Solving the math problem: AIMS math test gains due to Modeling Instruction and CIMM

by Jane Jackson (interview of Denis Lawton in summer 2007)

Solving the math problem is crucial. Toward this end, below is solid evidence for great effectiveness in math achievement of Modeling Instruction and Cognitive Instruction in Mathematical Modeling (CIMM) for middle school students in urban public low income schools.

Use of Modeling Instruction and CIMM can improve the high school graduation rate, contribute to economic development; and enhance the well-being of our culture by producing a populace who can think, reason, and understand.

A case study: Denis Lawton

Denis Lawton is an experienced and highly regarded 8th grade mathematics teacher in an urban Phoenix elementary school in a poverty-stricken neighborhood. He is the only 8th grade teacher in his school. In 2006-2007, his class consisted of regular to low-level students; all but one were Hispanic, one-half were ELL, ten were SPED with learning disabilities.

Denis reports a huge improvement in the pass rate in the "Arizona Instrument to Measure Success" (AIMS) 8th grade math test in spring 2007, the year after he took our graduate course, PHS534: "Methods of Physical Science Teaching." **Two-thirds of his students,** 65%,**passed the AIMS math test, compared to only half (48%) in the year before he took our course. Results were equally good in the next year, 2008.**

He reports that his 2007 students started out worse-prepared than the previous year's group, which makes their math achievement even greater than the test scores indicate.

He states as chief reasons for his improved AIMS pass rate that he implemented his course learning from summer 2006 at ASU. Specifically, he did one-week modeling cycles eight or nine times during the year in his pre-algebra sections.

Causes of success were, he said in a phone interview, "a deliberate focus on what concepts *mean*; repetition; modeling; kids having to verbalize and describe in whiteboard presentations, and me as the teacher going into the cycle with a crystal clear vision of what I wanted the students to produce at the end."

He began each modeling cycle with an activity in mathematical modeling that he learned in the course (modeling workshop); among them were measurement activities using Cognitive Instruction in Mathematical Modeling (CIMM) developed by Dr. Robert MacDuff, formerly a Postdoctoral Associate in the Modeling Instruction Program at Arizona State University, and adapted by workshop leaders Patricia Burr and S. Lee Rodgers. He taught slope in connection with graphing and linear equations for the first time to his pre-algebra students.

Students prepared whiteboards and gave presentations for a couple of days in each cycle. He said, "Doing the math was only part of it; kids *thought deeply* when preparing whiteboards about what questions I'd ask them. They prepped one another for this."

Denis gathered evidence showing the progress of the 66 students (out of 90) in his 8th grade math classes who had also taken the 7th grade AIMS test at his school (from a different

teacher). SPED students are included in the 66, he said. He wrote, "I looked at data analysis, algebra, and measurement -- the items we repeatedly explored in modeling." Here is a summary of some of his results. The number of those 66 students who got higher than 65% correct in each topic are:

AIMS test TOPIC	% CORRECT	7TH grade AIMS Test	8th grade AIMS test	gain
data analysis	66% & higher	35 students (53%)	49 students (74%)	20%
algebra -- overall	66% & higher	23 students (35%)	42 students (64%)	**30%**
geom. - measurement	70% & higher	24 students (36%)	36 students (55%)	20%

He wrote about these data, "I found that we were hitting almost one-half of the eighth grade standards with each modeling cycle. **I have no other explanation [than modeling instruction] for the incredible growth we saw."**

Another way of looking at it is, for the 66 students who took both tests while at his school, their AIMS math scores in standard format are:

AIMS math test	7th grade	8th grade
Falls far below	14	11
Approaches	21	10
Meets	31	41
Exceeds	0	4

This shows a huge improvement in individual students' math achievement from grade 7 to grade 8.

Denis was the only eighth grade math teacher in his school. He said that he hoped that his district wouldn't revert to more traditional 'drill and kill' methods; he wanted to use his evidence to convince his district that Modeling Instruction is a better way. (He gave written permission to use his name.)

[Update in 2009. He could not convince his colleagues; they chose a traditional math curriculum. The school district was failing, and the state-required consultant from West Ed insisted that teachers use direct instruction. Denis moved to the University Charter School in urban Phoenix.]

Commentary and further evidence:

More evidence of great success is provided by Ms. Robin Inskeep, an eighth grade *science* teacher at Porfirio Gonzales School in Tolleson Elementary School District. She wrote,
Date: Fri, 01 Oct 2004
From: "Inskeep, Robin" <RINSKEEP@tesd.k12.az.us>
I truly believe that the two modeling classes that I have taken, Methods of Teaching Physical Science and CASTLE [electricity], have greatly improved my teaching methods, which have resulted in the students having a deeper understanding of the concepts being taught. Last year was the first year that this method was implemented with the entire 8th grade. Without a doubt, the skills that I learned through the modeling courses were the major reason that **this class' scores for math approximately doubled in the 'meets and exceeds' category on the AIMS test** spring of 2004. You have my permission to quote anything that I have said.

An expansion of Modeling pedagogy to mathematics, Cognitive Instruction in Mathematical Modeling (CIMM), was piloted with tremendous success in remedial algebra at Paradise Valley High School in 2006-2007 by Math Department chairman Robyn Rosenthal (RRosenthal@pvschools.net) and two teacher colleagues. Paradise Valley Unified School District expanded CIMM to more schools in subsequent years, saving much money by reducing the dropout rate – and empowering students to think, reason, and understand. Data and a principal's letter are at http://modeling.asu.edu/CIMM.html . Robyn uses CIMM in 2012.

The need is urgent. CIMM and Modeling Instruction are a solution to the math problem -- and the science problem. These problems go together. **Schools are smart if they make concerted efforts to have teachers learn Modeling Instruction and CIMM.**

Appendix: the modeling workshop at ASU

Denis Lawton took PHS 534/MTE 598: Methods of Physical Science Teaching (Physical Science with Math Modeling Workshop). The course provides 8th and 9th grade teachers of science and mathematics with education in Arizona standards-based content and instructional strategies. Participants are introduced to the Modeling Method as a systematic approach to the design of curriculum and instruction. The name Modeling Instruction expresses an emphasis on making and using conceptual models of physical phenomena as central to learning and doing science. Mathematics instruction is integrated seamlessly throughout the entire course by an emphasis on mathematical modeling. Anticipated student outcomes include improved understanding in geometrical and physical properties of matter, mathematics and reasoning skills such as algebraic proportions, independent & dependent variables, relation between graphs and equations, and measurement & estimations; energy and states of matter. The course was taught by Patricia Burr and S. Lee Rodgers, teachers of ninth grade physical science until 2011 at South Mountain High School in the Phoenix Union High School District, and thereafter at Hamilton High School in Chandler USD

For information: http://modeling.asu.edu/MNS/MNS.html
For an introduction to CIMM, visit http://modeling.asu.edu/CIMM.html .
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