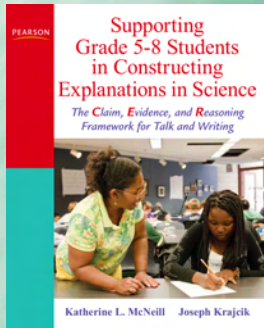


# Supporting Grade 5-8 Students in Writing Scientific Explanations

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## Book Development

- The book describes lessons learned from previous research including how to: design learning tasks and scaffolds, incorporate different teaching strategies into science lessons, and develop and use assessment tasks and rubrics to inform instruction (McNeill, 2009; McNeill & Krajcik, 2008; McNeill & Krajcik, 2009).
- The book includes multiple examples of student writing and approximately 40 minutes of video clips from grade 5-8 science classrooms.
- The book will be published by Pearson Allyn & Bacon in January 2011.



## Research Question

- How do teachers' pedagogical content knowledge, beliefs and classroom practices for scientific explanation and argumentation change after reading the book and participating in professional development?

## Framework for Scientific Explanation

- We developed an instructional framework for scientific explanation (McNeill & Krajcik, 2007; McNeill, Lizotte, Krajcik & Marx, 2006).



- CLAIM**
  - An assertion or conclusion that answers the original question
- EVIDENCE**
  - Scientific data that supports the claim
  - The data needs to be appropriate and sufficient to support the claim
- REASONING**
  - A justification that links the claim and evidence
  - Shows why the data counts as evidence by using appropriate scientific principles
- REBUTTAL**
  - Recognizes and describes alternative explanations
  - Provides counter evidence and reasoning for why the alternative explanations are not appropriate



## Description of Professional Development

- A series of three professional development workshops were offered.
- WORKSHOP 1** (8 hours)
  - Topics included an introduction to the CER instructional framework, common student difficulties, designing learning tasks, and scaffolds
  - Assignment: Read Chapters 1-3; bring in student work from a learning task applied in the classroom
- WORKSHOP 2** (3.5 hours)
  - Topics included teaching strategies, designing learning tasks with integrated teaching strategies, and application to discourse
  - Assignment: Read Chapters 4-6; bring in student work from a learning task applied in the classroom
- WORKSHOP 3** (3.5 hours)
  - Topics included discourse, developing assessment tasks, rubrics, and formative versus summative feedback.



## Method

- This study took place during the 2009-2010 school year with seventy grade 1-12 teachers in a large urban district in New England.

Primary Subject Taught	Years Experience <sup>a</sup> Range	No. of Teachers	Highest Degree Subject		
			Level	Education	Science
Science	Elementary	14	None	2	37
Specialist	Middle	12			
	High	19			
General Classroom Teacher		14	Bachelors	2	25
English/Language Arts		2	Masters	65	6
Special Education		4			
Other Resource Position		5	Doctoral	1	2

- Multiple data sources were collected for all participants:
  - Pre and post teacher surveys
  - Videotapes of the professional development workshops
  - Artifacts produced by the teachers at the workshops
  - Samples of strong and weak student writing that the teachers brought to the workshops
- Additional data was collected for five case study teachers:
  - Videotape of three science lessons
  - Student writing from all students in the lesson
  - Teacher Interviews
- The teacher survey asked teachers to analyze samples of student writing and classroom discourse:

**Classroom Example #1**

Below is an assignment that Mr. Morris gave to his students. Read through the assignment and then read the two examples of student writing for this task.

The diagram below shows two land masses separated by an ocean.

Do you think these two land masses have always been in the same location or do you think they were once in a different location? Explain why you think this.

**Student C**

The two land masses have not always been in the same location. They were once connected to each other without an ocean in between them. The land masses moved because of plate tectonics, which is the idea that the earth is made of huge large pieces that slowly move over time on top of the faster moving global mantle.

**Student B**

The two land masses have always been in the same place. The diagram shows that the two land masses are made of similar rocks. They are both made of sandstone and limestone. The two land masses also have similar plant fossils. That is why I think they were once connected and the ocean that is there now was formed from the water that leaked out from the cracks the land between the two land masses. There are probably a glacier or flood that brought the water to the ocean. If the water was trapped from the cracks, the land underneath would also be made of sandstone and limestone so will it have similar plant fossils. The two land masses have not moved. They were always very connected.

**Classroom Example #2**

Below is a transcript from a discussion that just completed an investigation exploring biodiversity in their neighborhood. The transcript shows the teacher, Mr. Lewis, beginning a discussion about the students' conclusions for the investigation.

Mr. Lewis: I want you to share your ideas about the question we have been investigating in the biodiversity or not schoolyard high or low? And I don't just want you to say yes or no. Rather I want you to tell me why you think the biodiversity is high or low. Okay, what do you think?

Chloe: I think that our schoolyard has a high biodiversity because my partner and I collected data that there are 20 different species in our schoolyard.

Mr. Lewis: OK, that is great. So you found data that there are 20 different species. Okay, what did you find?

Kyle: We found that there were a lot of some species, like squirrels, but for most species they were only one or two animals, like there was only one song sparrow.

Mr. Lewis: Interesting. So what do you think that means in terms of our research question? Does that suggest that the biodiversity is high or low?

Kyle: We think the biodiversity is in the middle. It would be higher if there were lots of all of the different species.

Mr. Lewis: Okay. What did other groups find?

## Results

Four themes emerged from the analysis of the multiple data sources:

- Theme #1:** In terms of student writing, teachers' understanding of claim and evidence was strong and their understanding of reasoning improved, but the application of reasoning to classroom practice continued to be challenging.

Code	Elementary (n=22)		Grade 5-8 (n=23)		High (n=17)	
	Pre	Post	Pre	Post	Pre	Post
Claim	59.10%	77.30%	73.90%	82.60%	71.40%	81.00%
Evidence	90.90%	90.90%	87.00%	95.70%	85.70%	95.20%
Reasoning	45.50%	81.80%	39.10%	91.30%	42.90%	90.50%
Conceptual	72.70%	50.00%	87.00%	73.90%	85.70%	76.20%
Personal	22.70%	27.30%	34.80%	34.80%	35.10%	33.30%
Literary	45.50%	13.80%	52.20%	21.70%	47.60%	23.80%
Questioning	4.50%	13.60%	30.40%	4.30%	33.30%	4.80%
Vague	18.20%	31.80%	39.10%	13.00%	38.10%	14.30%

- Theme #2:** In terms of classroom discourse, teachers exhibited a limited understanding of how to apply argumentation in terms of both the framework and identifying interactions.

Code	Elementary (n=22)		Grade 5-8 (n=23)		High (n=17)	
	Pre	Post	Pre	Post	Pre	Post
Claim	27.30%	36.40%	17.40%	30.40%	11.60%	11.80%
Evidence	77.30%	72.70%	73.90%	52.20%	52.80%	70.60%
Reasoning	18.20%	18.20%	30.40%	25.10%	29.40%	23.50%
Conceptual	63.60%	50.00%	78.30%	73.90%	94.10%	76.50%
Personal	0.00%	0.00%	0.00%	0.00%	0.00%	5.90%
Teacher Directed	18.20%	0.00%	13.00%	30.40%	11.80%	58.80%
Student Interaction	22.70%	31.80%	43.50%	47.60%	41.20%	70.60%
Student Participation	36.80%	38.40%	26.10%	17.40%	29.40%	17.60%
Teacher Moves	68.20%	77.30%	73.90%	73.90%	58.80%	52.90%
Vague	81.80%	45.50%	43.50%	34.80%	52.90%	47.10%

- Theme #3:** Teachers found designing the question to be challenging, but also important for providing students with the opportunity to justify their claims with evidence and reasoning.

- Theme #4:** Elementary teachers framed argumentation in terms of connections to other disciplines while high school teachers framed argumentation by discussing the science content or laboratory investigations.

## Implications and Future Directions

- The themes from the data analysis informed both the revision of the book and the facilitators guide to support future professional development.
- We will run two additional workshop series in spring 2011 with approximately 50 teachers and collect data to examine the impact of the revisions.
- Currently, I am working with Carla Zemba-Saul from the Pennsylvania State University on writing a similar book specifically for elementary teachers to address their needs.



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