Student Conceptions of the Nature of Science
Implications for Agricultural Education

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Science is an exciting, complex, and human endeavor.

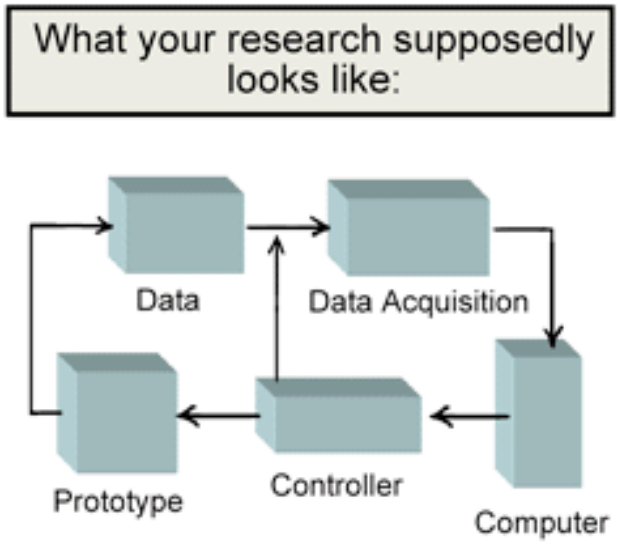


Figure 1. Experimental Diagram

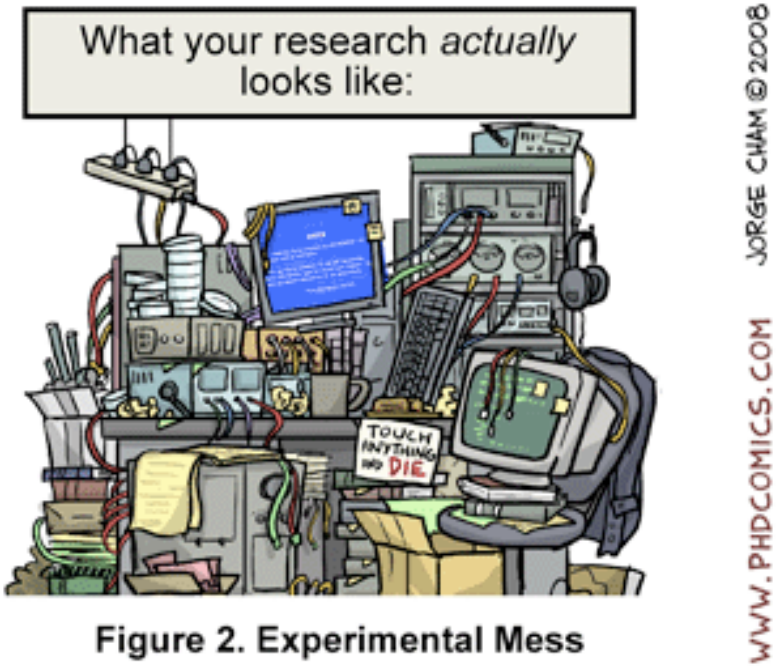


Figure 2. Experimental Mess

http://www.phdcomics.com/comics/archive.php?comicid=961

Key points of this talk

- The *nature of science* is relevant to agriscience and teacher preparation courses
- Direct instruction paired with experience and reflection can improve student understanding of the nature of science
- Agriscience instructors should address the nature of science along with content in their courses

Ideas about the nature of science are ***always*** conveyed in science teaching (McComas et al., 1998)

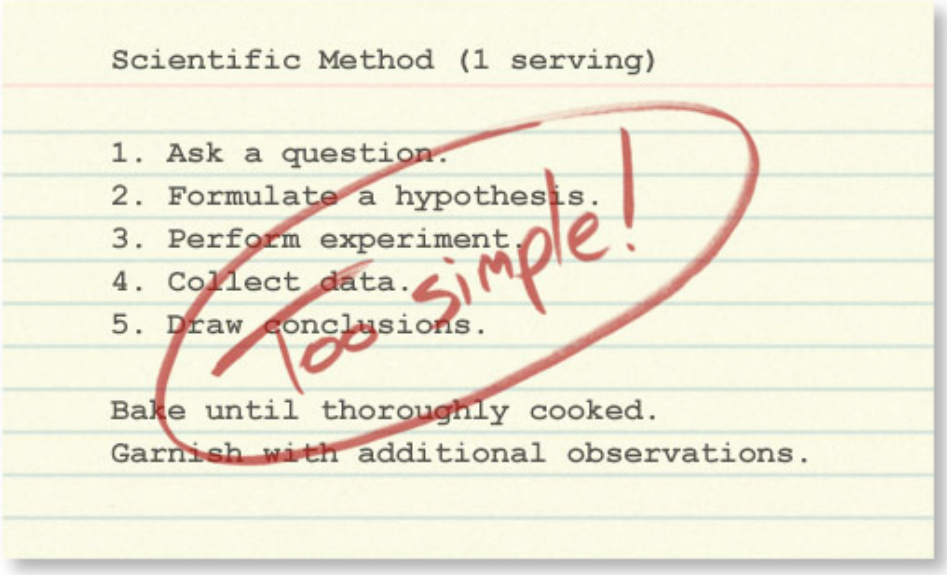


Image credit: http://www.examiner.com/article/us-lacks-science-graduates-new-web-site-hopes-to-help

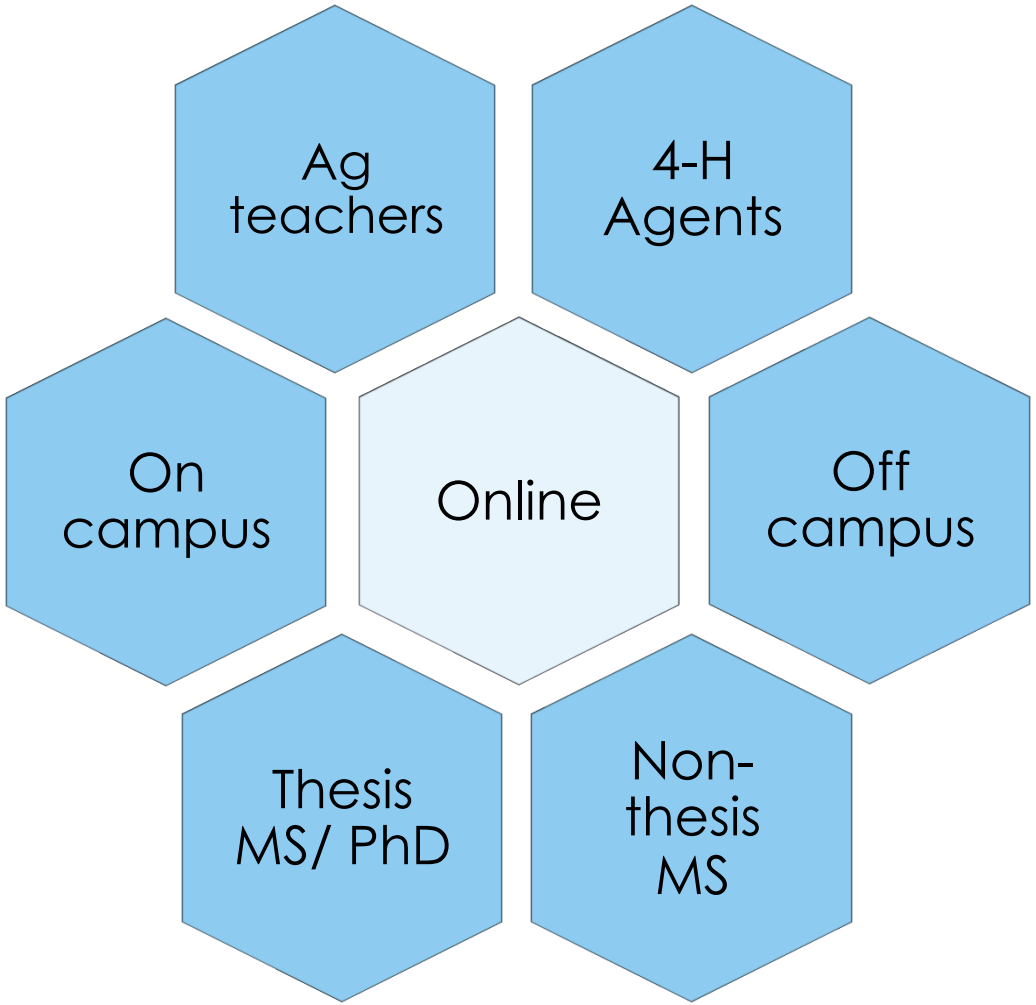
Image credit: http://undsci.berkeley.edu/article/0_0_0/howscienceworks_01

Science is a way of knowing

- distinction between observation and inference
- meaning and role of scientific theories and laws
- role of imagination and creativity in generating scientific knowledge
- observations are guided by theoretical perspectives
- scientific knowledge is socially and culturally embedded
- there is not one "scientific method" that will lead to absolute knowledge
- scientific knowledge is tentative yet durable

(Lederman, 2007)

Instructional context lends itself to a diverse group of graduate students



Research-based design strategies were used in course planning

Direct instruction (McComas et al., 1998)

- Readings
- Application assignments

Engage in scientific inquiry (Schwartz et al., 2004)

- Agriscience project

Reflection (Abd-El-Khalick, 2001)

- Discussion forum
- Reflection assignments

Student ideas about the nature of science were investigated

- Pre- and post- test based on Views of the Nature of Science, Form C (Abd-El-Khalick, 2001)
- Intrinsic case study (Berg, 1998)
- Qualitative analysis of open-ended responses

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Aspects of nature of science received different attention

- ***Methods of scientific inquiry***
  - Reading assignment
  - Reflection in discussion forum
  - Application assignment – observation
- ***Creativity and imagination***
  - Personal reflection following individual agriscience research project

More informed views about the methods of scientific inquiry

Does the generation of scientific knowledge require experiments?

	Pretest	Posttest	Change
Student C	Naïve	Informed	More informed
Student E	Naïve	Intermediate	More informed
Student F	Naïve	Informed	More informed
Student G	Naïve	Naïve	No change
Student H	Naïve	Informed	More informed
Student J	Naïve	Informed	More informed
Student K	Naïve	Naïve	No change
Student L	Naïve	Intermediate	More informed
Student M	Intermediate	Informed	More informed

More informed views about the methods of scientific inquiry

Student H: naïve to informed

To develop scientific knowledge ***one would need to conduct experiments****. (Pretest, 2:53)*

Experiments are not always required to develop scientific knowledge*. There are some opportunities which can allow observations to be used…(Posttest, 3:35)*

More informed views about the methods of scientific inquiry

Student L: naïve to intermediate

*I think that **the development of scientific knowledge requires experiments** or else the information would be a theory (an un-verified, non-repeatable answer to a question).. (Pretest, 2:50)*

*Science in general should consist of **information that is obtained in a repeatable/reliable way. That is what makes it scientific and not just a hunch.** We would not want to hear that the best way to plant a crop is to hand plant each seed individually 6 inches apart without first testing out other methods of planting or other distances of planting to determine the best growth and harvest. (Posttest, 3:30)*

Increased appreciation for the role of creativity and imagination in science

Do scientists use creativity and imagination?

	Pretest	Posttest	Change
Student C	Intermediate	Informed	More informed
Student E	Naïve	Intermediate	More informed
Student F	Intermediate	Intermediate	No change
Student G	Intermediate	Intermediate	Slightly more informed
Student H	Naïve	Intermediate	More informed
Student J	Intermediate	Informed	More informed
Student K	Intermediate	-	-
Student L	Naïve	Intermediate	More informed
Student M	Intermediate	Intermediate	No change

Increased appreciation for the role of creativity and imagination in science

Student H: naïve to intermediate

I feel experiments are more based on ***black and white factual knowledge*** *so there is little room for creativity (Pretest, 2:147)*

The study of science is a creative effort and ***various scientists are likely not to think the same about certain hypothesis****. This just shows* ***how using the same data, scientists can reach totally different conclusions*** *(Posttest, 3:79)*

I think the imagination and creativity is used ***during the planning and design*** *(Posttest, 3:96)*

Increased appreciation for the role of creativity and imagination in science

Student C: Intermediate to Informed

*The **planning and design stages** use the most imagination and creativity. (Pretest, 2:137)*

***Science can be interpreted in many different ways** and it is up to the person to use the evidence that they have to interpret what is taking place and happening. (Posttest, 3:76)*

*They use creativity and imagination in coming up with the experiment and how to test for what they are trying to find. **They then use creativity to expand on the data they collect**. (Posttest, 3:93)*

Students views of the nature of science changed

- Most students involved in the study started out with a naïve view of some aspects
- All students involved in the study developed a more informed view of some aspects
- Aspects that were explicitly addressed showed greater change than those that were not
- Varied change in other aspects

Recommendations for practice

What do we know ***and how do we know it***? (Matthews, 1994)

- Agriscience instructors at all levels should consider how they are presenting the field
- Teacher educators should address the nature of science explicitly in methods courses

Image credit: http://nerdgeekstuff.blogspot.com/2012/09/stand-back-im-going-to-try-science.html