AURORA UNIVERSITY

Evaluation Report

Middle and Secondary Mathematics Program with Science Connections

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2009-2010 Academic Year

Introduction

The Aurora University Middle and Secondary Math Program with Science Connections used a one-group, mixed-method evaluation, combining qualitative and quantitative elements. It focused on the five outcome areas defined by the Illinois State Board of Education (ISBE): (1) Quality of Professional Development, (2) Change in Teacher Content Knowledge, (3) Change in Instructional Practices, (4) Student Achievement, and (5) Sustained Administrative Support. The logic model on which the evaluation is based appears in Figure 1. The model reflects the program's goal to produce high-performing, highly-qualified mathematics teachers through high-quality professional development.

Quality of Professional Development: Three elements measured the Quality of Professional Development, the quantitative course evaluations that the teacher-participants completed at the end of each Aurora University course, the qualitative open-ended evaluations, also completed at the end of each course, and an early-summer focus group attended by 18 of the 26 participants.

Change in Teacher Content Knowledge: At the beginning of the program, the teacher-participants had taken the Diagnostic Mathematics pre-tests described below. During 2009-10, the course instructor administered the Probability and Statistics post-test at the end of the Statistics, Probability and Educational Research course and the Geometry and Measurement post-test at the end of the Understanding and Teaching Geometry. These scores provided one source of evidence of gain in content knowledge. Course grades provided a second source. In addition, classroom observations of teacher-participants offered a third source of evidence of content knowledge; observers used the Reformed Teacher Observation Protocol (RTOP).

Change in Instructional Practices: The teacher-participants' instructional-practice combination log and journal, their self-reported reflections on their practice, and observations of most of the teacher participants who taught mathematics (17 of 20) comprise the 2010 evidence pool. The teacher-participants also took the Survey of Enacted Curriculum (SEC) at the beginning of the program and retook the SEC this academic year.

Student Achievement: The evaluation examines two quantitative measures, (1) pre- and post-test student scores on subject-specific tests and (2) Illinois Standardized Achievement Test (ISAT), through middle school, and Prairie State Achievement Examination (PSAE) scores, for eleventh graders. The subject-specific tests are standardized instruments developed by the University of California/California State Mathematics Diagnostic Testing Project (MDTP).

Sustained Administrative Support: The evaluator regularly attended partnership meetings, and had access to program administrative documents. This evaluation is based on a Spring, 2010, focus groups with the with the administrative team overseeing all Aurora University IMSP grants, on observations at partnership meetings, program documents, and on interviews with the principal investigator and the team leader.

See Table 1 for a summary of measures used for each goal. Also listed are more detailed descriptions of the individual instruments. The logic model on which the evaluation is based appears in Figure 1. The model reflects the program's goal to produce high-performing, highly-qualified mathematics teachers through high-quality professional development.

Table 1: Middle and Secondary School Mathematics with Science Connections Goals and Measures 2009-2010

<u>Quantitative Measures</u>

<u>Course Evaluation Data</u>
At the end of each course, the participants complete a course evaluation, addressing issues of course content, pedagogy, and quality of instruction. In 2009-2010,the university discontinued the use of the Student Instructional Report SIRII instrument in favor of a university-wide assessment.

<u>Course grades</u>
Instructors assign a grade to each teacher-participant for each course, based on performance and demonstrated competency in the subject matter.

<u>Survey of Enacted Curriculum (SEC)</u>
Each teacher-participant took the *SEC* prior to beginning their program. In addition, each completes the *SEC* early in the fall. The surveys provide insight into the degree to which participants are implementing what they have learned in the degree program to inform their pedagogy. The SEC also provide evidence to the state of outside professional development that the teacher-participants received.

Table 1 Continued: Middle and Secondary School Mathematics with Science Connections Goals and Measures 2009-2010

Center for Research in Mathematics and Science Teacher Development (CRMSTD) Diagnostic Mathematics Tests for Middle School Teachers (DTAMS)
CRMSTD is housed in the Department of Teaching and Learning in the College of Education and Human Development at the University of Louisville. The center developed diagnostic mathematics assessments to help researchers discover content knowledge of middle school math teachers and to make the teachers aware of areas in which they need more development. At the beginning of the program, teacher participants took pre-tests in Number/Computation, Geometry/Measurement, Probability/Statistics, and Algebraic Ideas. In 2009-2010 the teacher-participants took post-tests in Probability and Statistics and in Geometry and Measurement.

Illinois Standards Achievement Test (ISAT) and Prairie State Achievement Examination (PSAE)
Program evaluation staff gathered and analyzed both aggregate and individual student data from teacher-participants' school districts in 2009-10. Since teacher-participants' students attended grade school, middle school, and high school, evaluators analyzed both ISAT and PSAE examination data.

Reformed Teaching Observation Protocol (RTOP)
The Reformed Teaching Observation Protocol is an instrument that allows the classroom observer to assign scores to different aspects of reformed teaching observed in the mathematics classroom. An observer used the instrument in 2009-10 with 17 of the 20 teachers who instruct in mathematics classrooms.

Qualitative Measures

Course/learning experience evaluations by teacher-participants
In addition to responding to the quantitative course evaluation mentioned above, each teacher-participant evaluated each of their learning experiences by answering open-ended survey questions regarding their courses. Those evaluations were used in aggregate to provide insight into program efficacy.

Participant Reflective Log/Journal
Teacher-participants kept a reflective log/journal. There are two columns, to each page: a log where the teacher/participant records regarding the integration of their program learning into their classroom instruction and the results that they see with students. Participants were required to post excerpts from their journal at the end of each course using a form accessed through an online course management system.

Self-Report Reflections
For each math-content class session for the math content courses, the teacher-participants reflected on how they could incorporate the newly-learned techniques into their practice. At the end of the course, the teacher-participants reflected how they added the material.

Focus groups
Program evaluation staff held focus groups with program participants and external partners. Data were analyzed for insight into program sustainability and efficacy.

Reformed Teaching Observation Protocol (RTOP)
The Reformed Teaching Observation Protocol also allowed observers to note short open-ended descriptions of the observed classrooms. These descriptions provided background information regarding instructional practice.

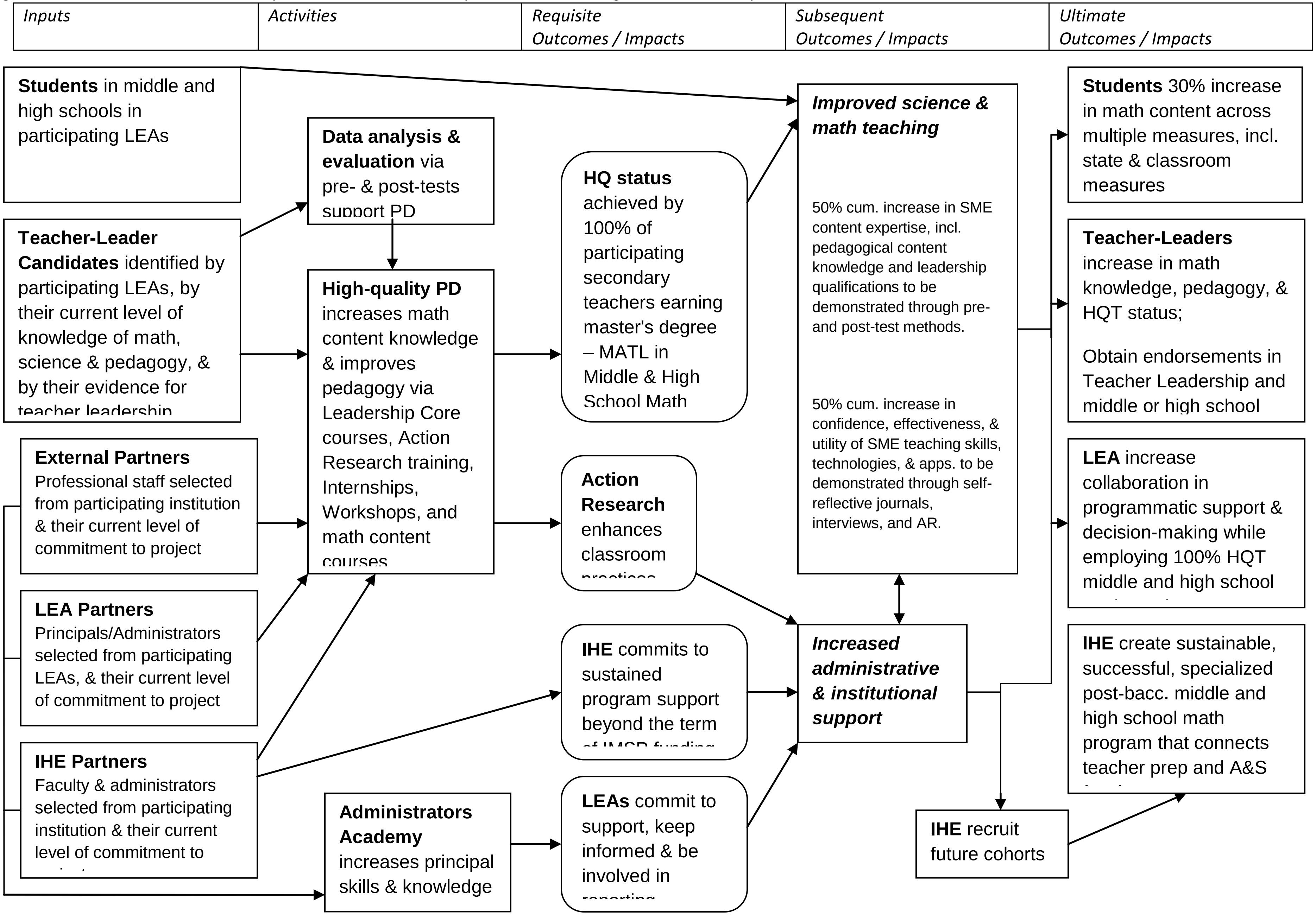
Changes in Teacher-Participant Content Knowledge

Before they began the program, the teacher-participants took content tests developed by The Center for Research in Mathematics and Science Teacher Development (CRMSTD) located in the University of Louisville's College of Education. These are Diagnostic Mathematics Tests for Middle School Teachers (DTAMS). The Center developed diagnostic mathematics assessments to help researchers discover content knowledge of middle school math teachers and to make the teachers aware of areas in which they need more development. At the beginning of the program, teacher-participants took DTAMS pre-tests in Number/Computation, Geometry/Measurement, Probability/Statistics, and Algebraic Ideas. Since there are no DTAMS tests in calculus, the teachers also took a calculus pre-test developed by the University of California/California State University's Diagnostic Mathematics Testing Project (DMTP).

During the 2009-2010 year the teacher-participants took mathematics content tests in Statistics, Probability and Educational Research and in Understanding and Teaching Geometry. The following data sources provide evidence of the teacher-participants' content knowledge: (a) their course grades, (b) their pre and post-test scores on the Diagnostic Mathematics Tests for Middle School Teachers (DTAMS), and (c) observations of their classrooms, where they implemented content. The teacher-participants' log/journals and end of course reflections (d) also provide some evidence of their mathematics content mastery.

(a) In terms of course grades, the mean grade for the 26 students who took Statistics, Probability, and Educational Research was a 3.81 on a 4-point scale, with a standard deviation of .491. Twenty-five students completed Understanding and Teaching Geometry. There the mean grade was 2.64, with a standard deviation of 1.551. Twenty-three students took Technology in Mathematics Classrooms. For the technology course, the mean grade was 3.78, with a standard deviation of .422. Table 2 illustrates the grades in the three mathematics content courses.

Figure. 1: IMSP – Aurora University Middle and Secondary Mathematics Logic Model for Implementation Years 2008-2011



	Final Grade			
Course	4.0 (A)	3.0 (B)	2.0 (C)	0 (F)
Statistics, Probability, and Educational Research	84.6% (22)	11.5% (3)	3.8% (1)	
Understanding and Teaching Geometry	42.3% (11)	15.4% (4)	19.2% (5)	19.2% (5)
Technology in Mathematics Classrooms	78.3% (18)	21.7% (4)		

Table 2: Teacher-Participants' Final Grades by Math Content Course, 2009-2010

The teacher-participants achieved their highest grades in the technology course, where all got As and Bs, their second highest grades in statistics and probability, and their lowest grades in geometry. From the students' reflections and log/journals for other sections of this evaluation and from speaking to the course instructor, the evaluator discovered that a number of students had poor geometry preparation: at least one teacher-participant had never taken a course in geometry before this course, even in high school.

(b) Regarding the DTAMs tests: There was a statistically significant gain between the teacher-participants geometry pre and post tests $t(19) = 4.53$, $p < .001$. The effect size is .7, with the teacher-participants improving seven-tenths of a standard deviation in their geometry scores after having completed their geometry course.

For probability and statistics, the opposite happened. The teacher-participants had significantly higher scores on the pre-tests than the post-tests $t(25) = -4.78$, $p < .001$. The effect size was -.56, with teacher participants losing half a standard deviation in their scores between the pre and post-tests. There is a chance that a mix-up occurred in the tests. When the university received the statistics test results from the University of Louisville, both sets of results were labeled "pre-tests." The evaluator used the test dates recorded on the reports to determine which set of tests had been given first. A call to the University of Louisville about the score decline revealed that sometimes when the post-tests are given at the end of a course and participants are fatigued, score declines may occur.

(c) Regarding observations, two professors were able to observe 17 of the 20 teacher-participants who teach mathematics in middle or secondary school. From RTOP observations, the evaluator computed a Propositional Pedagogic Knowledge index. The five items addressed whether the teacher-participants' lessons showed a solid grasp of fundamental concepts and subject matter, reflected abstractions, and related mathematics to other disciplines. Scores could range from 0 (five items never occurred) to 20 (every item was "very descriptive" of the classroom). Scores ranged from 6 to 17, with a mean of 11.6 and a standard deviation of 3.53. Table 3 illustrates the 5 items that made up the Propositional Knowledge index and the mean scores and standard deviations for each item. Nearly all teacher-participants showed a solid grasp of content (m=3.53). The least frequent feature across the 17 classrooms on the day of the observation was making connections to other disciplines and the real world (m=1.53).

	Involved Fundamental Concepts	Promoted Conceptual Understanding	Teacher Solid Content Grasp	Abstractions Encouraged	Connections to Disciplines and World
n	17	17	17	17	17
Mean	2.41	2.24	3.53	1.94	1.53
Std. Deviation	1.228	1.033	.624	1.144	1.179

Table 3: Five elements of Propositional Knowledge Content Scored in the Reformed Teacher Observation Protocol (RTOP)

A number of sources provided evidence on how the teacher-participants implemented changes in their instructional practice. Besides the classroom observations, the teacher-participants' reflections and their log/journals on instructional practice added other evidence. Content information from log/journals and reflections (d) is reported below.

Changes in Instructional Practice

According to their log/journals and reflections, in implementation Year 2, the teacher-participants used technology in their classrooms to a much greater extent. Many felt more confident teaching difficult topics, topics that they had not been able to tackle before participating in the program. For example, a number of teachers had not understood how to teach children the logic of geometric proofs until they completed their geometry content class. The use of more hands-on discovery with students represented another change. Noted one teacher-participant, "I felt like more of a facilitator than a teacher because the students discovered most of the new material through hands-on activities used throughout the lessons. ..My students were extremely lucky this year to be a part of my new and improved grasp of geometric concepts."

By Year 2, some teacher-participants integrated the different areas of mathematics for their students, for example relationships between algebra and geometry. Others integrated mathematics into different subjects. For example, a clever earth science teacher used Geometer's Sketchpad to teach students about the illusion of the flatness of the earth. In addition, the probability and statistics course helped a number of teacher-participants to analyze assessments in more detail so that they understood what they needed to re-teach. Some reconsidered their grading practices. A teacher-participant stated, "I am getting a better correlation of the skills that a student has learned to the grade that they earn in math." A few introduced students to data analysis using Excel. Teacher-participants felt more confident relying on research to inform their practice. Some teachers began to assume a leadership role, helping colleagues with the mathematics teaching issues they faced. Also, as the math content grew more challenging, a few teacher-participants discovered a deeper understanding of the need to differentiate instruction and how to do so effectively.

Below is a summary of changes that the teacher-participants reported making in their practices:

*Increased use of technology (geometric sketchpad, geoboards, SMART boards, clickers, graphing calculators, Excel)

*More hands-on student discovery

*Integrating different areas of math for students (e.g. algebra and geometry) or integrating math with other subjects

*Making classes more challenging for students

*Increased confidence teaching difficult concepts

*Improved assessment of students

*Using more research to inform practice

*Assuming leadership to help colleagues with mathematical issues

*More reflective practice

*Introducing students to data analysis

*Increased understanding of how to differentiate instruction

As noted above, observers used the RTOP tool when conducting observations of 17 teachers. The tool prompts observations across five dimensions: Lesson Design and Implementation, Content – Propositional Pedagogic Knowledge, Content – Procedural Pedagogic Knowledge, Classroom Culture – Communicative Interactions, and Classroom Culture – Student/Teacher Relationships. Table 4 summarizes the scale scores across the five dimensions; scores could range from a low of 0 to a high of 20. Teachers scored highest on Student/Teacher Relationships and Propositional Pedagogic Knowledge with means of 13.5 and 11.6 respectively and standard deviations of 2.9 and 3.5. They scored lowest in Procedural Pedagogic Knowledge, with a mean of 9.0 and a standard deviation of 3.6.

	Lesson Design and Implementation	Content--Propositional Pedagogic Knowledge	Content--Procedural Pedagogic Knowledge	Classroom Culture – Communicative Interactions	Classroom Culture – Student/Teacher Relationships
n	16	17	17	17	17
Mean	10.25	11.64	9.00	10.29	13.50
Std. Deviation	3.71	3.53	3.62	3.31	2.90

Table 4: Mean Index Scores across Five Reformed Teacher Observation Protocol (RTOP) Dimensions

Changes in Student Achievement

This evaluation presents evidence regarding student achievement from three sources (1) pre- and post-test student scores on students' subject-specific tests (2) the standardized Illinois Standardized Achievement Test (ISAT), through middle school or Prairie State Achievement Examination (PSAE) scores, for eleventh graders, and (3) observations of teachers' classrooms.

Subject-Specific Tests

To augment their students' achievement information reported on the state achievement tests, teacher-participants administered subject-specific pre and post mathematics achievement tests to their students at the beginning and the end of the 2009-2010 school year. Those teachers who had different students in fall and spring semesters, gave student tests at the beginning and end of the spring semester.

As in Year 1, each teacher selected an appropriate test developed by the California State University/University of California Mathematics Diagnostic Testing Project. The evaluator chose these tests for project use because (1) they cover a wide variety of mathematical levels; (2) the university teams that developed the tests extensively field-tested them; (3) the tests have been used successfully with a wide variety of children in a number of states both for diagnostic testing, and for pre- and post-testing in high-needs schools; and (4) the tests are available in both English and Spanish.

Tests are available to cover the following levels of mathematics:

- Pre-Algebra Readiness
- Algebra Readiness
- Elementary Algebra Diagnostic
- Geometry Readiness
- Second Year Algebra Readiness
- Mathematical Analysis Readiness/Intermediate Algebra Diagnostic
- Calculus Readiness/Pre-calculus Diagnostic
- Beginning Calculus Readiness

Most of the teacher-participants instructing students in mathematics at the pre-Algebra level or above (15 out of 20) pre and post-tested one class of students. (Six excluded teachers either taught elementary school or non-math subjects. One teacher dropped from the program in the late spring, before giving her students the post-test. Four teachers did not return both pre and post-tests.) Teachers selected a class to test that was nearest in content to that they currently studied in their program. The total number of students tested was 347; 281students took both the pre and post- test.

Table 5 indicates the types of tests that the teachers administered to students.

	Number of Teachers Administering Pre and Post Tests	**Percentage and Number of Students Taking at Least One Administration of the Test**
Prealgebra Readiness	4	27.4 (95)
Algebra Readiness	5	30.8 (107)
Geometry Readiness	2	15.9 (55)
Second Year Algebra Readiness	1	6.1 (21)
Calculus Readiness	3	19.9 (69)
Total	15	100.1 (347)

Table 4: Types of Mathematics Achievement Tests Administered to Students by Number of Teacher Participants Administering Tests and Proportion of Students Taking Tests

The evaluator used SPSS Version 17 to analyze the data. Using a paired-samples *t* test, there was a statistically significant difference in the pre and post-test results for students across all of the pre and post-tests, (t = 6.205, $p < .001$). The correlation between the students' performance on pre and post-tests was moderately high (r=.65, $p < .001$). The pre-test mean was 17.3, and the late-spring post-test mean was 20.2. The effect size (*d*) is .31. On average, the students advanced a third of a standard deviation from their early-spring test scores to their late-spring test scores.

Table 5 reports the differences in the test scores by type of test. Students made statistically significant gains across all categories of subject matter. Although those taking the shorter algebra readiness test appeared to grow most over the tests (*d* = 2.6), there were only 11 students taking that test. The calculus-readiness group grew over a standard deviation (*d* = 1.1), but there was little correlation between the students' pre and post-tests. The most reliable growth is probably that in geometry readiness,

Test Type and Number of Questions	**Pretest Posttest Mean**	**Pretest Posttest *sd***	***n***	***t***	**Significance Level *(p)***	**Effect Size (*d*)**
Prealgebra Readiness (40)	17.12 20.32	9.821 10.477	84	6.113	<.001	.315
Algebra Readiness (45)	6.18 13.91	2.401 3.448	11	8.441	<.001	2.60
Algebra Readiness (50)	21.76 25.13	8.394 8.838	67	3.503	.001	.391
Geometry Readiness (45)	14.26 21.66	7.692 7.680	55	8.517	<.001	.885
Second Year Algebra Readiness (45)	8.74 10.43	2.491 2.481	15	1.763	.10	.680
Calculus Readiness (40)	11.55 17.51	4.179 6.245	49	5.427	<.001	1.122

Table 5: Pre and Posttest Student Results by Test Type

with the students gaining nearly a standard deviation (*d* = .88) and a correlation of .72 between the pre and post-tests.

State Achievement Tests

Table 6 reports the proportion of students at different levels who met state standards in mathematics in the spring of 2010. Children in middle and elementary school took the Illinois Standardized Achievement Test (ISAT), while eleventh graders took the Prairie State Achievement Examination (PSAE). The achievement level of children in middle school and elementary school was higher than that of children in high school. At middle school level and below, 81.2% of children met or exceeded state standards. By high school, the proportion fell to 58.0% of the eleventh graders tested. However, in total more than three-fourths (75.9%) of the tested students met or exceeded state standards.

	Achievement Level in Mathematics			
Student Grade Level	**Warning**	**Below**	**Meets**	**Exceeds**
Elementary or Middle School	.0 (4)	18.3 (183)	61.5 (614)	19.8 (198)
High School	3.7 (11)	38.2 (114)	55.3 (165)	2.7 (8)
Total	1.2 (15)	22.9 (297)	60.1 (779)	15.9 (206)

Table 6: Student Achievement Level in Mathematics by Student Grade Level, Spring 2010

Observations of Classrooms

Four observational criteria addressed student performance: The degree to which the students (1) used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena; (2) made predictions, estimations and/or hypotheses and devised means for testing them; (3) were actively engaged in thought-provoking activity that often involved the critical assessment of procedures; and (4) were reflective about their learning. Scores on each measure could range from 0 (never occurred) to 4 (very descriptive of the classroom). When an index is constructed that combines all four elements, scores could range from 0 to 16. The mean across the 17 observed classrooms is 6.88, with a standard deviation of 3.02. Mean scores on individual items range from a 2.29 on active engagement in thought-provoking activity, to 2.18 for using a variety of means, to 1.29 on making predictions, estimation, and hypotheses, and a 1.12 on being reflective.

Quality of Professional Development

To discover the teacher-participants' views of program quality during the implementation year, the evaluator conducted a focus group with 20 teacher-participants at the end of the spring session. In addition, teachers evaluated each course with both open and closed-ended surveys.

The focus group revealed a trend that mirrored last year's results. The teacher-participants have suggested that in the future, the group take some classes together—teacher leadership classes, technology classes, and introductory math classes. However, they believe that for the more advanced mathematics content classes, those who majored in math (mostly high school teachers) need to take separate classes from those who had less exposure to college-level mathematics. High school teachers agree that it is helpful for them to understand the preparation their students have had in the lower grades, but they feel they were held back in the content area by teacher-participants with less mathematics preparation. That said, they note that they have helped tutor their classmates; and that experience has been a leadership experience for them.

The teacher-participants stated that the first mathematics content class worked well, partly because they received a good deal of feedback. They particularly enjoyed seeing the different ways in which teacher-participants solved the same problem. For the later content classes, they did not receive as much feedback and share information about how they solved problems. And, for later classes, they spent more time on mathematics content and less time on how to teach mathematics effectively.

The teacher-participants also wanted more time devoted to troubleshooting the issues with which they struggle in their own classrooms. They suggested that adding information about grant-writing would help in order for them to supplement their technology budgets. In addition, they suggested that the best way to articulate between grade levels would be to take one small piece of curriculum and see how it develops across grade levels. Further, they suggested that more time be spent on the pitfalls and strengths of all the resources available to them as teachers. They also suggested that perhaps the probability and statistics course should be delayed until they have collected their action research data.

In terms of positives, the teacher-participants appreciated the coaching they received from a high-school master mathematics teacher. The teacher-participants thought that the master-teacher had a greater awareness of school culture and the issues that they face in the classroom than did their college professors.

Teacher-participants felt grateful to gain a better understanding of the paths their students would take from elementary, to middle, to secondary school. Suggested an elementary teacher, “I’ve actually been able to take that back to my fourth grade team and talk about why we need them to master addition now, why we need them to master multiplication now and just stressing that importance, something simple like that, because I've been able to see the bridge."

Ultimately, teacher-participants felt grateful to be part of the program and understood they were pioneers. Stated one, "I think I can speak for all of us that we're really grateful to be involved, and the idea behind this program is fabulous, and it is just the question of being able to make that idea come to fruition. And everybody knows that that is going to take time and effort, and it is not going to be just wave a magic wand."

In addition to stating their views on courses at a group interview, the teacher-participants also completed written evaluation on the courses they took. At the time of this report, evaluations are available for the fall course, Statistics, Probability, and Educational Research and of the spring course, Understanding and Teaching Geometry. Teacher-participants evaluated Course Design, Course Content, and Instructional Materials on a 5-point scale, ranging from Very Low Quality (1) to Very High Quality (5). Table 7 reports the mean, mode, and standard deviation for each category of the two courses.

For both courses, the most common score is "3" or average in every category. In both cases the teacher-participants rate the content slightly higher than the design and the materials. Scores are similar

	Stat., Prob. & Educational Research			Understanding & Teaching Geometry		
	Design	Content	Materials	Design	Content	Materials
Mean	2.91	3.14	3.00	2.94	3.00	2.65
Mode	3	3	3	3	3	3
Std. Deviation	.750	.774	.756	1.144	1.000	1.169
n	22	22	22	17	17	17

Table 7: Statistics on the Design, Content, and Materials of Statistics, Probability and Educational Research and on Understanding and Teaching Geometry

across the two courses. The lower standard deviation for the Statistics, Probability, and Educational research course indicates slightly higher agreement in opinion. Overall, that course appears to have received slightly higher marks.

The open-ended replies reflect similar opinions to those stated in the focus group. For both classes, the teacher-participants expressed respect for the instructor's knowledge of the subject. They also expressed admiration for certain dispositions. Those in the Probability and Statistics class commented on the instructor's willingness to answer questions and positive attitude toward all students. Some in the Geometry class appreciated the fact that the instructor held everyone accountable.

However, in both classes there was a continued frustration with the combining of teacher-participants who have less background in mathematics with those who have more. In the geometry class, the teacher-participants appreciated the teaching assistant who was a master mathematics teacher at the high school level.

In both classes the teacher-participants requested more emphasis on relating the topic to their lives. In the statistic and probability class, they wanted greater emphasis placed on their own action research projects. In the geometry class, they requested more emphasis on how to teach mathematics and less on the details of mathematics content.

Sustained Administrative Support

The Aurora Partners for Leadership in Teaching consist of Aurora University faculty and administrators, administrators and teachers from the school districts with program participants, the Illinois Mathematics and Science Academy, the Robert Crown Center for Health Education, the SciTech Interactive Museum, and the Packer Foundation Center for Applications Based Learning. This summary is based on a Spring, 2010, focus groups with the administrative team overseeing all Aurora University IMSP grants, on observations at partnership meetings, program documents, and on interviews with the team leaders.

Impact on the Partnership

In Year 2 of program implementation the partners continued to be (1) an engineering firm, (2) a learning center for science and technology, (3) a mathematics and science academy for gifted students, (4) a center for health education, (5) a science museum, (6) six high-needs school districts, and (7) a university. The partnership information reported here results from a focus group held in mid June and attended by all partners.

Partnership Role

In Year 2, the partners viewed themselves as serving a number of roles. Two main functions they saw themselves performing were communication and trouble shooting. For example, in terms of communication, district partners made principals aware of what was happening with their teachers. They communicated to the university ideas about what professional development would have the greatest impact on students in their districts.

Program faculty members communicated to the partnership scheduling issues and classroom problems needing solution; they advised school districts of teacher-participants' concerns. The leader of a health center that deals with school children communicated the needs of teachers and students to her staff and helped teacher-participants see the relationship between health and science and math. Because of the program and the partnership, the center introduced more mathematics into the presentations the staff makes to school children. She noted, "They talk mathematics in the classes all of the time."

In terms of trouble-shooting, the partnership discussed who are ideal candidates for the IMSP program and that some of the current participants need a good deal of support to succeed. Members discussed the continuing challenge of varying academic backgrounds among the teacher-participants. In the future, they suggested separate classes for teachers with different levels of mathematics preparation.

The partnership backed program faculty when they used rigorous grading systems. Also, when some of the teacher-participants wanted to begin their internships a year early, the partners stepped in to try and open slots quickly.

The partners also saw themselves as providing quality control, offering guidance regarding teacher-participant and faculty expectations. They provided checks and balances, monitoring the budget. The principal investigator viewed the partnership group as a group to which she was accountable, fiscally and programmatically.

Impacts

The partners saw a number of impacts from having worked together. The group defined partnership as a way to leverage their strengths. Knowing each other opened new opportunities for them. For example, a number of the partners proposed and received a grant to design a new math-science academy. The academy would involve pre-service as well as certified teachers, parent programs, after-school programs, and a whole “community-wide system.”

The science museum representative emphasized the “strong intangible about the networking with all the associated institutions in the Fox Valley area, in knowing what they’re doing and comparing notes back and forth.” He said that his museum was better able to design exhibits, avoiding duplicating what others are doing.

A district administrator mentioned the district’s gains in the technology area, that teachers had been able to try new technology, helping him allocate his tight budget wisely. “Unless I had seen it [the technology] operate, I would have been very hesitant to make that stretch.”

Another district administrator mentioned that school districts can become isolated communities, and that the partnership created “a much larger community” preventing districts from working in silos. A leader of the math science academy echoed that sentiment, mentioning the greater impact the school could have by collaborating more with the community.

One of the districts involved in the partnership sought an expanded relationship with the university’s College of Education. Before serving together on the administrative team, the two institutions had little interaction. Another district administrator mentioned the satisfaction of seeing teachers in the district grow through the program. “I’ve seen some people stretch, and people around me have said ‘Wow!’.”

Partnership Culture

In Year 2, the partnership continued to mention mutual respect. “When issues are brought to the table, no one is defensive; everybody is in a problem-solving mode, and in a very healthy manner.” With continued respect, trust has grown. “This year because we’ve been more deeply in implementation and content, we’ve also been more open in this group about what the problems are.”

Members also mentioned a joint interest in “improving what we do.” They noted “a shared commitment to the community that we’re working in.” The varied backgrounds of group members made the partnership valuable for brainstorming. Members felt that they could build on each other’s ideas. The group felt that it is consensus-driven, and that collaboration and trust help build consensus.

Issues

A group member wondered whether the program should have shown as much flexibility as it did in altering the internship schedule for a number of participants. By doing so, internships needed to be developed quickly, perhaps affecting the quality of the experience. Another group member expressed the wish of meeting with other university partnerships in the state to discover what they have been doing and what aspects have been most successful.

Conclusions

In conclusion, the Middle and Secondary School Mathematics Program with Science Connections experienced many elements of success in its second year of implementation. Compared to Year 1, a higher proportion of the teacher-participants’ students met or exceeded state guidelines in mathematics, as shown by their state standardized test scores. In Year 1, 74.7% of students taught math by the program’s teacher-participants met or exceeded state guidelines. In Year 2, the proportion rose to 78.1%. As in Year 1, students at all levels showed statistically significant gains in their pre and posttests in content. The gains ranged from a third of a standard deviation to 2.6 standard deviations.

In their log-journals and their end-of-course reflections, many teacher-participants felt more confident in their subject matter. They also expressed a greater understanding of the connections between different areas of mathematics. Some had developed a more thorough understanding of the path their students take as they study mathematics in elementary, middle, and high school—how, for example, geometry is taught to students of different ages.

The observations revealed that the teacher-participants have a solid grip on the content that they teach their students. However, from Year 1 to Year 2, the mathematics content in their courses grew more challenging. While all teacher-participants passed their math content courses in Year 1, some were not successful in one Year 2 math content course, Understanding and Teaching Geometry. It turned out that at least one teacher-participant was taking college-level geometry who had not taken high school geometry.

In the area of partnership, from Year 1 to Year 2, the partners felt they had a better grasp of the program and were able to troubleshoot issues with a deeper understanding. The continued to feel respect and trust in each other. By Year 2, some partners were able to leverage their work with each other for other projects, for example, designing a mathematics and science charter school. Others had used the knowledge they gained through exposure to the program to redesign some of their own programs. The health education center had incorporated more mathematics into their health work with young people.

On the challenge side, in Year 2, it was more difficult to engage the teacher-participants in pre and post-testing their students. In Year 1, the teacher-participants expressed their distaste for giving up two class periods with the students, one to pre-test and one to post-test. In Year 2, motivation seemed to slip; a smaller proportion of teacher-participants turned in both pre and post –tests. Also, as mentioned earlier, some students did not appear to take the post-test seriously.

Also in Year 2, the teacher-participants continued to express frustration with the different mathematical background levels of program members. Those who had majored in mathematics in college sometimes felt the content was not rigorous enough. Those who had a weak mathematics background sometimes found the content too difficult. Both groups hoped that the instructors would spend more time on how to teach mathematics and less on the content itself.

By summer term, the program lost three students. One moved from the area. A high school science teacher dropped out, hoping for a more science-oriented program. And a third teacher-participant had struggled to keep up with the classes.

In sum, from Year 1 to Year 2, strong positive aspects have been increased student achievement and the multiple benefits arising from strong partnership. Lessons learned have been to screen potential participants more carefully or separate participants into more homogeneous groups, continuing the tutoring and help for those with weaker mathematical backgrounds.