Integrating scientific argumentation to improve undergraduate writing and learning in a global environmental change course

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1. PURPOSE OF THIS WORK
- Improve the inquiry-based writing component of ERS201: Global Environmental Change
- Promote student-led generation, evaluation, and dissemination of data, and improve data literacy skills
- Focus writing instruction around argumentation
- Design and implement effective assessment strategies to gauge student learning

2. COURSE DETAILS AND STUDENT POPULATION
- Designed as a second-year course, required for Earth Science majors/minors
- Satisfies the Science Applications and Population & Environment General Education requirements
- Course has a graduate Teaching Assistant, and two undergraduate Maine Learning Assistants
- During the spring 2013 semester (analyzed here), there were a total of 22 students with the following major and standing distribution

3. PRE-COURSE ASSESSMENT - CO2 VS. SEA LEVEL

In our anonymous, ungraded course pre-assessment, we asked students to draw a plot of four coordinates representing CO2 and sea level data from different times in Earth history. We then asked them to address the question, “Is there a relationship between atmospheric CO2 and sea level, and if so, why?” Although many of the students were familiar with the greenhouse effect, they often had difficulty understanding the graphical presentation of data (i.e., conventions regarding dependent and independent variables, labeling, how to represent uncertainty, and their knowledge of the greenhouse effect and its impact on the cryosphere). In addition, we were unable to understand and measure student misconceptions about the climate system.

4. WRITTEN ARGUMENTS

At the beginning of the course, we asked students to describe what makes a good scientific argument.
- All (100%) responses indicated the need for evidence/data
- Most included some combination of hypotheses testing (limited and/or clearly defined assumptions, error estimation, comparison with accepted research/studies, and clear presentation of data)
- An example response:

5. EFFECT OF ARGUMENTATION ON LEARNING
- Assessment gains at beginning and end of class (N = 10 students taking both)
- 30 multiple choice questions grouped into 7 topics
- Anonymous, not graded

6. FUTURE DIRECTIONS
- Focus problem sets and written arguments on CO2 variability, energy balance, temperature variability, and climate sensitivity
- Incorporate two group projects: evaluation of Representative Concentration Pathways, and impacts of 21st-century carbon emissions (e.g., sea level rise, ocean acidification, ecosystem impacts)
- Further pre/post-assessment data collection to better understand learning outcomes

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