Some thoughts on the importance of teacher as practitioner of science in classroom science investigation—Supplemental References.

MnSTA Newsletter
Volume 53 No. 3 A Quarterly Publication of the Minnesota Science Teachers Association Inc. Spring 2017

Addressing Public Science Skepticism through Classroom Research Experiences

by Russ and Mary Colson

Minnesota Science Teacher Association (MNSTA) Spring Newsletter, Vol 53, No3.

(read excerpt)

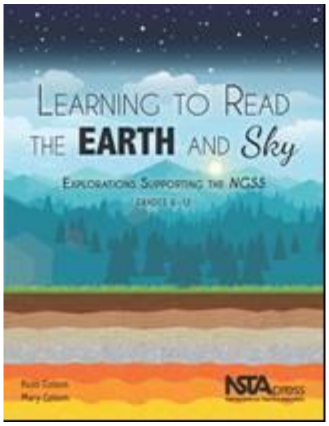
FLORIDA ASSOCIATION of SCIENCE TEACHERS

Florida Association of Science Teachers (FAST) Journal 2017 (submitted)

The Importance of Teacher as Practitioner of Science in the Earth Science Classroom: An Example Considering the Water Cycle and Salt Water Incursion in South Florida

by Russ and Mary Colson

(read excerpt)



Learning to Read the Earth and Sky, Explorations Supporting the NGSS, Grades 6–12

by Russ and Mary Colson

Available from NSTA Press at www.nsta.org/store.
https://www.nsta.org/store/product_detail.aspx?id=10.2505/9781941316238

Planning NGSS-Based Instruction: Where do you start?

by Mary and Russ Colson

The Science Teacher v83 n2 p51-53, Science Scope v39 n6 p16-18, and Science and Children v53 n6 p23-25.

(read full article at NSTA)

Excerpts from articles:

(excerpt) Addressing Public Science Skepticism through Classroom Research Experiences

by Russ and Mary Colson

In late February 2017, Kyrie Irving's claim that the Earth is flat, not round, was 'trending' in social media. As a basketball star for the Cleveland Cavaliers, his words can influence people, and Bill Nye (the science guy) weighed in on the discussion, saying that it's heartbreaking when people even joke about such things. How could anyone be so skeptical of an established science fact?

Given how we often present science in both news media and the science classroom as well-established theories from the scientists, usually without underpinning evidence, isn't a certain skepticism expected? Unless people can make observations, do some testing, and construct and modify models on their own, why shouldn't they be skeptical of ideas 'from the scientists?" Skepticism is in fact essential to valid scientific investigation. To quote from Kyrie Irving, "Anytime you have a specific question, like, 'Is the Earth flat?' or 'Is the Earth round?' I think you need to do research on it," Irving said.

We tend to agree with him on that. Science deals with figuring things out, not simply believing theories someone else has figured out for us. For example, for us, the belief that the Earth is round became more than faith in what scientists tell us when we saw the curvature of the horizon as we came down off of Mauna Kea during a family vacation in Hawaii. Similar epiphanies can be achieved in the classroom where students construct ideas based on observation and experiment, the same practice of research that scientists follow.

...

Asking students to engage in an 'investigation' of high level ideas without understanding underpinning concepts will likely devolve into an exercise in idle speculation or blind acceptance, not research. However, classroom investigation does not need to begin with an attempt to reconstruct an entire high-level scientific idea. A teacher-mentor can engage students in the investigation of a small component of the idea and then help students see the connection to the bigger picture. This stepwise approach offers both experience with how theories are developed through observation and reasoning and understanding of the bigger ideas that were developed through decades (or more) of research.

Any hope for success of the NGSS initiative lies with teachers. No curriculum, however well designed, can engage students in true exploration, because a fixed curriculum requires a pre-determined activity with a pre-determined outcome—two things not consistent with true investigation. Only teachers can lead their students in open-ended exploration, including exploring ideas they themselves might not fully understand, becoming fellow scholars and scientists in the classroom.

We aren't suggesting that a teacher should do only investigative activities—no one can rediscover through investigation all the ideas of science accumulated over the past several thousand years. Nor do we think that all teachers must do truly open-ended investigations to the same degree—each teacher has a different basket of skills and experience to offer his or her students. However, we believe it is essential to our public understanding of what science is, and to our public trust of science, that teachers offer experiences in doing science to the best degree they are able.

(excerpt) **The Importance of Teacher as Practitioner of Science in the Earth Science Classroom: An Example Considering the Water Cycle and Salt Water Incursion in South Florida**

by Russ and Mary Colson

A recent news headline "People trust science. So why don't they believe it?" presents an interesting paradox. The headline comes from an article by Alia E. Dastagir published in March 2017 in USA Today (online) and updated in early June 2017 to reflect new information about the Paris climate agreement.

Does this disbelief reflect a problem with our education system? Isn't the teacher's job to ensure that students know science? That they believe science?

Perhaps not. Science deals with figuring things out, not simply believing theoretical models someone else has figured out for us. The science educator's job is to equip students with the intellectual tools and applied experience to understand how to figure things out scientifically. This is a different goal from merely conveying the theories to students in a memorable and understandable way so that they 'know' science.

Let's take the water cycle as an example of an established scientific model. We can teach the model for the movement of water using a diagram, perhaps like the one shown in Figure 1. This diagram captures the idea that water moves through the many environments and ecosystems of the Earth. It also summarizes centuries of hard-won knowledge in a concise way. Yet it does not provide any evidence on which this model is based nor does it engage students in an investigation. It simply states a model which students can accept. Or not.

Why shouldn't students remain skeptical in the absence of any first-hand investigative understanding of how we know the water cycle is true?

We believe the goal of teaching is not simply to convey the theories of science—the water cycle, or plate tectonics, or the large-scale balance of energy that controls earth's climate—but to convey an ability to pursue the practices of science through which those theories were developed.

An authentic investigation in the classroom ought to engage students, like scientists, in asking questions, designing experiments, interpreting results of experiments, and summarizing those interpretations into mental models of how the universe works. A static or scripted curriculum faces significant challenges to accomplishing this goal. The static curriculum might, for example, impart an investigative flavor by encouraging students to brainstorm questions, but then the curriculum has to pre-choose a question for further investigation. The static curriculum might encourage students to come up with ideas for experiments, but then it guides students to a pre-defined experimental approach.

If our students ask a bunch of questions, and then we proceed with an investigation from the curriculum, we send the powerful message that our students' questions don't matter because someone else—the scientists or curriculum writers—have already figured it all out. If we encourage students to think about experimental design, but then do a predesigned experiment without meaningful input from ourselves or our students, we send the powerful message that designing an experiment is not something that we or they can do. In addition, we fail to give students the experience of designing an experiment.

Allowing students to follow through on their own questions and experimental designs seems like the best solution. The problem is, a flexible and untested classroom investigation can easily degenerate into a directionless activity that teaches neither the models of science nor the practices. To avoid this undesirable outcome, students need boundaries and expert guidance during the course of their investigations.

We propose that to develop and maintain a dynamic curriculum for teaching and learning, the science teacher must be engaged in the exploration as a mentor and practitioner of science. An engaged practitioner of science is needed to prompt and guide student through authentic explorations where the outcome of the experiments is not known, the experimental design requires iterative modifications, and the interpretation of results is a mystery to solve.

Return to "Topics for Debate."
Back to Issues in Earth Science.