Effects of Modeling Instruction Professional Development on Biology Teachers' Scientific Reasoning Skills

In summer 2018, Kathy Malone and her colleagues published a research article on the Lawson Classroom Test of Scientific Reasoning (CTSR or LCTSR) in a 3-week BIOLOGY Modeling Workshop. The article is "Effects of Modeling Instruction Professional Development on Biology Teachers' Scientific Reasoning Skills". Kathy is a long-time Modeling Workshop leader in biology and physics. I like the article and recommend it; it is thorough, well-expressed, and important. – Jane Jackson, ASU

I quote from the abstract:
... this study examines the effects of Modeling Instruction in a biology workshop on teachers' scientific reasoning skills. In addition to teacher interviews, focus groups, and writing samples, data from Lawson's *Classroom Test of Scientific Reasoning (LCTSR)* were collected from teachers before and after the workshop. The results suggest that the three-week Modeling Instruction in the biology workshop contributed to gains in in-service teachers' scientific reasoning, and thus provides evidence that the teachers in this study are more prepared to help develop similar skills with their own students as they engage in the Modeling Instruction curriculum.

Of the 30 participants who took the pre-test and the post-test, "five were middle school educators, three were English language learner (ELL) co-educators, and 22 were high school educators."

On the LCTSR PRE-test, "most teachers were classified as late transitional reasoners (N=15), followed by the category of early transitional reasoners (N=12). Only one teacher was identified as a formal operational reasoner."

On the LCTSR POST-test, "the majority of teachers were again classified as late transitional reasoners (N=15), followed by the category of early transitional reasoners (N=6). Six modelers were identified as a formal operational reasoner based on post-test data. This shift towards late transitional reasoners and formal operational reasoners suggest that the teacher modelers are more capable of reasoning abstractly in varying contexts following the Modeling Instruction in the biology workshop."
...
"The greatest overall increase in sub-skills occurred within the context of control of variables (about a 9% increase pretest to post-test) and this sub-skill was the one most often mentioned by teachers in the interviews and writing samples. The second largest increase in subskill shown on the LCTSR was in hypothetical-deductive reasoning with about a 4% increase pretest to post-test. The Modelers engaged in hypothetical-deductive reasoning in 13 out of 14 of the MI workshop days, and this skill was also the second most often mentioned in the writing samples, interviews, and focus groups.

However, the sub-skills of proportional and correlational reasoning were not impacted by the Modeling Instruction workshop even through Modelers engaged in these activities 7 and 13 days, respectively, out of the 14 days of the MI workshop. This is a discouraging finding and may

highlight the need to incorporate explicit connections to proportional and correlational reasoning skills into future Modeling Instruction workshops through the use of additional deployment tasks that target each type of reasoning skill independently rather than concurrently."

I quote from the conclusion:

This study provides evidence that Modeling Instruction grounded in biology and authentic practice has the capacity to support the development of in-service teachers' scientific reasoning skills. After participating in the three-week workshop, teachers related how MI pedagogy enhances and promotes scientific reasoning subskills, especially as it relates to control of variable reasoning and hypothetical-deductive reasoning.

In part, these results may be attributed to the development and implementation of the Modeling Instruction workshop which utilized the following effective practices associated with quality professional development: (i) concurrent exploration of content and pedagogy that is embedded in practice (i.e., modeling cycle in teacher-mode and student-mode); (ii) experienced workshop leaders with classroom and content experience; (iii) focused content (i.e., What is Life?, Population Interactions, Evolution units of study); (iv) sustained duration and with a professional learning community (i.e., three-week workshop with follow-up meeting and interviews throughout the academic year); (v) planned with a coherent set of strategies (i.e., white boarding, consensus meetings, deployments).

Although the modelers displayed gains in scientific reasoning skills, only 20% of the teachers were identified as formal operational reasoners at the end of the workshop. This result is not surprising however, as past research suggests that pre-service teachers have a tendency to display a lack of scientific reasoning skills.

When coupled, these results for pre-service and in-service teachers do not bode well for the education received during their college years and stress the need for in-service workshops that allow educators to experience authentic practices, as well as a need to explore shifts in pre-service teacher training. As has been found in the teaching and learning of nature of science (NOS) concepts and processes, scientific reasoning skills may not be easily apparent when taught implicitly. Thus, there is a need for teacher education to include opportunities for the explicit instruction of scientific reasoning skills, which may include metacognitive reflection practices on scientific reasoning skill utilization after teachers engage in activities in student-mode.

Ref: Andria N. Stammen, Kathy L. Malone, and Karen E. Irving. Effects of Modeling Instruction Professional Development on Biology Teachers' Scientific Reasoning Skills, *Educ. Sci*. 2018, 8, 119.
FREELY download it in pdf at http://www.mdpi.com/2227-7102/8/3/119