

Undergraduate Climate Change Curriculum Development and Validation

Proposal for CU i3 Graduate RA Funding

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Introduction

In recent times, the media and other sources may have fostered ideas of climate change that are inaccurate. As a result, it is incumbent upon the university to ensure proper climate understanding throughout the United States. Current research evaluates the understanding of primary and secondary students on the topic of climate change, but there is a need for formal research to ascertain the level of understanding of college undergraduates. There is also a need for a tested and approved undergraduate-level curriculum that will address any misconceptions and utilize the current science education methods such as inquiry.

The Department of Atmospheric and Oceanic Sciences (ATOC) serves the undergraduate community at CU through ATOC 1060 - *Our Changing Environment*. ATOC 1060 is an option that fulfills the College of Arts and Science natural science sequence core curriculum requirement and can enroll 400 students each regular semester. It is extremely important that students in these large lecture classes are taught research-based climate change curriculum. Therefore, it is necessary that ATOC 1060, as well as other classes that cover climate change, presents factual science on the topic to the undergraduates so they may make informed decisions about the environment in their careers, whether their job relates to science and technology or another line of work such as business, communication, or secondary education. Furthermore, other departments such as Chemistry, Environmental Science, Geography, Geology, and Ecology and Evolutionary Biology could also benefit from a climate change curriculum. We propose to develop a scientifically based undergraduate climate change curriculum that can be used throughout the university, to validate its effectiveness through testing in ATOC 1060, and to share this curriculum with various cognate departments. In conjunction with the validation process, we plan to evaluate the understanding of climate change concepts within the undergraduate ATOC 1060 class.

Project

We propose to develop and validate a climate change curriculum for college undergraduate atmospheric science and related classes. The curriculum will incorporate current and accurate science, based on the scientific literature plus input from knowledgeable professors and lecturers, as well as other practicing climate scientists. Science-education methods will be emphasized and current educational research methods will be used to validate the curriculum. The curriculum will contain numerous *keystone* lessons from which professors can pick and choose. Each of these *keystone* lessons will be a stand-alone lesson that highlights an important aspect of climate and atmospheric science pertinent for everyday scientific literacy. This curriculum will be tested in ATOC 1060 or ATOC 1050 - *Weather and Atmosphere* classes.

We also propose to evaluate undergraduate students' knowledge of climate change and global warming, to identify incorrect ideas, and to address these misconceptions with research-based conclusions through the climate change lessons. Our research will culminate in a written

curriculum that we will share with the university through documents and presentation(s) in the spring of 2010. We will submit our research to scientific journals for publication after we complete all analysis. This project is proposed to take place from June 1, 2009 through April 30, 2010, with 25% RA funding requested for Fall 2009 and Spring 2010. Proposed milestones and their associated timeframes are listed below.

Proposed Milestones

- Develop assessments and learning objectives for undergraduate climate science curriculum. (June through August 2009)
 - o Coordinate with professors teaching and researching climate (various departments, including ATOC) to compose objectives.
 - o Integrate current climate science research and newsworthy events.
- Develop undergraduate-level **keystone** lessons that address learning objectives. (August 2009)
 - o Utilize current science education methodologies in coordination with School of Education faculty.
- Plan research methodology. (September 2009)
 - o Utilize research methods such as those used by the University of Colorado's Physics Education Research group.
- Validate learning through testing in ATOC 1060, *Our Changing Environment*, during Fall 2009 semester. (October through December 2009)
 - o Proposed research process: Administer pre-assessment; obtain control and test groups; teach **keystone** lesson to test group; administer post-assessment; evaluate results.
 - o If necessary, utilize student surveys and interviews.
- Revise and retest curriculum, if necessary. (January 2010)
 - o Additional or follow-up testing can occur during the Spring 2010 semester.
- Analyze data and compose research reports (February through April 2010)
 - o Author report on the development and testing of climate science undergraduate curriculum.
 - o Write report addressing incorrect preconceived notions about climate change.
- Distribute curriculum throughout ATOC department and university. (February through April 2010)
 - o Disseminate information via CU web-interface.
 - o Present curriculum to other instructors such as professors and incoming graduate students so that they may be able to use it in their classes.
 - o Integrate curriculum into ATOC 1070, *Weather and Atmosphere Lab*.
 - o Present findings to colleagues during ATOC seminars and science education research seminars.

Support and Matching 25% RA

Funding for the 2009/10 school year is requested for the project to support Kim Trenbath, the proposed Research Assistant. The ATOC faculty support this curriculum development

project, as they have voted to fund Ms. Trenbath for the first part of this research with university fellowship dollars during the summer of 2009. However, for completion of the scope of the project, involving testing in during the Fall 2009 and composition of research article(s), continued funding is needed beyond Summer 2009. The matching 25% RA funds have not been identified at this time, but may come from a TA assignment in the ATOC Department.

Experience Teaching ATOC 1060

Kim Trenbath will teach ATOC 1060, *Our Changing Environment*, during summer session 2 at the University of Colorado; she will be solely responsible for this course with oversight from department faculty. She will be able to utilize some of the developed curriculum methodologies during this class, which will be an excellent first-hand teaching experience. She will utilize the knowledge she gains from this assignment to further enhance the climate science curriculum that will be tested during Fall 2009.

Research Towards a Degree

The proposed research matches the interests of Kim Trenbath, the proposed graduate RA, as well as fills a large need in ATOC. Ms. Trenbath is an ideal candidate for this position as she has completed her Master's in ATOC, with research in air quality that led to a Master's thesis, and has completed her secondary-science post-baccalaureate teaching certification through the School of Education. She also has Bachelor's and Master's degrees in Engineering. This proposed research will blend together her interests in science and education to enhance the science education experience of undergraduates. Her career goal is to become an atmospheric science professor with a focus on teaching.

In the past, professors within ATOC were faced with the task of streamlining their method of teaching climate science. In April 2009, Kim Trenbath proposed to establish this curriculum, and the ATOC department awarded her departmental funding for the summer of 2009. The ATOC faculty have also agreed that comprehensive science education research can lead to an ATOC doctorate degree, as long as all departmental requirements are met.

Broader Impacts

The proposed project will involve and benefit a variety of parties throughout the university and beyond. This is an excellent use of the i3 funding because the proposed work integrates many departments throughout the university and will utilize and expand on research and methods conducted by education research groups at the University of Colorado. Ms. Trenbath's involvement in the work proposed will begin ATOC's collaborations with other STEM departments throughout the university in science education research. Foremost, the development of a climate change curriculum may transform the way climate change is taught at the University of Colorado, leading a movement that will result in better student understanding and fact-based scientific literacy.