

Undergraduate Students' Climate Change Conceptions
Proposal: University of Colorado's iSTEM Graduate RA Funding
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This request is for a continuation of Kim Trenbath's 2009 -2010 iSTEM grant. While the general topic of her research is the same, she has changed her research questions. She has completed much of what she proposed for the 2009 through 2010 grant, but replaced some aspects of the previous proposal with well-defined research questions and a improved research methodology. The projects that last year's grant and this year's proposal support will be included in Kim's doctoral dissertation.

Accomplishments under 2009 -2010 iSTEM grant

ISTEM awarded Kim a 25% RA for the 2009 – 2010 academic year to develop and validate a climate change curriculum for undergraduate atmospheric science courses. She accomplished most of her 2009-2010 milestones outlined in that proposal, but changed others based on the nature of her research. Accomplishments include: the development of a climate change curriculum and a set of keystone lessons that address students' possible incorrect ideas; distribution of the climate change curriculum and keystone lessons to Department of Atmospheric and Oceanic Sciences (ATOC) professors and outside entities; analysis of the effectiveness of a keystone lesson through pre- and post-assessments; and development of a white paper describing the preliminary results of her analysis.

Kim taught her climate change curriculum and keystone lessons to her Summer 2009 class, ATOC 1060 – “Our Changing Environment”. She conducted pre- and post-assessments around two of the keystone lessons. She compiled the results of a study of students' understanding of the nature of science in response to a class project in a white paper titled, “Identifying Students' Views of the Nature of Climate Change Science in ATOC 1060: Does a Transformed Curriculum Improve Understanding?” She shared these findings and her climate change curriculum with others during a poster session hosted by ATOC. She also distributed the curriculum to ATOC faculty, graduate student-instructors, and outside entities such as the Laboratory for Atmospheric and Space Physics (LASP) Office of Outreach and Communication.

In place of the treatment and control validation process proposed in 2009, Kim designed and gathered data for a study that investigates how students learn about climate change while experiencing a climate change curriculum. The current proposal requests funding to support Kim while she continues to analyze the data she has collected and writes papers that she will submit to conferences at the end of the summer. The proposal also requests funding for Kim to run a similar project during the Fall 2010 semester with refined research questions and student assessments. She will compose and defend her dissertation during the Spring 2011 semester.

Project Description

Some ATOC professors may wonder, “why do some students miss questions on exams that relate to concepts that I discussed extensively throughout the semester?” It could be that these students entered the class with incorrect, preconceived notions about the material. These preconceptions exist in classes involving climate change and are perhaps due to the students' incorrect interpretations of the science or to inaccurate representations of the material in the media. These

preconceived notions can be challenging to address, in part because there are many different ways to teach climate change. If they are addressed, and the student learns and adjusts his or her views or knowledge, this is called “conceptual change,” which is the goal of teaching students with incorrect preconceived notions.

Some students have little or no prior knowledge of climate change, so the question then is, “how do students learn about climate change?” If we can figure out how students’ views on and knowledge of climate change evolve throughout a college class, we can tailor our course material to increase the amount of conceptual change in our classrooms.

There have been many studies that use closed-form questionnaires to capture college-level students’ conceptions of climate change, including Boyes and Stanisstreet (1992), Groves and Pugh (1999), Jeffries et al. (2001), and Khalid (2003). Other researchers utilized open-ended techniques such as on-line assessments (Madsen et al., 2007). Cordero et al. (2008), Matkins and Bell (2001), Pruneau et al. (2003), and Rebiech and Gautier (2005) pre-tested students’ understanding of climate change, and compared the results with a post-test that they administered after the students took a class. While all studies capture students climate change conceptions through the use of assessments, none of them dig deeper to show how students came to these conceptions and how the conceptions transform throughout a climate change class.

Kim’s dissertation research addresses the “how” by investigating the following research questions:

- What are the climate change perceptions held by undergraduates before they take ATOC 1060?
- What are their perceptions at the end of the class?
- How do students’ climate change perceptions transform throughout the semester?

Study 1

Kim is currently gathering data in a 215-student section of ATOC 1060 - “Our Changing Environment”, taught by a department lecturer. She developed a questionnaire to capture student’s perceptions of climate change at the beginning and end of class. Analysis of the pre/post questionnaires will show the amount of change the students experienced.

Determining HOW students’ conceptions change takes more investigation. To answer this research question, Kim selected five students to be “focus students” for her research. She selected these focus students based on their pre-class responses to the climate change questionnaire. Each focus student represents a different level of climate change understanding. Kim is interviewing these students 4 times throughout the semester using a protocol designed to capture their understanding of climate change, aspects of the class that helped them learn, and elements of climate science of which they remain skeptical. The interviews are conducted after discussions of significant concepts that may affect their climate change understanding.

In conjunction with the interviews, Kim routinely takes observational field notes during the ATOC 1060 lectures, evaluates classroom artifacts (exams, homeworks, and lecture slides), and conducts interviews with the professor. This data collection is on-going during the Spring 2010 semester.

During Summer 2010, Kim will analyze, categorize, and code the data to elucidate the ways in which each focus student learned climate change. The results will also show if and how each student corrects any prior incorrect ideas or preconceptions. By the end of the summer, Kim will compose

a paper based on her research findings. She will submit abstracts to Science Education conferences and the American Geophysical Union annual meeting in late summer.

Study 2

Since the beginning of the current study, there has been a need for refined methods, specifically surrounding the climate change questionnaire. During Summer 2010, Kim will validate the climate change questionnaire using “think-alouds” with professors and graduate students and will pilot a new, refined questionnaire in ATOC 1060 taught during Summer 2010 (session B).

Based on her findings from the data gathered Spring 2010 and the climate change questionnaire validation over the summer, Kim will design a second study. She will gather data for this study Fall 2010. The second study is anticipated to be similar to the first, but research questions and design may be slightly refined. Modifications will depend on the outcome of Study 1. Results from both studies will be included Kim’s dissertation.

Ultimately, the results of the studies described here can be expanded into suggestions for instructors of climate change courses. The focus students represent a stratified sample of students across the various climate science backgrounds within the ATOC 1060 classes. Some may have incorrect ideas prior to the class. Some may know nothing about climate change. The findings from the interviews with focus students can be extrapolated to develop teaching strategies that help professors to correct misconceptions and improve the basic climate literacy of their students.

Summary of Milestones

May 5, 2010 – End of data collection phase, Study 1

May 12 through August 20, 2010 - Draft literature review, chapter of dissertation

June 30, 2010 – Analysis of data from Study 1

July 2, 2010 – Revise and validate climate change questionnaire

July 6, 2010 – Pilot revised questionnaire in ATOC 1060 Summer 2010 (pre-assessment)

July 16, 2010 – First draft of paper, Study 1

August/September 2010 – Submit abstracts to conferences

August 5/6, 2010 – Pilot revised questionnaire in ATOC 1060 Summer 2010 (post-assessment)

August 20, 2010 – Design Study 2 including obtaining IRB approval

August 23, 2010 – December 16, 2010 – Data collection, compilation, and analysis, Study 2

January 2011 – April 2011 – Data analysis and dissertation writing

April 2011 – Dissertation defense

Funding received from iSTEM will directly benefit Kim’s dissertation research, as evidenced by the project design and milestones above. Kim contributes knowledge from her research to others in the department. She is currently leading the department’s effort to transform the laboratory curriculum of ATOC 1070 – “Weather and Atmosphere Laboratory” to include real weather instruments, part of an NSF grant. She taught an on-line class, “Climate Literacy – Essential Principles for Instructors”, through the Continuing Education in cooperation with the Cooperative Institute for Research in Environmental Sciences (CIRES) during Spring 2010. This class’ curriculum includes climate science basics and possible misconceptions and is geared towards middle-school and high-school science teachers. She utilized her preliminary findings from the current iSTEM funded research (Study 1) to develop a presentation on general Climate Myths and presented as part of a panel discussion for the LASP public lecture series. Kim will continue to contribute her knowledge

to those in her department, ATOC, and through outlets such as CIRES and LASP, as the opportunity arises. She has defined her role within the department as a science education specialist. She continues to work with faculty and graduate students in ATOC to improve the quality of undergraduate education.

Evidence of Faculty and Department Support

Linnea Avallone, Kim's ATOC Faculty Advisor, has teamed up with Erin Furtak, from the School of Education to ensure that Kim's research meets the standards of both ATOC and the education research community. Kim will have members from various STEM education outlets throughout the University, as well as the ATOC department, on her PhD committee.

Matching funds for 2010 – 2011 school year might be provided from a TA assignment in the ATOC Department, RA support for the transformation of the ATOC 1070 Laboratory curriculum (described above), or a climate change education outreach center such as CIRES Outreach. Kim will contribute to a NSF STEM proposal requesting funding continuation for the current curriculum transformation. If awarded, that grant could support Kim's 25% RA during the Spring 2011 semester.

Current and Pending Funding

Spring 2010

- iSTEM grant 2009 -2010, 25% RA
- ATOC University Fellowship Dollars, 25% RA stipend
- Dr. Peter Pilewskie and LASP, 25% RA tuition
- School of Continuing Education for teaching Climate Literacy – Essential Principles for Instructors, approx \$1200

Summer 2010

- LASP Outreach for LASP public lecture and educator workshop, approx \$350
- CIRES Outreach for Climate Literacy Bootcamp, approx \$700
- CIRES Outreach for development of Climate Literacy Modules, amt unknown, PENDING
- ATOC 1070 Teaching Assistant (1-class) \$1958, PENDING, not preferred
- GTP Seed Grant, \$2,500 WAITING TO APPY (could move to Fall 2010)

Fall 2010

- CIRES Outreach for Climate Literacy work, hourly, PENDING

Spring 2011

- NSF STEM Grant, WAITING TO APPY

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