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Analyzing NGSS Scientific Practices in Action.

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Abstract

This ongoing research involves the Science Practices in the Classroom Matrix (SPCM), an analytical tool used for identifying the level of sophistication of scientific practices occurring in classroom lessons and the level of student versus teacher centeredness. The SPCM was developed through iterative rounds of coding videotaped lessons and confirming and disconfirming components of the Matrix, followed by a process of discussion and consensus building. The SPCM is being used to systematically determine how science teachers enact the scientific practices in their classrooms in meaningful ways. Additionally, implications of the use of the SPCM in prospective science teacher education and practicing teacher professional development will be discussed.

Purpose

- Students rarely have opportunities to engage in the scientific practices in the classroom (Capps & Crawford, 2013).
- Teachers engaged in an authentic paleontological field investigation (intensive six day, two summer program).
- Classroom lessons were videotaped.
- The need arose to systematically analyze the nature of the instruction.

The purpose of the Matrix is not to evaluate teachers, but to gain a better understanding of the level of sophistication and level of student-teacher centeredness of inquiry-based instruction. It also allows us to find potential relationships between teachers'

- knowledge and views of inquiry and NOS
- knowledge of science content
- the nature of teacher instruction

Theoretical Framework

- Teaching science as inquiry is engaging students in the practices of science, where learners grapple with data and use evidence to justify explanations to make sense of the natural [and material] world with the expert guidance of a teacher (Crawford, 2014).
- Situated cognition is a learning perspective that describes knowledge as a product of the activities, context, and culture in which the learning is situated (Brown et al., 1989).

NGSS Sciences Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument form evidence
8. Obtaining, evaluating, and communicating information

How can we systematically analyze the ways in which students in the classroom are engaging in science practices?

Can we use the Science Practices in the Classroom Matrix to enhance practicing and prospective teacher knowledge of the scientific practices?

Science Practices		a / b	robust / student centered (minimally guided)	more informed / guided	emerging / teacher centered (heavily guided)	absent
			3	2	1	0
Planning investigations	a		An investigation is revised in light of new evidence	An investigation is planned that accounts for variables	An investigation is planned to generate data	Planning investigations not present
	b		Students independently plan investigation	Teacher guides student in planning investigation	Teacher provides a plan for an investigation	
Carrying out Investigations	a		A revised investigation is carried out	An investigation is carried out that accounts for variables	An investigation is carried out to produce data	Carrying out investigations not present
	b		Students independently carry out investigation	Teacher guides student in carrying out investigation	Teacher carries out investigation	
Analyzing data	a		Limitations of data analysis are evaluated and data are reanalyzed through an iterative process	Data analysis is conducted through systematic quantitative (e g statistics) or qualitative methods to create visual representations	Descriptive analysis of data is conducted or visual representations of data are created	Analyzing data not present
	b		Students independently analyze data	Teacher guides students in analyzing data	Teacher analyzes data	
Interpreting data	a		Limitations of interpretations are evaluated and data is reinterpreted through an iterative process	Analyzed data (from quantitative or qualitative methods) are compared and contrasted	General patterns are recognized in the data	Interpreting data not present
	b		Students independently interpret data	Teacher guides students in interpreting data	Teacher interprets data	

Table 1. An portion of the SPCM. The full SPCM covers all eight of the NGSS Science Practices

Implications for research and teacher education

The SPCM has multiple uses. First, the SPCM will be used to differentiate teachers' enactment of the science practices through the Fossil Finders professional development project. Recordings of their enactment of the Fossil Finders curriculum will be analyzed with the SPCM then compared to teachers' knowledge and views on inquiry and NOS, both before and after the professional development intervention.

Second, the SPCM may offer teacher educators a way to support practicing and prospective teachers in understanding the science practices, bringing research into practice. Prospective teachers may have difficulty differentiating between features of inquiry and student-teacher centeredness (Forbes, 2011). A proposed study is in development to see if an intervention on the scientific practices and use of the SPCM enhances prospective teacher knowledge of the practices and changes prospective teacher's views of engaging their students in the scientific practices, as shown below.

Reflection on Student Teaching → Lesson on Scientific practices and using the SPCM → Participants use the SPCM to analyze their student teaching → 2nd Reflection on Student Teaching → Researcher interviews participants individually → Analyzing video clips of scientific practices in classrooms

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Scenarios from classrooms participating in Fossil Finders

From DJ's Class:

Analyzing Data - a1/b2

I (Instructor): Alright gentlemen, what'd you guys just do?

S1 (Student): Umm, we took the information from these (has raw data sheets in hand)

I: And what was that information that you took?

S1: All the fossils that we found.

S2: And then we had to write down how many fossils we got from each type of organism. (Students are organizing their data into a data table).

Interpreting Data – a2/b1

I: So you know how we were looking at different bar graphs to compare, now we compare our chart with these ones. In this sample they found more brachiopods than clams. That sounds a lot like the one over here. You might be able to draw some interesting comparisons. We can look at all these different sites…So our data looks a little different than that, but what is nice about this is this is just a small part of this. Put that data in and those numbers will change a little to account for everything that we found. This is kind of a cool thing to be able to compare to what we found and compare what was found with what other people found.

From KN's Class:

Planning Investigations – a1/b1

I: So we are going to be taking measurements for the rest of this investigation. We're going to be looking at length and width. When we get out actual samples, and I'll show you how to measure these organisms that we have. We are going to be taking a look at a measurement this way and also a measurement this way. And when we record those then the database will multiply them together to get a number the database can use.

Interpreting Data - a2/b3

I: What did they find? Can someone tell me what this graph is telling us?

S: They have brachiopods and clams here, but I think we see they don't have any crinoids. They have trilobites. So they are missing some organisms that we have... And then, you can see that these two (taxa) were flourishing because they have relatively about the same number of fossils (students looking at pie graphs).

Overviews of DJ's and KN's classrooms

DJ

- Carried out science practices mostly at an emerging level
- Students mainly guided in science practices
- Students engaged with a broad range of science practices in less depth

KN

- Carried out science practices using a combination of emerging and more informed levels.
- Students were guided and worked independently in science practices
- Students engaged in few science practices in more depth.

Teacher	DJ	KN
Grade Level	5th	7th (Earth Science)
Teaching Experience	4 years	5 years
Education	BA Int. Relations, MEd	BS Biology, MA in Education
College Science Courses	2	16
# of Professional Development Workshops	2	0
Research Experience	None	Yes
Pre/Post NOS and Inquiry Scores (out of 24)	Pre = 12 Post = 22	Pre = 18 Post = 22

Table 2. Background experiences of teachers studied.

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