Summary of

Aurora University Summer Institute in Physical Science Year 1 (2009) and Year 2 (2010)

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Introduction

Aurora University (AU) and its educational and community partners collaboratively developed and implemented an innovative Summer Institute Program in Physical Science with mathematics connections. The program was designed as a two-week immersion in problem-based learning (PBL) integrated with strong physical science content. The instruction was in content-area curriculum and in action research. This program meets the goals of the Illinois Mathematics and Science Program (IMSP) for improving the teaching of physical science in high needs school districts. The foci of the evaluation are the IMSP project outcomes, which are based on professional development outcomes articulated by the Council of Chief State School Officers. These outcome areas are: (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 two-year Summer Institute was developed to expand teacher-participants' understanding of subject matter in science and enable them the opportunity to gain experiences needed to become school and district-based intellectual leaders in science. As a result of a needs assessment, the two-year program was planned to provide teacher-participants understanding of science content knowledge by focusing on concepts and applications, as well as emphasizing strategies to increase competence in problem solving. The program was also designed to assess and improve individual teaching, and at the same time, incorporate technology to enhance science instruction and understanding.

The 2010 AU Summer Workshop/Institute in Physical Science recently completed the second two week summer workshop in problem-based learning (PBL) integrated with strong mathematics content. Mathematicians, scientists and engineers provided on-site, real world applications of science aligned with the principles of IMSA's PBL model.

COLLABORATIVE PARTNERS INVOLVED IN THE WORKSHOP

The Challenger Learning Center for Science and Technology, Woodstock

The Illinois Mathematics and Science Academy (IMSA), Aurora

The Robert Crown Center for Health Education, Hinsdale

The Packer Foundation Center for Applications Based Learning, Naperville

Fermi, Batavia

Aurora University, Aurora

This report is a summary of both the 2009 and 2010 two-week intensive immersion in problem-based learning (PBL) in science and results of the program thus far.

Participants: Twenty-one teachers from two school districts participated in the program in 2009. Teacher-participants' backgrounds varied in subject and grade level and

included 10 (science), 2 (math), and 9 (other subjects). Twelve teachers participated in the program in 2010. Some 2009 teacher-participants dropped out of the program prior to the 2010 summer workshop and others were added. Again, teacher backgrounds varied in subject and grade level and not all taught science. Of the 12 teachers in the 2010 summer workshop, 6 taught science, and 6 (other subjects). The six other teachers included: 2 elementary teachers, 1 high school special education, 1 middle school special education teacher, 1 middle school careers teacher, and 1 interventions teacher.

Goal of the Summer Institute:

- Increase teacher-participants' content knowledge
- Expand pedagogical knowledge
- Improve student math achievement
- Integrate problem-based learning in math instruction

Workshops included the following topics:

- Introduction to problem-based learning (PBL) and the nature of scientific inquiry
- Mathematics and science applications in aviation
- Mathematics and science applications in student alcohol abuse and student obesity
- Mathematics and science applications in space flight, robotics, and telescopes
- Mathematics content using coursework adapted from Vermont Mathematics Initiative
- Action based research planning
- Problem-based learning
- Inquiry-based learning
- Provide insight into various research developments
- Mathematics and science applications in particle physics
- Instruction in teaching Algebra, Geometry, and Geometer Sketchpad software
- Mathematics and science applications in robotics
- Various technology experiences

Program Design: This program used a one-group pre-test post-test design, with a mixed-method approach representing both qualitative and quantitative components.

Quantitative Data Collection and Findings:

Diagnostic Teacher Assessments in Math and Science (DTAMS) pre/post test:
DTAMS were used to assess teachers' content knowledge in mathematics. DTAMS were given at the beginning and end of the 2009 two week workshop with scores analyzed for increase in content knowledge, and again at the beginning and end of the 2010 summer workshop. The posttest for 2009 was used as the pretest for 2010. The physical science assessments measured three areas: matter, motion and forces, and energy.
Findings:

CCSSO Matrix Outcome B (Changes in Teacher-participant Knowledge)
DTAMS: Cronbach's Alpha was calculated for pre test and post test

Pretest Mean	Pretest SD	Range-low	Range-high	Pretest N	Pretest Missing
14.95	6.2	7	30	21	0
Post Mean	Post SD	Range-low	Range-high	Post N	Post Missing
15.16	4.5	7	23	19	2

Pretest reliability = 0.84 Posttest reliability = 0.7 Pearson = 0.5
*analysis of individual scores indicates that teacher-participants showed slight gains in content knowledge following the two week workshops.

Pretest Mean	Pretest SD	Range-low	Range-high	Pretest N	Pretest Missing
15.16	4.5	7	23	19	2
Post Mean	Post SD	Range-low	Range-high	Post N	Post Missing
13.6	3.2	8	19	12	0

Pretest reliability = 0.7 Posttest reliability = 0.5 Pearson = 0.06

The Diagnostic Teacher Assessments in Mathematics and Science (DTAMS) were used to assess teachers' content knowledge in science. Teacher-participants were tested with a pre and post test at beginning and end of the summer 2009 workshop, and again at the end of the 2010 summer workshop. The posttest for 2009 was used as the pretest for 2010. Results of the DTAMS proved no significant change or improvement for the tested group or as individual teachers. Note that with the change of teacher-participant numbers from 2009-2010, only 9 participants were able to provide a pre and post test. Several teacher-participants did not return for the second year of the workshops so the pre and post tests could only be compared to the teacher-participants who took the DTAMS both years. Of 9 individual teacher-participant scores that tested both in 2009 and 2010, 4 improved their score from pretest to posttest, 4 scored lower on the posttest, and 1 remained the same. Mean for pretest was 15.16 and mean for posttest was 13.16. Specifically, DTAMS results proved that 3 of 9 showed gains in Knowledge Type Declarative Type I, 5 scored the same, and 1 of 9 scores decreased. Regarding Knowledge Type Inquiry, 6 of 9 showed gains, 2 remained the same and 1 score decreased. Of Knowledge Type Schematic, 3 of 9 showed increases, 1 remained the same, and 5 scores decreased. With Knowledge Type Pedagogy, 3 showed gains, 5 remained the same and 1 score decreased. Not all teacher-participants were science teachers, and they were learning content in a relatively short period of time. Post tests were given following a two-week immersion program as opposed to a semester time frame as in other programs. With the change of teacher-participant numbers from 2009-2010, only 9 participants were able to provide a pre and post test. This was a challenge for group score comparisons.

Survey of Enacted Curriculum (SEC): The Survey of Enacted Curriculum (SEC) assessment was given at the beginning of the 2009 workshop and at the beginning of the

2010 workshop for comparison. These data are used to identify changes in practices from year to year among teacher-participants. In the area of Time on Topics, 27 various science topics are listed and length of time teachers spend on each topic. Most remained the same from 2009 to 2010 with the exception of Properties of Matter, which increased from 4% to 17% and Measurement in Science which decreased from 13% (2009) to 7% (2010). In the area of student Content-Cognitive Demand, sub categories include memorization, conducting investigations, communicating understanding, analyzing information, and making or applying connections. Composite results show that memorization/recall increased from 26% (2009) to 46% (2010), and a decrease in conducting investigations (13% decrease). Composite results of communicating understanding show an increase of 21% (2009) to 33% (2010), and a slight decrease in analyzing information 17% (2009) to 12% (2010). Finally, making connections decreased from 18% (2009) to 3% (2010).

Learning Experience Evaluations by Participants: Teacher-participants evaluated their workshop learning experiences through a locally developed instrument addressing course design, content and materials. Brief surveys and open-ended responses provided insight into program efficacy. Evaluations results are provided for both the 2009 summer program and 2010 summer program. Teacher-participants responded to each question with strongly agree, agree, neither agree or disagree, disagree and strongly disagree or N/A.

Findings (Survey):

CCSSO A (Quality of Professional Development Activity) Course evaluations for course design, content, and instructional materials.

2009	Very Low	Low	Average	High	Very High
Course Design	1	1	13	51	34
Course Content	0	2	12	56	30
Instructional Materials	0	3	11	54	32

2010	Very Low	Low	Average	High	Very High
Course Design	0	5	21	55	19
Course Content	1	7	26	50	16
Instructional Materials	0	7	28	44	21

Illinois Standards Achievement Tests (ISAT) and Prairie State Achievement Exam (PSAE): Illinois Standards Achievement Test (ISAT) measures individual student achievement relative to Illinois Learning Standards. ISAT results for the summer

program in science for (2010) report that 58% of fourth graders (n=29) of teacher-participants met or exceeded state expectations, and 82% of seventh graders (n=342) met or exceeded state expectations. A total of 371 students of teacher-participants met or exceeded state expectations. No teacher-participants taught 11th grade science (PSAE). These percentages are encouraging given the fact that the test is limited and cannot be compared as a pre and post test (test only given in grades 4 and 7). The number of students that met or exceeded state expectations is high considering the teacher-participants teach in high needs schools.

ISAT science is only offered to 4th and 7th grade students. Pre and post comparisons cannot be provided.

Reformed Teaching Observation Protocols (RTOP): Reformed Teaching Observation Protocols (RTOP) were conducted between March and May of 2010. University professors observed teacher-participants, looking to gather information on content, lesson design and implication, and classroom culture, for indications of reformed teaching. A typical observation was one class period. Scores ranged from 0 (never occurred) to 4 (very descriptive). Including teacher-participants who did not continue with the 2010 workshop, but did participate through the 2009-2010 school year, N=12. Out of a possible 20 points for Lesson Design and Implementation, 1 scored at least 18 points, 3 scored 15-17 points, and 2 scored between 10 and 14 points. Lesson design included instructional strategies, student engagement, student exploration before formal lesson, and encouraging students to seek alternative modes of problem solving. Out of a possible 40 points for Content, five scored at least 35 points, four scored 30-34, and eight scored 25-29 points. The two main categories for Content were propositional knowledge and procedural knowledge. Classroom Culture was divided into Communicative Interactions and Student/Teacher Relationships. Each had a possible of 20 points. 2 scored at least 35 of the total 40 points, 2 scored 30-34 points, and 3 scored 25-29 points. Communicative Interactions looks closely at students communicating their ideas, and student questions and comments to determine the direction and focus of discourse. 2 scored at least 18- 20 points, and 2 scored 15- 17 points. Observers recorded such comments as "did not encourage student exploration of lesson ideas", "students need to investigate and problem solve before formal presentation", and "did not encourage students to seek alternative modes of investigation". It should be noted that teacher-participants teach in high needs school districts and the districts have a high % of at-risk students.

Qualitative Data Collection and Findings:

Surveys and Interviews of Organizational Leadership: Aurora University and its educational and community partners collaboratively developed a Summer Institute Program in mathematics with science connections. Partners include Illinois Math and Science Program (IMSP), Aurora University, Challenger Learning Center for Science and Technology, Illinois Math and Science Academy (IMSA), Robert Crown Center for Health Education, Packer Education Center, SciTech Interactive Museum, and Fermi Lab. These partners responded to the evaluation questions. Their responses are summarized below:

1. All partners worked well together throughout the development of the math and science project. When surveyed, they were asked for their perceptions about their collaborative efforts. All responses were extremely positive.

2. Partners were then asked to explain what they considered most effective about the development and maintenance of the collaboration process. The partners responded with favorable comments about Aurora University, the organized planning of workshop activities, the strong leadership and coordination of the program, and the availability of a quality contact person when needed.

3. Partners were also asked what could have been done to improve the collaboration process. They felt more time might have been allocated to planning the project. One respondent stated that more time may have allowed him the opportunity to view other partners' curriculum outlines. Two partners stated that the state's time-lines were difficult for planning, and that budget expectations were a hindrance.

4. When asked what was most effective in terms of actual implementation of the workshops the partners responded positively toward holding individual workshops at the partner locations rather than the university. This allowed partners to use their own personal resources which made experiences more "real". Respondents also stated that the "demonstrations" were dynamic, and that partners who attended more than one workshop day found connections among all workers were reinforced.

5. When asked how the workshops could have been more effective the partners responded that more reasonable communication and cooperation with ISBE was needed. They also felt that a more clearly defined, homogeneous group of educators would have provided a personalized program specific to grade levels, and that more cohesion with activities rather than a series of independent activities would have been beneficial.

6. Finally, partners were asked for suggestions for improving the development and implementation of future workshops. Partners felt that mutual planning of workshop content and pedagogy would be helpful. They also stated that a repeat of the same model used in Year One of the program should be considered. In addition, partners suggested that learning experiences that would be relevant to the diverse group of teachers and less of a challenge to the partners/instructors (due to the range and diverse backgrounds) could be developed. Finally, partners stated that more time for planning would be helpful, but they also understand that the time limits were unavoidable due to the timing of approval and budget coordination

Learning Experience Evaluations by Participants: Teacher-participants recorded their workshop experiences using a Professional Development Activity Log (PDAL). These reflections were recorded on an on-line "Moodle" computer program that teachers could access at the end of each day of the workshops. Teacher-participants continued to record their experiences using the Professional Development Activity Logs (PDAL) once a month from September through May using the on-line "Moodle" program through the

university. Teacher-participants logged 93 entries, with entries for teacher-participants ranging from 5 to 10. Detailed teaching lessons, changes in instructional practices, and lessons learned through the summer workshop and implemented in the classroom were noted on the PDALs. Teacher-participants again recorded their experiences each day following the 2010 workshops and will again record their monthly reflections during the 2010-2011 school year.

Reflection Samples: Data was collected through self-reported reflections and answers to survey questions. Open-ended responses of the teacher-participants indicate that the workshops were successful in many respects. One teacher-participant spoke about the potential increase of student knowledge. "Today's information and technology-related activities will reach students and help develop those who learn by 'hands-on'. It is a way to meet the needs of all students." A second teacher-participant commented, "I believe that more hands-on activities for students will increase their understanding." One teacher summed up that particular day with, "I think the activities today will force students to think and predict. As a result, all students will have some success and gain confidence."

With improving student science achievement through technology, some teacher-participants' comments included, "Technology increases engagement and is another way to reach students and support their individual development". Another stated, "I was trying to find ways to incorporate hands-on activities into other content areas as well." Regarding the presentations and sites, one teacher-participant stated "The activities at the various sites were very interesting and engaging. I was happy to have been exposed to a wealth of information from the presenters." And finally, "I really appreciated the time to get expert help on my action research project."

With teacher content knowledge in mind, enthusiastic comments were made by teacher participants regarding an outcome of increased teacher knowledge. "I can organize and understand the systematic approach to Problem Based Learning (PBL) as a result of this workshop." Similarly, "PBL will increase academic achievement, because it will encourage higher-order thinking and engagement". Another stated, "I plan to use the information from today's lesson to develop my action research project." And finally, "Teacher-participants spoke positively about continued coaching in PBL. They felt more prepared to integrate problem-based learning (PBL) in their lessons. Other statements that emerged include, "It was valuable to reflect on our individual PBL's and work to make improvements by asking questions." Another commented, "The PBL last year was extremely effective with engaging students and increasing academic achievement. This year I have a more positive attitude toward PBL", and "having my students participate in PBL will make their learning more authentic and will create a lasting impression of the activity." A final teacher-participant responded, "I love all the PBL stuff, I cannot get enough!"

Continued outcomes of student achievement will be assessed after the school year as teacher-participants implement content, knowledge and skills learned from their participating in the program. Many reflective comments pertained to the ideas learned from the program and how they will be utilized when teaching.

Data collection to follow:

Action Research Project *will continue to be* developed by each teacher-participant. These projects will be demonstrated in the classroom and at Aurora University on June 4, 2011. Key to this project will be indications of program effects on teacher-participants' content knowledge, pedagogical understanding, as well as increased student achievement.

Conclusion

This was the second year of workshops and will be the second year for teacher-participants to incorporate lessons learned in their classes. One part of the program measurement consists of teacher-participants' journal entries and reflections. The teacher-participants recently reflected on the 2010 workshops. They were enthused and shared many elements of success in their entries. The teacher-participants were motivated to; once again, bring what they learned in the program to their classrooms. Whether it was technology, problem-based learning, or incorporating critical thinking into lessons or strategies learned, they went back to their classrooms inspired. One teacher-participant stated that they received a wealth of knowledge from the presenters, and intended to continue to access them (at their invitation) for additional support. From the reflections, it is evident to this evaluator that the teacher-participants understand the connections between the different areas of science with math associations. The teacher-participants often expressed that they are doing everything possible to help their students achieve academic success.

According to the results from year one (2009) to year two (2010), the AU summer program in science has resulted in a successful, innovative professional development program. The program has, and will continue, to improve content knowledge of the participating teachers, and strengthen the quality of their instruction. The developed and implemented successful professional development program has met the original goals set for the summer program. These goals include: (1) increase teacher-participants' content knowledge, (2) expand pedagogical knowledge, (3) improve student science achievement, and (4) integrate problem-based learning in science instruction. As reported in their reflections, the teacher-participants believe that they have strengthened the quality of their instruction methods and they feel more confident in their approach to assisting students increase achievement in science.