LOGIC MODEL: AN EXCERPT FROM

External Evaluation Final Project Report

Improving the Quality of Arizona Teachers of Physical Sciences and Mathematics

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Final Project Evaluation Report

Year 1	**January 3, 2008 to June 30, 2009**
Year 2	**July 1, 2009 to June 30, 2010**
No-cost Extension	**July 1, 2010 to January 31, 2011**

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Executive Summary

From 2008 through 2010, 288 Arizona high school and metro Phoenix middle school teachers of mathematics and the physical sciences (most teaching out-of-field and/or in low SES LEAs) participated in professional development consisting of modeling workshops, other content courses and follow-up sessions intended to improve pedagogy and ultimately to increase students' understanding of mathematics and science content as a result of teachers' better instructional strategies. During the 2008 and 2010 summer sessions, the Arizona teachers were joined by 21 physics and chemistry teachers sent by the Ministry of Education in Singapore specifically to experience modeling instruction.

Testimonials from individuals who participated in the summer sessions and follow-up Saturdays, including those who had been mentored, indicated their high level of satisfaction with the modeling workshops. They noted that students who experience modeling instruction are more engaged in learning and interacting with their peers and the curriculum.

Dissemination of project findings has been accomplished through publication of a journal article, oral presentation at a national conference, newsletter feature and emailing of an annual report to hundreds of educators and state leaders. Other strategies include expansion to other schools and future contacts with the new Arizona Superintendent of Instruction and the district U.S. Representative.

Implementation surveys administered by the Project Director in 2009 and 2010 garnered feedback on content, methods, coordination with other science and/or math colleagues, and the extent to which the modeling workshops enhanced pedagogy and content knowledge. Teachers provided information about their implementation of instructional methods consistent with modeling including modeling discourse. Respondents were very positive about the value of modeling both for students' learning and for improving instruction. Challenges included the time demands of modeling and the need for more support (resources, practice and additional professional development).

In response to a Physics Implementation survey completed in 2009 and 2010, the majority of teachers reported that the Modeling Workshop(s) enhanced their teaching pedagogy at a high level and improved their content knowledge in physics at a high level. A few noted that they had been able to coordinate their physics courses with science and math colleagues so that the courses enhanced each other and students learned more. Teachers also reported the extents to which each of the nine Mechanics units and six components of modeling instruction were implemented.

In response to a Chemistry Implementation survey completed in 2009 and 2010, the majority of teachers reported that the Modeling Workshop(s) enhanced their teaching pedagogy at a high level and improved their content knowledge in chemistry at a high level. A significant number of teachers noted that they had been able to coordinate their physics courses with science colleagues so that the courses enhanced each other and students learned more; a few noted that coordination with math colleagues had been successful. Teachers also reported the extents to which each of the nine Chemistry units and six components of modeling instruction were implemented.

In response to a Physical Science Implementation survey completed in 2009 and 2010, the majority of teachers reported that the Modeling Workshop(s) enhanced their teaching pedagogy at a high level and improved their content knowledge in physical science at a high level. A few noted that they had been able to coordinate their physical science courses with math colleagues so that the courses enhanced each other and students learned more. Teachers also reported the extents to which each of the five units and six components of modeling instruction were implemented.

Continuation of the professional development services has been negatively impacted by fewer funding opportunities. In summer 2010 120 teachers participated in the ASU Modeling Instruction program, choosing from five different Modeling Workshops, an astronomy course, and a Leadership Workshop. In summer 2011 a full set of eight summer courses will be offered, with funding relying on out-of-state enrollees' tuition to pay instructor wages, donations from local companies and counting on 50 tuition exemptions from the College of Liberal Arts and Natural Sciences.

The project's objectives to increase student and teacher content knowledge were met. Students and teachers gained content knowledge based on increases in pretest and posttest mean scores on concept inventories including the *Force Concept Inventory*, *Mechanics Baseline Test*, *Chemical Concepts Inventory*, *Physical Science Concept Inventory*, *Mathematics Concept Inventory*, *Assessment of Basic Chemistry Concepts*, *Conceptual Survey in Electricity and Magnetism*, *Simplified Force Concept Inventory*, *Matter Concept Inventory*, *Diagnostic Electric Circuits Test*, and the *Conceptual Survey in Electricity and Magnetism*.

During fall semester 2009, two Modeling Instruction Mentors mentored sixteen chemistry teachers and four physical science teachers who had expressed interest in being mentored. Mentoring included classroom visits followed by either phone conversations or follow-up visits in which teachers were provided feedback. Teachers evaluated the benefits of being mentored, as well as the performance of individuals who provided mentoring, and indicated high levels of satisfaction.

A retired expert physics and chemistry teacher, Earl Barrett, was hired as a short-term consultant to establish a self-sustaining mechanism in Phoenix Union High School District for education and communication among school principals, assistant principals and teachers who use modeling instruction. The Phoenix Union High School District Science Specialist led a series of educational sessions for principals and assistant principals in the district. The purpose of the training meetings was to show administrators what modeling instruction looked like so when they evaluate teachers they are more aware of what the best practices are in Modeling Instruction. Through this project's work with the school district, administrators were encouraged to help teachers incorporate these practices, specifically, to do labs, utilize modeling best practices and use technology.

Earl Barratt was hired as a short-term consultant during fall semester 2009 to establish a self-sustaining mechanism in Gilbert and Chandler school districts for education and communication among school principals, assistant principals, physics teachers and chemistry teachers who use modeling instruction. He surveyed all the physics teachers in the two districts in November and December 2009. He also surveyed all the physics and chemistry teachers in Deer Valley SD and met with school administrators. Following meetings with district administrators and a study of the survey responses from the physics and chemistry teachers, the consultant noted that teachers using modeling to reform pedagogy need the support and encouragement of the district administration, that the mid-year assessment of student performance did not align with the modeling sequence in chemistry and that this situation needs to be addressed. Mr. Barrett recommended a dialogue with modeling leaders dealing with this issue and the lack of equipment needed to fully employ Modeling Instruction.

Follow-up Saturday workshops provided teachers with an opportunity for ongoing professional development. They included teachers with modeling skills and modeling instruction novices. The RTOP or RTOP assessment materials was an important component of each workshop, and the external evaluator observed that "It would make sense for the RTOP to be introduced during the summer professional development sessions so that teachers understand that it is an important component of implementing modeling."

Appendix A: Project Logic Model and Evaluation Plan

Clarifying Program Theory

Planned Work	I Basic Assumptions A. Resources: ASU faculty; ASU Modeling Program; Grant administrators (Robert and Jane); ASU laboratories and facilities; ABOR funding; previous research findings; Modeling assessments; teachers and principals from established and new partner school districts. B. Barriers: Teachers HQ but not highly effective; out-of-field teachers; low teacher salaries; geographic isolation of teachers in many high-need districts; poorly stocked school laboratories; poorly prepared students; unaffordable university tuition; high turnover of administrators and teachers II Activities A. Products: Valid and reliable Modeling Instruction B. Services: Professional development consisting of workshops/classes with follow-up Saturday sessions during the school year. C. Infrastructure: Established Modeling Program with pre/post assessment results.
Intended Results	III Outputs: Mathematics and science teachers take 1 or 2 of 10 Modeling Workshops or other content courses; teachers participate in 4 all-day Saturday meetings in 3 subject areas; principal training sessions and meetings; students are pre/post tested IV Outcomes A. Short-term Outcomes (learning): Principals report increased understanding of Modeling; teachers increased content knowledge; teachers learn instructional strategies and scientific use of classroom technology B. Intermediate Outcomes (action): Increased numbers of teachers in schools who use Modeling instruction; C. Long-term Outcomes (condition): More teachers attain HQ status; HQ teachers are more effective; participating teachers' students increase content understanding from pre to post; increased support for Modeling among principals V Impact: Improved teaching of mathematics and science in Arizona junior and senior high schools with improved AIMS math and science scores

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Theory of Change: Increased teacher mathematics and science content knowledge and use of modeling instruction as well as principal support of high quality proven (modeling) instruction will result in increased student understanding of mathematics and science content.

VI. **External influences that:**

A. Support Project Activities: ABOR funding; national recognition of Modeling Program; highly qualified in science is not necessarily "highly effective" in teaching science; teachers need content preparation to teach advanced second-year science courses; national recognition in education and business of the need for increased student proficiency in the sciences; low AIMS scores in math and science focus the need for improved learning for all students in these subjects

B. Limit Project Activities: Teacher turnover; teacher attrition; low Arizona salaries for teachers; administrator turnover; science not a high priority in many schools; poverty; teacher isolation in rural communities; many physics teachers didn't major in physics; teachers need content preparation to teach advanced second-year science courses – which is not provided nor funded by the DoEd; financial obstacles to teachers updating science content (many teachers cannot afford the $1600 per course tuition); high stakes tests because they promote rote memorization of facts; and lack of administrative support and parental support for inquiry science and for math-science coordination.

The Plan for Tracking Intended Resources, Activities, Outcomes and Impacts

Resources	Activities	Outputs	Short and Long Term Outcomes	Impact
Teachers of STEM Teacher stipends ASU laboratories ASU classrooms Workshop facilitators ASU faculty ASU infrastructure High need SDs HQ data from SDs ABOR ITQ funds	Recruit teachers from high-need districts and schools, workshop facilitators, mentors and ASU faculty; offer Modeling Workshops & content courses (rotated scheduling at ASU)	9 graduate courses (including new course Electricity for Middle/Secondary teachers) taught in summer 2009; 10 additional teachers will become HQ in targeted subject area; Total service delivery hours/course: 60 to 90	(1-3 yrs) Teachers become HQ, increase posttest content scores & use RTOP to improve instructional practices. Teachers implement modeling instruction (4-6 yrs) Teachers become more effective as measured by student AIMS tests	The majority of Arizona math and science teachers in all schools will be highly qualified.
Modeling leaders ASU Physics Dept Classrooms of modeling workshop leaders ABOR ITQ funds	12 structured follow up Saturday workshops during 2009-10 school year; mentoring during fall semester by Larry Dukerich and Rosanne Magarelli	70% of teachers involved in summer PD will participate in the structured meetings	(1-3 yrs) Participating teachers will report higher level of modeling than non-participating teachers (4-6 yrs) some teachers will become modeling leaders	More teachers in science and math departments will use modeling instruction.
Teachers Students Modeling Survey ASU Modeling office ASU infrastructure ABOR ITQ funds	Teachers will implement Modeling Instruction in their classrooms	Modeling Implementation Survey will be administered to all participating teachers	(1-3 yrs) Students in teachers' classrooms will demonstrate pre/post gains in the appropriate Concept Inventory (4-6 yrs) Post test gains will increase substantially each year.	Improved student science and math content knowledge in AZ as demonstrated by increased science and math AIMs scores.

Objectives, Formative Measures and Performance Measures

Objective 1: 75 Arizona (majority in high-need districts) teachers participating in June and July 2009 Modeling Workshops and other content courses will improve their physics, chemistry, physical science and/or mathematics content knowledge as demonstrated by concept inventories.

Formative measures: Course surveys, teacher satisfaction

Performance measures: Pre/post assessment of teachers using concept inventories (e.g., FCI); number of teachers who were not HQ (pre) and number who become HQ (post).

Objective 2: Teachers who participate in June and July 2009 Modeling Workshops and other courses will improve STEM instructional strategies including effective classroom discourse management and content organization.

Formative measures: RTOP Self-Assessment to assess level of implementation, teacher satisfaction and self-assessed increase in knowledge and skills with Saturday follow-up workshops; names of participating teachers

Performance measures: Modeling Instruction Implementation Survey

Objective 3: Students in classrooms of participating teachers who implement Modeling Instruction will demonstrate pre/post content gains.

Formative measures: Modeling Instruction Implementation Survey

Performance measures: Appropriate Concept Inventories

External Evaluation Plan

The timeline of the evaluation plan had to be adjusted primarily because of the cutbacks in administrative offices at ASU. The updated evaluation plan is displayed here with the adjusted dates in parentheses. An example of this is that we thought the assessment data would be analyzed by Dr. Popp by the end of December, 2009 but Dr. Popp didn't receive the data from the ASU center until the last week of March 2010

Obj.	Formative Evaluation	Outcome Evaluation	Data, Measure, Instrument and/or Activity	Timeline and Responsibilities Target Date (with Adjustments)
1	X		Grades for ABOR ITQ supported teachers in Modeling workshops and courses	Jane Jackson and course instructors August 2009
1	X		List of ABOR ITQ supported teachers with contact information (email and phone) and names of summer 2009 courses; HQ status pre and post	Jane Jackson sends to Rose Shaw via email September 1, 2009
1	X	X	Additional demographic and mentoring information collected, all summarized and reported. Some information will be used in the outcome evaluation.	Rose Shaw collects meaningful information after agreement with Jane Jackson. Mentoring survey has been developed. October 15, 2009 (May 15, 2010)
1	X		Post grades for June 2010 courses	Jane Jackson and Instructors June 2010

Obj.	Formative Evaluation	Outcome Evaluation	Data, Measure, Instrument and/or Activity	Timeline and Responsibilities Target Date (with Adjustments)
1		X	Pre/post (summer 2009) teacher content assessment scores	Jane Jackson sends scores to Rose Shaw for analysis/reporting May 1, 2010
2	X		Workshop satisfaction survey administered at all 12 Saturday follow-up workshops	Workshop facilitators and picked up by student worker Monthly
2	X	X	Summarized follow-up workshop surveys ongoing with longitudinal aggregation for outcome evaluation	Rose Shaw 2009-10 school year
2-3	X	X	Modeling Instruction Implementation surveys developed with editing cycles	Jane Jackson and Rose Shaw November 10, 2009
2-3	X	X	Modeling Instruction Implementation surveys posted on www.externalevaluator.com	Rose Shaw December 1, 2009 (Adjusted: April 10, 2010 and Jane will administer as usual instead of by web because teachers prefer the process and method used previously.)
2-3	X	X	Modeling Instruction Implementation Surveys completed by participating teachers	Jane Jackson and Rose Shaw (Adjusted: Jane and her staff will do this as per previous years; Rose will process and summarize data.) Start: March 15, 2009 End: April 15, 2009
2		X	Development of Modeling Instruction Mentoring assessment instrument; administered to mentored teachers	Rose Shaw Developed: Sept and Oct 2009 Administered to teachers: Jan 2010 (Administered April 2010)
2	X	X	RTOP teacher self-assessment and/or summaries of RTOP-informed narratives from the mentors (Larry Dukerich and Rosanne Magarelli)	Rose Shaw Start: August 10, 2009 Complete: December 24, 2009 (Adjusted completion: April 20, 2010)
3		X	Analysis of student data from 2008-09	Sharon Osborn Popp December 2009 (Adjusted: June 30, 2010 because the data were just received by Dr. Popp during the last week of March 2010; cutbacks at ASU delayed this)
3		X	Report of results disseminated	Report From Popp received by Shaw March 1, 2010 (Adjusted: June 30, 2010)
3		X	Prepare, collect, and enter pretest and posttest student data for 2009-10	Sara Swinson June 2010