Using Evidence: An Analysis of U.S. and German Science Teaching and Learning

A Collaboration of
CAESL and BIQUA Researchers

Project Overview

- CAESL and BIQUA researchers have similar data sets focused on "sinking and floating"
- Purpose: Having tools that measure use of evidence may lead to steps to improve students' understanding of science
- **Research questions:**
  How do students use evidence to justify their explanations about the natural world?
  How can we measure the use of evidence by students and teachers in the science classroom?

Scene from a German classroom

Project Work Plan

Student Responses Group

- Construct a common analytic framework on the use of evidence in science
- Based on this framework, develop middle school assessment items that probe students' use of evidence
- Evaluate the reliability and validity of these items through cognitive labs and field testing

Video Group

- Use an inductive process to develop video codes for use of evidence in science classrooms
- Based on inductive codes, develop an instrument to characterize teachers' and students' use of evidence
- Apply this instrument to existing video data and analyze results

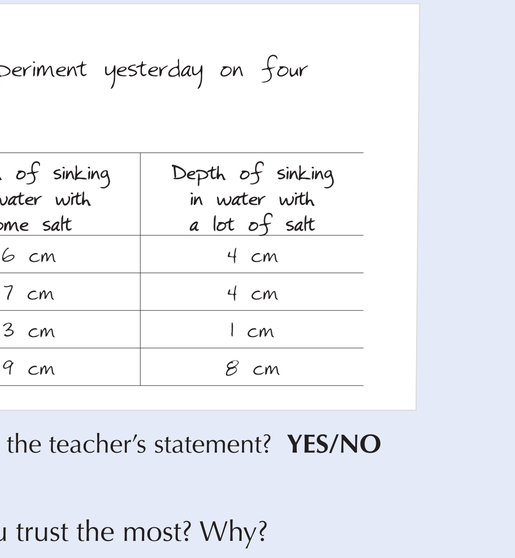
Timeline

Project Start and Planning: Organize existing data for sharing and exploration at the San Francisco meeting.	Jul. - Nov. 2005
San Francisco Meeting: Develop the analytic framework and plan next steps.	Nov. 30 - Dec. 2, 2005
Student Response and Video Groups: Refine the analytic frameworks, collect data, and analyze data.	Dec. – Aug. 2006
Student Response and Video Groups: Prepare initial findings and draft papers.	Aug. – Sept. 2006
Berlin Meeting: Discuss findings, refine draft papers, and plan for the culminating cross-case analysis paper.	Sept. 14 - 16, 2006
Project Completion: Complete and review cross-case analysis paper set and submit final version to Journal of Educational Assessment and various conferences.	Oct. 2006
Dissemination: Special issue of Journal of Educational Assessment is published, present at various conferences.	2007

Student Responses Group: Sample Item

A teacher writes on the chalkboard, "Things sink the same amount whether they are in freshwater or saltwater." She asks the students to provide data for or against this statement.

Student Responses Group: Evidence Framework
Rectangles are "things" (e.g., statements) and hexagons are "processes."



Student A:
In last week's demonstration, the teacher put an egg in water, and it sunk. When the teacher added a lot of salt to the water, the egg floated.

Does the data from Student A support the teacher's statement? **YES/NO**

Student B:
When I go swimming in the ocean in the summer, it doesn't feel any different than when I go swimming in the pool. I think I sink the same amount whether I'm in the ocean or in the pool.

Does the data from Student B support the teacher's statement? **YES/NO**

Student C:
Here is the data table from our experiment yesterday on four different objects.

Object	Depth of sinking in water with no salt	Depth of sinking in water with some salt	Depth of sinking in water with a lot of salt
A	8 cm	6 cm	4 cm
B	10 cm	7 cm	4 cm
C	5 cm	3 cm	1 cm
D	10 cm	9 cm	8 cm

Does the data from Student C support the teacher's statement? **YES/NO**

Which of the students' data would you trust the most? Why?

Which of the students' data would you trust the least? Why?

Based on the data provided by all three students, do you think the teacher's statement is true? Why or why not?

Video Group: Data

- Videotapes collected by researchers at Max Planck Institute in Berlin, Stanford University, University of Münster, and the University of Münich
- Videotapes include classroom discussions of sinking and floating in grades 3/4 (Germany) and 6/7 (US)
- 100+ videotapes will be analyzed using a common instrument

Codes and Instrument

- Developed inductively by examining transcripts carefully and collaboratively
- Inductive codes organized into an instrument that will focus on four elements:
  – Argumentation
  – Nature of Science
  – Reasoning
  – Conceptual Understanding

Transcript with Preliminary Inductive Teacher and Student Codes

Transcript	Teacher Code	Student Code
Teacher: Yes, that's more or less the evidence, just what you said, it displaces exactly the amount of water that corresponds to its own size, because the cube is exactly the same size as the inner space of this glass cube. Super. And now there is another question, how is it… with a ship like this one? How much water does a ship like this displace? … Saskia	Teacher confirms students empirically-based reasoning Teacher asks to transfer prior knowledge to model of real-world object	
Saskia: Ahm well, the ship, it floats on the water and it doesn't sink, does it, so it doesn't displace any water since it doesn't take up any space, it's not like a cube that sinks and takes up much space and makes the water rise again, because the ship floats on the water.		Student makes presumption from empirically-based reasoning
Teacher: I think I see what you mean. What you say is, the ship floats, right. So, if now I'd put it in the basin… (T makes a drawing on the blackboard) it might look like this.	Teacher restates student's reasoning by making visual representation of student's presumption	

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