional Development Sessions Provided**	**Post-Test Date**
Grade 3-5 (Vinton County)	Nov. 2008	1	May 12 2009
Grade 3-5 (Wellston City)	Nov. 2008	2	May 18 2009
Grade 3 (Gallia County)	Dec. 2008	1	May 21 2009
Grade 4-5 (Gallia County)	Feb. 2009	1	May 21 2009
Grade 6-8 (Gallia County, Vinton County, & Wellston City) Life Science	Oct. 2008	4	May 21 2009
Grade 6-8 (Gallia County, Vinton County, & Wellston City) Physical Science	May 2009	4	May 21 2009

Evaluators observed two teachers in their classrooms and conducted brief interviews with them following the observations. The Inside the Classroom Observation and Analytic Protocol from Horizon Research, Inc. was abridged by the evaluation team and used as a guide for observing teachers in their classrooms. The evaluation team modified the Inside the Classroom Interview Protocol, also from Horizon Research, Inc., and examined specific details related to the implementation of the project and its impact.

Members of the evaluation team conducted group interviews at the participants' last professional development workshop day or during a separate post-assessment session. All teachers present during the post-assessment testing were invited to participate in a group discussion to share examples of how the professional development they received through Rio Connections has influenced them, as well as the project's strengths and areas in need of improvement.

Student achievement gains have been assessed by collecting de-identified student level data from the Ohio Department of Education website. At this point in time, science is assessed at the fifth, eighth, and Ohio Graduation Test (OGT) levels, while math is assessed at all grade levels

from first through eighth and the OGT. Achievement gains are reported by movement between levels (advanced, accelerated, proficient, basic, limited). Analysis is limited because student data is not disaggregated by teacher, but it should show some movement toward greater achievement by students. As all teachers in a given grade level within each participating district received the professional development, an overall trend in improved scores by grade level can be examined. Though not conclusive, a trend would be one indication of program impact.

Primary Evaluation Findings

- The percentage of students proficient or above on the OAT are examined by grade level and district. From 2007 to 2009, five out of the six student groups had an increase in the percentage of students proficient or above in science on the OAT. From 2008 to 2009, four of the same student groups had a ten percent or greater increase in the percentage of students proficient or above in science.

- From 2007 to 2009, 11 out of the 18 student groups had an increase in the percentage of students proficient or above in math on the OAT. From 2007 to 2009, four of the same student groups had a ten percent or greater increase in the percentage of students proficient or above in math, and two additional groups were less than one percentage point shy of a ten percent increase.

- The majority of participating teachers changed their classroom practices, as reported in group discussions, interviews, and the Survey of Instructional Practices.

- From pre- to post-test, two thirds of the science teachers and nearly half of the math teachers had an increase in their corresponding content test scores.

- Three of the four science teacher groups had a statistically significant change in content tests scores from pre- to post-test.

- The project design of having math and science facilitators serve as classroom coaches was well received by teachers. Teachers reported many of the facilitators previously taught in the districts, which made them familiar with what is needed. They also noted a greater comfort level was reached, which allowed them to pose content questions easily.

- At the end of the project, most teachers report feeling supported by their coach.

- A theme from across the qualitative data sources (interviews and focus groups) reveals the professional development is aligned to the assessed needs of the students and districts.

- Teachers in the districts who participated in field trips to the University of Rio Grande science department highly valued the experience and noted that it benefitted the students. Conversely, teachers from the districts that were unable to participate in the field trips noted that they too would like their students to have the opportunity.

Recommendations

- It is recommended that the teachers' completed and scored post-tests be returned to them so that they have a better understanding of their own strengths and weaknesses in the content area.

- It is recommended that teachers be further engaged in the higher goals of the project. That is, while some teachers see the benefit of knowing the content area they teach at a higher level, others do not and believe they only need to know the content to the grade level they are currently teaching. Increased understanding of the value inherent in this concept would move teachers beyond "what do I need to know", to "what else can I learn".

- Teachers would likely benefit from increased awareness of the purpose of involving STEM faculty from the University Rio Grande.

- The teachers spoke very highly of the field trips to the University of Rio Grande science labs. It is recommended that all efforts be made to continue this clearly valuable experience for area students.

- It is recommended that the coaches track the number of hours spent mentoring individual teachers in order to ensure each teacher is getting adequate mentoring.

PROGRAM DESCRIPTION

The Leadership Team

The Principal Investigator for the project is Dr. Jacob White, who is a full-time University of Rio Grande employee and has been an Assistant Professor of Chemistry and the Associate Director of the Southeast Ohio Center for Excellence in Math and Science (SEOCEMS) for the past three years. Dr. White is also familiar with Education Department General Administrative Regulations (EDGAR).

Throughout the duration of the project, Dr. Barbara Hatfield, Provost and Vice President of Academic Affairs and Professor of Mathematics, has assisted Dr. White in the administration of the grant. Due to prior collaboration efforts between the Gallia-Vinton ESC, Gallia County Local Schools, Vinton County Local Schools, and Wellston City Schools, a major part of the grant administration is contracted to the Gallia-Vinton ESC. Dr. Denise Shockley, Gallia-Vinton ESC Superintendent, serves on the Advisory Board, coordinates regional professional development activities, assists in the development of program materials, recruits trained facilitators, and assists in trainings for facilitators.

All trained facilitators and coaches have experience in developing and providing professional development, in particular OMAP/OSCI. Each semester, at least six STEM faculty members were expected to work directly with teachers during implementation days and on-site visits to build additional knowledge and skill level, engage in collaborative problem-based activities, review samples of student work, and demonstrate evidence of the application of theory. This year, STEM faculty also presented content lessons to enhance the workshops. Table 3 below details the project's key personnel.

Table 3: Rio Connections Key Personnel

Name	Role in Project	Area of Expertise	Experience
Jacob White	Principal Investigator and Science Coach, Vinton County; Train Coaches, Visit Teachers,	Science	College Teaching, Research
Barbara Hatfield	University Administrator, Fiscal	Math/Science Professional Development	High School and College Teaching, Admin., Research
Denise Shockley	Local District Liaison	Professional Development	Teaching, Admin., Research
Kimball Clark	Train Coaches, Visit Teachers	Science	College Teaching, Research
Dana Evans	Train Coaches, Visit Teachers	Science	College Teaching, Medical Practice
John Means	Train Coaches, Visit Teachers	Science	College Teaching, Research
Nicolyn Smith	Train Coaches, Visit Teachers	Math	College Teaching, Research
Noyan Er	Train Coaches, Visit Teachers	Math	College Teaching, Research
Karen Boch	Arrange Local Schedules, Wellston	Curriculum	Teaching, Curriculum
Patrick Stout	Arrange Local Schedules, Gallia County	Curriculum	Teaching, Principal, Curriculum
Mary Ann Hale	Arrange Local Schedules, Vinton County	Curriculum	Teaching, Elem. Principal, Curriculum
Sandra Wilkin	Science Coordinator/ Science Coach, Vinton County	Science	Teaching
Iris Green	Science Coach, Wellston	Science	Teaching
Beth Conley	Science Coach, Gallia County	Science	Industry Scientist
Jim Oiler	Science Coach, Gallia County	Science	Teaching
Henry Dillon	Math Coordinator, Math Coach, Gallia County	Math	Teaching
Peggy Murdoch	Math Coach, Wellston	Math	Teaching
Ernestine Smith	Math Coach, Gallia County	Math	Teaching
Mary Jane Wolfe	Math Coach, Vinton County	Math	College Teaching, Research
Janet Benner	Math Coach, Vinton County	Math	Information Unavailable

Teacher Participant Selection Process

By the end of the third program year, which will be June 2010, all teachers in grades three through eight who teach math and/or science in each of the three districts will have participated in the professional development program. This also includes special education teachers who work in concert with classroom teachers in inclusion settings. Building principals and district curriculum coordinators from the three participating schools were given the task of evenly dividing their third through eighth grade teachers into one of four cohorts: Science Cohort I, Science Cohort II, Math Cohort I, and Math Cohort II.

Cohort I mathematics and science teachers received at least 80 hours of intervention services during the first year of Rio Connections implementation. During the second year of implementation, Cohort II will become the main group that receives services and will serve as a comparison group to Cohort I. Cohort I will continue in the second year by participating in 40 additional hours of professional development activities. In year three, teachers new to the district and/or reassigned to teach in grades three through eight will become the Cohort III group, which will serve as a comparison group for Cohort II in the second year of the project. At this point, it is not possible to discern comparison groups from participant groups.

Cohort I Participants

According to the original plan, half of the districts' teachers were expected to be in Cohort I and half in Cohort II. However, school district representatives selected more than half of their teachers to participate in the first year of the project. For the second year of this professional development project, Math Cohort I consisted of 66 math teachers, including all of the teachers in grades three through eight for Gallia County Local and Wellston City as well as grades six through eight for Vinton County Local. There were 39 mathematics teachers from Gallia County Local, 16 from Wellston City, and 11 from Vinton County Local who participated in the project.

Science Cohort I consisted of 35 science teachers in grades three through five in the participating districts. Science participants included 22 teachers from Gallia County Local, four from Wellston City, and nine from Vinton County Local. Nine teachers from Gallia County Local and two teachers from Wellston City participated in both math and science professional

development for the second year of this project.

Cohort II Participants

Math Cohort II consisted of 14 teachers in grades three through five from Vinton County Local. Science Cohort II consisted of a total of 22 teachers in grades six through eight that attended one of the two four-day workshop sessions. Eight teachers were from Gallia County Local, five from Wellston City and nine from Vinton County. There were a total of 18 teachers that attended the fall workshop and a total of 21 teachers that attended the spring workshop. Seventeen middle school teachers attended both the fall and spring science workshops.

Professional Development

Teachers who participate in the Rio Connections project were to receive 80 hours of professional development in their first year and 40 hours in their second year. This professional development was in the form of workshops, implementation days, coaching sessions, and visits by STEM faculty. Four specific emphases were to be included in the workshops, coaching activities, and each STEM faculty visit: integration of mathematics and/or science content standards, various teaching tools, differentiated instruction, and techniques for assessing student learning.

In its first year, the project encountered difficulty in scheduling math and science trainers to travel to the three participating school districts when needed to facilitate the workshops. The leadership team made the decision to train the coaches as facilitators and this arrangement continued through this year. The project hosted train-the-trainer sessions in the fall of 2008 for both OSCI and OMAP modules. Mathematics coaches received training as facilitators for OMAP Module: Geometry, Measurement and Data Analysis. Science coaches received training as facilitators for OSCI Module: Life Science for Grades 6-8.

The professional development workshops for all three districts occurred during the 2008-2009 academic year and predominately occurred on-site in each of the districts. Project leadership responded to district and participant feedback collected last year to modify workshops in a manner that fit the individual districts' needs. These modifications included the grouping of

participants, the workshop topic, and the number of workshops provided. The modifications also resulted in variations in the concentration of professional development hours by activity across the groups of teachers.

Cohort I teachers were re-grouped into new grade bands for this year. Mathematics teachers from Gallia County Local received five workshop days of modified OMAP Module: Geometry, Measurement and Data Analysis curricular materials for grades three through five or six through eight. Mathematics teachers from Wellston City attended five workshop days of the same module modified for grades three and four or five through eight. Vinton County Local sixth through eighth grade teachers received modified OMAP Module: Data Analysis, Probability and Number curricular materials.

Cohort I OSCI workshops were also grouped into new grade bands for this year. Science teachers in Gallia County Local, Vinton County Local, and Wellston City received modified OSCI Modules for grade three, four, or five. The workshop for third through fifth grade teachers in Vinton County Local and Wellston City Schools was combined and held at Wellston Intermediate School. These teachers received the modified OSCI module for grades three through five. One modified OSCI workshop for grade three and one modified workshop for grades four and five for Gallia County Local were held at River Valley Middle School in Bidwell.

Cohort II included two workshops. Vinton County Local mathematics teachers in grades three through five received modified OMAP Module: Algebra curricular materials for grades three through five. Middle school science teachers from all three districts attended the OSCI Module: Life Science workshop over four days in the fall and the OSCI Module: Physical Science workshop over four days in the spring. Both of these workshops were held at the University of Rio Grande campus.

Each district collaborated with the University of Rio Grande and the Gallia-Vinton ESC to create a core team of district coaches selected from adjunct faculty, retired mathematics and science teachers, and consultants. All eight coaches from the first year of the project returned, and an additional mathematics coach was hired to accommodate the additional Cohort II science

teachers and provide train-the-trainer sessions to science coaches. In addition to facilitating the professional development workshops, the team of nine coaches was trained by the STEM faculty and OMAP/OSCI trainers to engage in peer mentoring, team teaching, strategy modeling, and assessment.

The Rio Connections project's coaching model for professional practice is based on the PRAXIS III criteria developed by Educational Testing Service. The framework is augmented to apply to both experienced and novice teachers through utilization of *Enhancing Professional Practice: A Framework for Teaching* by Charlotte Danielson. In addition, Rick Stiggins' research, which stresses "assessments for learning" as well as "assessments of learning," is embedded in this coaching model. The importance of authentic assessments and the use of these assessments to inform instruction are stressed.

The Rio Connections coaches worked with teachers in their classrooms or buildings at least four days a week in each district. Coaches initiated classroom mentoring with teachers at the beginning of the school year, prior to the start of the professional development workshops.

DETAILED EVALUATION RESULTS

Teacher Content Knowledge

The primary evaluation question regarding teacher learning is as follows:

2) Do the professional development workshops lead to an increase in teacher content knowledge, as compared to a similar group of teachers in the same district who are not participating in the program?

Table 4: Math Teachers' Content Knowledge Change by Teacher Group for 2008/2009

The science and math teachers completed pre- and post-tests that assessed their content knowledge. Because the teachers are divided into subgroups by grade and/or district groups and the professional development and content instruction as well as instruments vary, the data were analyzed by subgroup. The following tables contain detailed results on change in content knowledge by group (Tables 4 and 5). The significance level is somewhat more stringent than what is used to assess individual teacher change. The data do show that nearly half of participating math teachers had an improvement in their math content test from pre- to post-test.

Teacher Group	Number of Participants	Number Matched	Improved	No Change	Decreased	10% or More Improvement	Statistically Significant Change in Group
OMAP Algebra (Vinton 3-5)	13	13	7	3	3	5	No
OMAP Geometry (Gallia 3-8, Wellston 3-8)	55	49	20	11	18	9	No
OMAP (Vinton 6-8)	11	6	5	0	1	4	No
Total Math	**79**	**68**	**32**	**14**	**22**	**18**	N/A
Percentages			**47% of Matched**	**21% of Matched**	**32% of Matched**	**27% of Matched**	N/A

For science teachers, the data do show that over two thirds of the pre- to post-tests showed an improvement. For the science teachers, 17 participated in both life and physical science and completed tests for each. All of the scores are reported here, but the total number of individual teachers participating was actually 53. Three of the groups showed a statistically significant change from pre- to post-test.

Table 5: Science Teachers' Content Knowledge Change by Teacher Group for 2008/2009

Teacher Group	Number of Participants	Number Matched	Improved	Stayed Same	Decreased	10% or More Improvement	Statistically Significant Change in Group
OSCI Life Science (Gallia 5-8, Vinton 6-8 & Wellston 6-8)*	18	16	12	2	2	9	Yes, p<.003 Wilcoxen Signed Ranks
OSCI (Vinton & Wellston 3-5)	13	13	10	1	2	7	Yes, p<.013 Wilcoxen Signed Ranks
OSCI (Gallia 3-5)	22	20	12	4	4	8	Yes, p<.022 Wilcoxen Signed Ranks
OSCI Physical Science (Gallia 5-8, Vinton 6-8 & Wellston 6-8)*	21	17	10	1	6	3	No
Total Science	**74***	**66**	**44**	**8**	**14**	**27**	N/A
Percentages			**67% of Matched**	**12% of Matched**	**21% of Matched**	**41% of Matched**	N/A

*Note: 17 teachers participated in both the life sciences and physical sciences professional development. For data reporting purposes, instrument completion is reported but in total 53 teachers participated.

In addition to the quantitative information, qualitative analysis of a variety of data sources was conducted. Focus groups were carried out with coaches and teachers who represent the three school districts that took part in the math professional development. Further, two of the five mathematics coaches were interviewed. This section summarizes teachers' and coaches' perceptions of the math professional development.

Two common themes from the responses were the program helped teachers learn math content and improve their teaching methodology. With regard to math content, a teacher said, "*I think a lot of it is math content that we have forgotten maybe or not used for a long time because we are not in that grade level where they are using that, which has been very enjoyable getting that higher level math*." Another teacher said, "*…and when I understand something better, I'm much better at teaching it. So, that has helped me on a personal level, learning some things I didn't know because math is kind of a weak area for me*." Teachers described how the program has helped them to understand content standards better, as exemplified by the following statement, "*It deepens our knowledge of what we are teaching. It makes us more comfortable, because some of the standards are words so that I not always know what they want from me."* A coach added the professional development, "*gave the teachers… new experiences and techniques with geometry and data analysis in elementary*."

In the focus groups, teachers said they enjoyed both the classroom coaching and workshops. Participants in the math professional development described their experiences with the coaches as overwhelmingly positive. Teachers value the coaches' involvement with them. Coaches were often described as supportive, knowledgeable about content, experienced in the classroom, and accessible. One teacher stated, "*The instructors were very positive and encouraging. They got us to try new things and to think differently*." Teachers reported a high level of comfort in working with their coaches. As one described, "*… she is not interested in criticizing, she's just interested in making us better."*

Teachers appreciated the coaches offering support and feedback in the classroom. One teacher explained the value of the classroom coach: "*…You are in a real environment, going by the fly, there is a plan set and you watch how someone else deviates from that or alters that or finds a way to make a connection for that kid or two so you get to see a real live situation instead of just talking about what could happen or what might happen*." Other teachers describe their coach's involvement differently, where the coach observed the teacher in the classroom and then offered feedback. According to one of these teachers, the coach, "*shot me an email within the next couple of days after observing and just made a little comment about what she saw and something that I could…have done differently*."

Along with classroom coaching, teachers noted the workshops provided valuable, relevant information. It also appears that project leadership was highly responsive to teacher recommendations from last year. As one teacher described, "*I think this year, they were more focused on certain content areas and that was nice. And, grade levels were separated and that was very beneficial*. Another added, "*It made it easier to take what you learned there and apply it to your classroom whereas before, sometimes they would be talking about things in seventh or eighth grade and you know, in third grade, I couldn't even water it down. It was more applicable*." While the number of workshop days and their spacing during the school year differed for the groups of teachers, they generally preferred their own particular arrangement. Many teachers noted that they were concerned about the time spent out of the classroom, but feel the sacrifice is worthwhile because the professional development has been of high quality.

In response to an inquiry about Rio Grande STEM faculty observing them in their classrooms, some teachers felt nervous because they are "higher education people." Others felt their presence was distracting for students since the university faculty members were not familiar to them. Some teachers suggested STEM faculty teach students in classrooms with the teachers present to increase content knowledge and help teachers with ideas for classroom management while reducing the need for substitute teachers.

Overall, teachers viewed the math professional development as beneficial. Most noted that they would like to see the project continue next year in a similar manner. Teachers appreciated the opportunities for collaboration and planning with other math teachers, which seldom occurs outside of this professional development. Recommendations from teachers for improving the program included

- additional time for collaboration and planning,
- alternating workshops and classroom coaching monthly so there are more opportunities for reflection and sharing of lessons, and
- field trips for students to apply mathematics concepts.

Focus groups were also conducted with teachers in the science program, and three of four coaches for the program were interviewed. The following summary provides an overview of

teachers' and coaches' perceptions of the science professional development. Similar to the participants in the math program, those who took part in the science professional development found the workshops and classroom coaching helped increase their knowledge of content and teaching methodology: *"I think it's beneficial for us to have more exposure to the content, and understanding it on a higher level and then being given examples of how to bring it down to the level of our students so that they could understand it.*" A teacher also said, "*They* [students] *know a lot more than we do. We know a lot without knowing enough about a lot of things. Each of us has a specialty. I admit science is my weakness. When we have a workshop, it makes me feel more comfortable*." Another described this confidence, "*I also found it helpful, I am from elementary and I was told to teach* [middle school] *science. This has given me many resources. I can actually go in and teach it now*."

Many teachers felt encouraged and excited about teaching science. One teacher shared that through the project, he/she was helped in "*… understanding the standards and what they want from you. They're* [students] *learning more because I'm understanding the standards more*." As a coach explained, "*It is hard to understand but the teachers, many of them are still not familiar with their state indicators... There was a lot of guidance on those things, especially for teachers who were new to teaching science*."

Science teachers are also very satisfied with the project's coaches. Coaches were often described as supportive, knowledgeable about content, experienced in the classroom and accessible. "*She does a lot of the research as far as planning and coming up with fresh ideas, more motivating ideas. We don't have time sometimes to develop a really in-depth lesson. It's nice to have a resource person that has a lot of the lessons put together, or can come in and model a nice lesson.*" Another teacher described his/her coach less as a resource person but more as a model, "*She would teach a lesson, or model, something that was new and then we would teach it the second half of the day to our second group*." One teacher described a difference in his/her coach's strategies compared to last year, "*… this year, she modeled more for us to kind of make us more independent and teach the lesson the second time with her assistance instead of each of us assisting her*." The coaches' feedback was also valued, as one teacher noted, "*Unfortunately, I did an activity that wasn't in my standards and she did email me… and*

said I know that this is in your textbooks, [teacher's name], *but this is not in your standards. I'm glad she pointed that out to me*."

Along with classroom coaching, science teachers noted the workshops provided valuable, relevant information. "*I felt very comfortable asking questions in that situation, because there were some things that I wasn't sure about. So, I felt like that helped me to understand better, doing it as a group*." While science teachers in the group with one workshop day praised the experience, they would have liked more than one workshop day. One suggestion was to have workshop days throughout the school year, such as once at the beginning of each quarter and to have the content correlated with the indicators for the quarter. One teacher who participated in both math and science workshops this year described, "*that was an issue with some of the OMAP stuff: we learned it and the kids were not conceptually ready yet and it was hard for us to get organized.*" Similarly, while most middle school teachers and coaches understood it was difficult to get a trainer, some would have liked to have the physical science workshop earlier in the school year so ideas could have been incorporated before the spring achievement testing.

Most science teachers felt the content and activities presented were related to their indicators. However, there were some teachers who felt information presented was at a higher level and not directly tied to what they need to know for their own indicators. Similar to the math teachers, teachers appreciated the collaboration within their district and grade levels. As one teacher noted, "*It is like our own professional learning community*." Teachers participating in joint workshops with other districts would prefer to work within their own district. They described the comfort of working with familiar people and how "*the discussion is more fluent, it just flows more freely*." Coaches preferred this year's arrangement where they attended training with the teachers, as one explained, "W*e all got to do it at the same time and therefore there were not any discrepancies and… that allowed us to spend more time in the classroom with the teachers*."

Those science teachers who discussed STEM faculty indicated a more positive response to their assistance than they did in the prior year. There was, however, one teacher who described feeling nervous when STEM faculty observed in the classroom because he/she has a much higher level of content knowledge. As mentioned above, some felt the content and activities presented

during the workshops "*went a lot deeper or more than it needed*." Other teachers had a different perspective, "*Dr. White was there to explain to us a little more in-depth about things that were going on. Not that he expected us to teach our children this, but so we understood it.*" Another teacher praised the STEM faculty and recommended additional contact with them next year. Coaches were also positive about STEM faculty involvement this year. One described, "*I think we had more contact this year with our STEM faculty. I think the teachers received more content knowledge that way*." Another coach felt supported as exemplified by the following statement, "*The STEM faculty were wonderful and if a teacher had a question that I could not answer, sometimes we would email* [them] *and* [they] *would get back to us with the answer*."

Additional suggestions for the future of the science professional development included:

- Actual or virtual field trip to URG or have STEM faculty travel to schools,
- More classroom management instruction or information on how to pace the year while covering standards before OAT testing,
- Earth science content and activities next year,
- Have URG education students with science specialization implement activities with elementary school students, and
- Lab safety demonstrations as teachers have some equipment they have never used or been trained to use.

Impact on Teaching Practices

The primary evaluation question regarding teaching practices is as follows:

2) Do teachers who receive professional development implement new ideas and skills into their classrooms?

Instructional Practices Science

The Surveys of Enacted Curriculum Teacher Instructional Practices instrument was completed as a pre- and post-test by both the math and the science teachers. Forty-five science teachers' pre- and post-test instruments were matched by individual identifier. The data were analyzed by question with a paired samples t-test. Most of the questions had some change from pre to post, indicating the teachers were altering their teaching methods. Some questions had a statistically significant ($p<.05$) change from pre-test to post-test and are included below (Table 6).

Table 6: Science Teachers' Instructional Practices Pre to Post Change					
Question	**Response Scale**				
In a typical week, about how often do you do the following in your science instruction?	**Never (1)**	**Rarely (2)**	**Sometimes (3)**	**Often (4)**	**All or almost all the time (5)**
Analysis	**Mean Pre**	**Mean Post**	**Change**	**Significant**	
Require students to supply evidence to support their claims.	3.6	3.9	0.29	Yes	
Ask students to discuss alternative conclusions based on evidence.	3.2	3.6	0.32	Yes	
Engage the whole class in discussions based on the science content standards.	3.8	4.2	0.31	Yes	
Ask students to explain concepts to one another.	3.2	3.5	0.32	Yes	
Differentiate classroom instruction to meet students learning needs in sciences.	3.6	4.0	0.33	Yes	
Allow students to work at their own pace.	3.4	3.8	0.34	Yes	
Preparedness In the right section, please indicate how PREPARED you feel to do each one.	**Not Adequately Prepared (1)**	**Somewhat Prepared (2)**	**Fairly Well Prepared (3)**	**Very Well Prepared (4)**	
Analysis	**Mean Pre**	**Mean Post**	**Change**	**Significant**	
Provide students with concrete experience before abstract concepts.	2.5	2.8	0.26	Yes	

Instructional Practices Math

Seventy math teachers' pre- and post-test instruments were matched by individual identifier. The data were analyzed by question with a paired samples t-test. Most of the questions had some change from pre to post, indicating the teachers were altering their teaching methods. Some questions had a statistically significant ($p<.05$) change in the desired direction, from pre-test to post-test and are included below (Table 7).

Table 7: Mathematics Instructional Practices Pre to Post Change				
When students work on mathematics exercises, problems, investigations or tasks, how much time do they:	**Mean Pre**	**Mean Post**	**Change**	**Significant**
Make estimates, predictions or hypotheses.	3.43	3.61	0.18	Yes
For the items below, indicate how well prepared you are to:	**Not Well Prepared (1)**	**Somewhat Prepared (2)**	**Well Prepared (3)**	**Very Well Prepared (4)**
	Mean Pre	**Mean Post**	**Difference**	**Significant**
Teach mathematics at your assigned level.	3.25	3.41	0.16	Yes
Provide mathematics instruction that meets the Ohio Mathematics Content Standards.	3.33	3.55	0.22	Yes
Teach mathematics with manipulatives, such as counting blocks or geometric shapes.	3.12	3.32	0.20	Yes
Teach classes with students with diverse abilities.	2.58	2.84	0.26	Yes

Classroom Coaching

The Rio Connections coaches worked with teachers in their classrooms or buildings but the amount of in-classroom coaching per participant varied widely. Teachers received between 10 and 67 hours of classroom coaching. The evaluators examined the amount of change in scores from pre-test to post-test by number of coaching hours but found no correlation. The number of coaching hours were not strictly tracked which may account for the lack of change. Further, the number of cases in some analyses became quite small when a large number of variable groups were compared, which may also account for the lack of change. Though the number of hours varied, teachers reported positively about the classroom coaching during the focus groups and highly value the assistance they receive from the coaches.

Classroom Observations

Two teaching observation sessions were documented during the second year of Rio Connections teacher professional development project. A modified Inside the Classroom Observation and Analytic Protocol developed by Horizon Research, was used during the observations. One of the sessions was a math lesson, and one was science lesson. Both observations were conducted by a former teacher/school principal who is very familiar with elementary and secondary education.

The observations revealed substantial variability in regards to preparedness and instruction. One of the observed lessons was rated fair due in part to a number of issues, including a crowded classroom (25 students), no science equipment, and the teacher lacking certification in the subject. Additionally, during the interview, which followed the observation, this teacher noted attending only one day of professional development provided through this project. The second observation was rated good and given a "Level 3: Beginning Stages of Effective Instruction" in the capsule rating of the observation protocol. This lesson included manipulatives, the students were lead through discovery of the answer, and they worked as a class and in small groups. Below is the "The Story of this Lesson", which is a synopsis provided by the observer at the end of the observation protocol.

> This was a lesson teaching the students an item they will see on the upcoming state achievement test. It was almost all process, leading the students through consecutive steps to finding a solution to the given problem. The students did not master the process because it had virtually no meaning to them. Although patterns are important in life and exist all around us, solving for a table such as the one in the activity is never used in real life.

Clearly, there is variability in the amount of professional development provided to the teacher groups, and this may be determined by the districts' ability to provide substitute teachers so that teachers can attend the professional development workshops. Further, there are other constraints within the educational system such as classroom size and teaching in a noncertified subject that a professional development project may not be able or designed to impact but nonetheless are revealed through the observations.

Focus groups with teachers representing the three school districts that took part in the math and science professional development were conducted. In addition, two of the five math coaches and three of the four science coaches were interviewed. As noted above, along with learning math or science content, many teachers said they obtained new ideas related to teaching math or science. One teacher's comments were representative of the views of others: *"I think one of the best things we have learned is that math is not just done one way. I know the way we learned is that math is done one way and you can forget any other way. But now, as long as you are getting the right answers and you can prove how you did it... "* Another made a similar comment, *"I have handed over some responsibility to the students and I am not always trying to lead the*

show." A coach said, "I do think that the skills and the professional development that the teachers in this area are getting… they are getting encouraged and getting the knowledge and development in literacy and science and to teach science in an inquiry-based way."

Coaches observed teachers incorporating activities from the professional development into their classrooms. Many teachers cited specific activities, games or songs they now use. Science teachers often mentioned how they integrated more vocabulary into their classrooms as modeled through the project. Ideas for hands-on activities were particularly useful for participants. As one teacher described, "*I have incorporated a lot of the game activities, which I think is really good for my students too, where it makes a real world connection where they can make those discoveries a little easier on their level*." Another teacher said, "*These were activities that were focused on my indicators, my benchmarks and they were activities that we easily brought together with few materials and stuff that my kids would enjoy doing.*" One coach described the benefits to participating teachers, "*They received valuable lessons for their classrooms. I gave them examples of different presentation methods, ways to address a subject and encourage a student to be active in it. They received new materials.*"

Teachers have incorporated websites and other resources shared by coaches or facilitators during the professional development. As one coach described, teachers are also referring to more informal sources, each other, as resources for new ideas to use in their classrooms, "*I think we have teachers emailing each other much more than before. If a teacher in one building, say seventh grade, runs into a website that has a lot of good materials, they can share it with other seventh grade teachers. The interaction I think was good at lunch time, instead of teachers eating and going their separate ways, they would spend time talking about what they were doing in their classroom, talking about how they could use this or use that*."

Impact on Students

The primary evaluation question toward impact on students is:

3) Do students of participating teachers show an increase in math and/or science achievement as **compared to a similar group of students** in the same district whose teachers did not participate?

The student data is examined overall by grade level since all teachers participated by grade levels across the districts. For example, all third grade math teachers in Wellston City and Gallia

County Local School Districts participated in the math professional development. Because all teachers by grade level participated in the professional development, comparisons between student groups in the same district will not be made.

The percentage of students across the districts who were proficient or above in math and science by grade level for the past three school years, as reported by the Ohio Department of Education, are below (Tables 8 and 9). The 2008 scores represent student data from the first year of the project, with the exception of Vinton County grades three through five whose teachers began the professional development in the 2008/2009 school year. The 2007 data is prior to implementation of any of the professional development and serves as the baseline for all of the districts with the exception of Vinton grades three through five.

The grade levels by district that have an improvement from baseline are highlighted. Nearly two thirds (11 out of 18 grade levels) of the participating districts' test scores showed an increase in the percentage of students rated as proficient or above on the 2009 Ohio Achievement Test in math from 2007 to 2009. Four of the groups had a 10 percent or greater change, and two additional groups were less than one percentage point shy of a ten percent or greater change.

Table 8. Percentage of Students Proficient in Math by Grade and District for 2007 through 2009

	Grade 3			Grade 4			Grade 5		
	2007	2008	2009	2007	2008	2009	2007	2008	2009
Gallia County Local	92.2%	83.3%	88.3%	70.3%	83.2%	84.9%	56.6%	56.8%	66.7%
Vinton County Local	N/A	80.6%	72.5%	N/A	64.7%	82.9%	N/A	55.8%	52.0%
Wellston City	83.6%	85.0%	91.7%	73.2%	67.2%	91.3%	49.2%	40.6%	49.3%
	Grade 6			**Grade 7**			**Grade 8**		
	2007	2008	2009	2007	2008	2009	2007	2008	2009
Gallia County Local	79.8%	77.3%	78.5%	70.2%	82.1%	80.1%	73.7%	79.1%	83.3%
Vinton County Local	69.3%	68.2%	66.1%	69.4%	71.7%	70.2%	72.1%	72.8%	67.3%
Wellston City	63.7%	61.5%	65.2%	65.9%	59.3%	56.5%	64.9%	68.4%	81.5%

In science, five out of the six grade levels show an increase in the percentage of students at or above proficient from the 2007 baseline (Table 9), two of which made a fifteen percent or greater improvement. The grades are highlighted below.

Table 9: Percentage of Students Proficient and Above in Science by Grade and District 2007 through 2009						
	Fifth Grade			Eighth Grade		
District	2007	2008	2009	2007	2008	2009
Gallia County Local	73.7%	66.3%	79.0%	64.7%	65.8%	80.5%
Vinton County Local	64.5%	63.4%	67.2%	54.2%	54.9%	53.2%
Wellston City	45.4%	50.5%	62.5%	56.5%	47.4%	68.1%

The number of students proficient or above in math and science by grade level for the past year, as reported by the Ohio Department of Education, are listed below (Tables 10 and 11).

Table 10: Number of Students Tested and Number Proficient or Above and Not Proficient By District in Science 2009			
District and Grade	Number Tested	Prof. +	Below Prof.
Gallia 5th	187	148	39
Gallia 8th	175	141	34
Wellston 5th	145	91	54
Wellston 8th	116	79	37
Vinton 5th	181	122	59
Vinton 8th	172	92	80
Totals	976	672	304

Table 11. Number of Students Tested and Rates of Proficient or Above and Not Proficient By District in Math 2009			
District and Grade	Number Tested	Prof. & Above	Below Prof.
Gallia 3rd	176	155	21
Gallia 4th	172	146	26
Gallia 5th	187	125	62
Gallia 6th	188	148	40
Gallia 7th	170	136	34
Gallia 8th	175	146	29
Wellston 3rd	111	102	9
Wellston 4th	122	111	11
Wellston 5th	145	72	73
Wellston 6th	97	63	34

Wellston 7th	134	76	58
Wellston 8th	115	94	21
Vinton 3rd	177	128	49
Vinton 4th	166	138	28
Vinton 5th	181	94	87
Vinton 6th	181	120	61
Vinton 7th	174	122	52
Vinton 8th	172	116	56
Totals	2843	2089	754

Evaluators also gathered qualitative findings regarding the benefits to students from the professional development the teachers received. Many teachers described how the professional development offered through the project made them excited to teach math or science. As one teacher explained, "*I know when I go to a workshop and come back, my kids can tell I have been inspired and I am a little bit more excited*." Math teachers described the different teaching styles and approaches to problems, which were "*more understanding of the students' perspective*." One teacher explained, "*I think the way that the problems have been presented, it has allowed me to see problems from someone else's perspective, maybe how a child would think more and this enables me to better reach them*." Another said, "*I think that is one of the most important things I have gotten out of this professional development, to take our time, make sure that everybody, all the children, have something to offer to this problem-solving discussion…that it was okay to delve deeper into it and make sure they are mastering it or understanding something fully*."

When asked about the benefits for students from the professional development, many described the benefits of hands-on activities for students. According to one teacher, "*Hopefully they are getting more mastery for next year and they are carrying it on and they will remember. Maybe those memorable days will trigger that… They need that connection.*" According to another teacher about students, "*Even some on the test, you can see them when they like* [made arm gestures that go along with an educational song.] *You can see them thinking and processing it all.*" One teacher noted, "*I think the hands on activities allow for more student interaction… They can work together to find the answer*." Another described the longer-term benefits to students, "*I think we are seeing some of that, that they are going to become better problem*

solvers regardless if it is in math or whatever area. They are not afraid to take a chance, to explore the possibilities and not be afraid to express themselves."

Those teachers whose students attended the project-sponsored field trip to URG to participate in biology, chemistry, physics, astronomy and anatomy activities raved about the experience. The hands-on activities were appealing to the students and they felt a connection to the university. As a coach described, "*They were so impressed. I think a lot of them maybe didn't think they could go to college, maybe got a little more encouragement and got to see what it was really like and that's a college that's not that far from where they live*." A teacher also touched on this increased interest, "*We had a lot of students who decided they wanted to go to college who didn't want to before."*

CONCLUSION

Most of the evaluation findings point to another, generally successful year for the Rio Connections project. There are good indications of teacher and student impact. Several key findings will be reiterated to demonstrate this. First, a number of teachers showed an improvement in content knowledge in math or science. For example, 32 of the math teachers scores improved (out of 68 matched), and 18 had a 10 percent or greater improvement. Also, 44 of the science teachers' scores improved (out of 66 matched) (science figures includes some duplicates because teachers completed two sets of pre- and post-tests). Second, the instructional practices pre- to post-tests indicate change in teaching methods across a number of questions and that teachers feel better prepared. Third, the majority of teachers and coaches report they believe the project has made a difference in teacher readiness. Fourth, qualitative data from teachers and coaches indicate that most teachers highly value the professional development and believe the project is making a difference. Fifth, and perhaps most significantly, there appears to be a trend of improvement in the percentage of students proficient or above on the OAT in math but more so in science. For example, 11 of the 18 student groups' OAT scores in math improved from one or two years prior, some of which improved by ten percent or more and 5 out of 6 student science groups showed improvement. Further, from 2008 to 2009, four out of the six student groups' had between a 10 and 15 percent increase in the percentage of students at or above the proficiency cutoff in science. Student test scores are by far the best indication that the project has had an impact.

All efforts have been made by the project staff to implement a math science partnership project that has an impact on teacher knowledge and student learning. The staff members have worked hard to address recommendations made in the prior year in order to improve the project. While it has been a challenge to gather comparison group data, such studies require substantial resources to bring to fruition.