BRINGING GLOBAL CLIMATE CHANGE EDUCATION TO ALABAMA CLASSROOMS

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Marie Wooten*, Marllin Simon, Kevin Fielman, Ming-Kuo Lee, Yu-Lin, and Luke Marzen
Auburn University, Auburn, Alabama

1. ABSTRACT

Auburn University has launched a state-wide Global Climate Change Education (GCCE) Program that aims at improving high school and public education in climate change science. Our overarching goal is to generate a better informed public that understand the consequences of climate change and can contribute to sound decision making on related issues. With funding provided by NASA, we are developing new educational modules that can be incorporated into the existing course of study for 9-12 grade biology, chemistry, physics, and environmental sciences classes. Because of the complexity of Earth's climate, the development GCCE modules must involve contributions from nearly every field of science. Teachers are trained in the use of these modules for their classroom through partnership with Alabama Science in Motion (ASIM) funded by the state of Alabama. Science in Motion provides an equal opportunity for hands-on use of state-of-art equipment that many Alabama students would never experience. ASIM is under the umbrella of the Alabama Math Science Technology Initiative (AMSTI). Certified AMSTI teachers will attend summer professional development workshops taught by ASIM specialists to learn the use GCCE modules in their classrooms. During the school year, the ASIM specialists in turn deliver the needed equipment to conduct GCCE classroom exercises and serve as an in-classroom resource for ASIM teachers and their 9-12 grade students. Scientists are partnered with ASIM specialists and leading teachers to implement and test efficacy of instructional materials, models, and NASA climate change data used in classroom. The project is evaluated by professional evaluators to refine the modules, improve the training tools, and assess student learning. The GCCE program is sustained through our unique partnership with ASIM and the Alabama State Department of Education. The GCCE program has the potential to reach over 200,000 students when the modules are fully implemented in every school in the state of Alabama.

* *Corresponding author address*: Auburn Univ., Dept. Biological Sciences, Auburn, AL 36849; e-mail: wootemw@auburn.edu

2. INTRODUCTION

There is growing concern over the change that is occurring to our climate and the impact it will have on the people, water resources, and ecosystems. Although the magnitude of climate change in the future is difficult to predict, there are likely to be affects on ecosystems, and human systems such as agricultural, transportation, water supply, and health infrastructure – in ways we are only beginning to understand (International Panel on Climate Change, 2007; National Academies Report, 2008). These rapid changes make it less likely that human and natural systems will adapt. In order to deal with climate change impacts greater efforts are needed toward educating the public about the science of climate change. Our overarching goal is to improve the teaching and learning about global climate change through secondary education in a majority of the high schools in the state of Alabama, employing resources and data provided by the National Aeronautics and Space Administration (NASA). In order to achieve this goal we have developed educational modules that contain laboratory, field, and computer activities in targeted areas of global climate change education (GCCE). Our main objectives are to create modules that can be incorporated into the existing course of study for 9-12 grade biology, chemistry, physics or environmental sciences classes. Teachers are trained in the use of these modules for their classroom through partnership with Alabama Science in Motion (ASIM), which is administered by the Alabama State Department of Education. Specifically, this program is designed to: 1) improve understanding of climate change, enhance problem solving skills, generate greater interest in science, develop better informed persons capable of making decisions, and promote more interest in science, technology, engineering, and mathematics (STEM) careers among students; 2) enhance teachers' content knowledge of climate change and their ability to direct inquiry-based instruction and use of scientific data in the classroom; and 3) generate climate literacy, support for STEM education, climate conscious communities, and reduction in the carbon footprint among the diverse citizens of the state of Alabama.

3. PROGRAM DEVELOPMENT & IMPLEMENTATION

3.1 Alabama Science in Motion Program

The GCCE program is sustained through unique partnership with the Alabama Science in Motion (ASIM) program, which is funded by the Alabama State Department of Education. The program is free and allows all Alabama high schools, no matter the size and location, to utilize the same high-tech, state-of-the-art laboratory and field equipment. In 1994 the governor of Alabama signed the Alabama Science in Motion program into legislation and Alabama became the first state in the nation to institute a state-wide Science in Motion program. ASIM is administered by the Alabama Math Science Technology Initiative (AMSTI). There are 539 high schools in the state that are served by the ASIM program with 216,862 students (2007-2008 count). In order for a school to be serviced by ASIM they

must be designated as an AMSTI-school. This designation is given if all mathematics and science teachers and administrators come to 4 weeks of professional development training. At present over 40 percent of the schools in the state are AMSTI-schools. The governor, Mr. Bob Riley, has set a goal that all schools will be AMSTI designated by 2011. Of the current AMSTI-schools, 80% of the teachers attend a summer two-week institute in biology, chemistry, or physics for years 1 and 2 of the program. The proposed GCCE modules will be delivered in a separate 4-day professional development workshop for teachers that have already received years 1 and 2 training. The GCCE will become the focal point for the professional development for all AMSTI-teachers in grades 9-12 for ASIM year 3 and beyond training. The professional development workshops are delivered by ASIM specialists who are certified biology, chemistry and physics teachers that serve their respective disciplines. During the school year, the specialists in turn deliver the needed equipment to conduct specific classroom exercises and serve as an in-classroom resource for ASIM teachers and their 9-12 grade students. Science in Motion provides an equal opportunity for hands-on experimentation that many Alabama students would never experience. The program better prepares students for postsecondary education and recruitment into STEM disciplines.

The state is divided into 11 regions and each region is serviced by a university or college nearby (Figure 1). Each university houses the equipment and vans used by ASIM. Each region has at least one van or "mobile lab" for the instruction of biology, chemistry and physics. These "mobile labs" travel to the high school to deliver the needed equipment for a specific laboratory exercise and the discipline specialists provide classroom assistance. Professional development workshops held during a two week period every summer are required for teachers to improve content knowledge and equipment use. In addition, the teacher is expected to use at least five ASIM laboratory activities per academic year that teach principles in the Alabama Course of Study (Bulletin 2005, No. 20). Auburn University-ASIM (Region 1, Figure 1) is serving as the hub for the GCCE development and implementation. Once the program is fully implemented, the program has the potential to reach ~90,000 students and over 200,000 when AMSTI is fully implemented in every school in the state.

3.2 GCCE Project Timeline

The timeline for the GCCE program development and implementation includes three milestones to be completed in three years:

Year 1: Development of Global Climate Change Education Modules –Scientists, ASIM specialists, and lead teachers form a team to develop instruction materials, write detailed procedures and test the modules in the classroom.

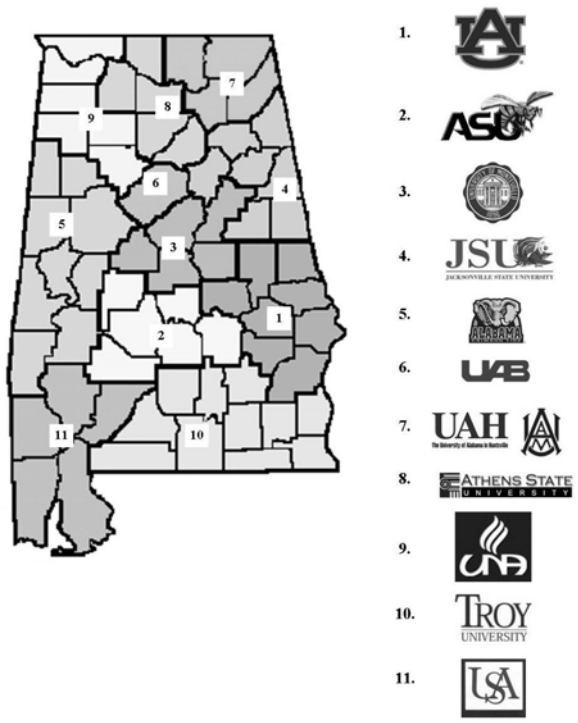

Figure 1: Alabama is divided into 11 Science in Motion regions. Each region is serviced by a local college or university and content specialists. Auburn University is located in Region 1 and includes eight counties and 26 high schools. The other regions are serviced by the universities and colleges listed.

Year 2: Regional Implementation – The modules will be introduced to all ~150 science teachers from Auburn University-ASIM/Region 1 (Figure 1). These teachers will be provided a two-day professional development workshop during the beginning of year 2 of the project. The teachers will implement the workshops during the academic year. In summer a state-wide work shop will be held at Auburn University to train all ASIM specialists (total of 33) from the other 10 ASIM regions in the state.

Year 3: State-wide Implementation - The modules will be introduced to all teachers in the other ten ASIM regions by their respective ASIM specialists at a two-day workshop at each of the ten sites followed by implementation during the academic year. Thereafter, the finalized modules will be posted on the AMSTI/ASIM web site for use by all teachers in the state of Alabama.

4. EDUCATIONAL MODULES

The GCCE modules are developed by scientists in various content areas (e.g., biology, chemistry, physics) in conjunction with ASIM specialists and lead teachers. The modules employ Roger Bybee's (1997) Five E's of the learning cycle: Engage, Explore, Explain, Extend and Evaluate. The modules are aligned with the Alabama Course of Study, Alabama Graduation

Examination, National Learning Standards in Science, Geography, Technology, and Environmental Education. Modules learning activities include field data collection, computer simulations, and laboratory measurements. Students employ NASA data, remote sensing imagery, and Google Earth to investigate effects of global climate changes on physical environments and humans. GCCE instructional materials include background content information (including an introductory Podcast), a detailed description of the specific exercise, Pre-laboratory Powerpoint notes, Pre-lab test questions, and detailed procedures that utilizes the five E's of the learning cycle for each module. The standards alignment (e.g., Science National Learning Alignment Standard, 1996) is articulated, and an equipment/materials list is generated, along with specific references. Various exercises are posted on the ASIM web site (https://fp.auburn.edu/asim/) for all science teachers and students in the state. The modules enable students to gain hands-on experience in collecting and analyzing data, as well as, to empower students and teachers to become more engaged in issues related to global climate change. The following modules have been developed in each of the science content areas: biology, chemistry and physics (Table 1).

5. PROGRAM DISSEMINATION

Several methods of dissemination will be employed. First, the College of Sciences and Mathematics hosts an annual symposium to educate faculty, graduate students and undergraduate students on the interdisciplinary interface of sciences and mathematics. A forum "Frontiers in Global Climate Change" will be held in the spring semester of 2011. The leadership team will serve as the coordinating committee for the symposium. The keynote address will be delivered in a fashion so that individuals not engaged in specifics of climate change research can become more informed. This forum will enable the leadership team to continue to meet and to refine background understanding regarding GCC education. In addition, it will provide the leadership team with specific training in topics relevant to GCCE. The symposium will be advertised on-campus and to neighboring institutions in the region, which includes two Historically Black Colleges and Universities: Alabama State and Tuskegee University. Media coverage will be requested as well through Auburn University Office of Marketing and Communications. The symposium will open with remarks from the leading scientists regarding the GCCE project and AU-AMSTI taking a leadership role in providing educational resources for this state. Second, the ASIM director and coordinator will present specific workshops at the annual meeting of the Alabama Science Teachers (www.asta.auburn.edu) to 'roll-out' the ASIM Year 3 and beyond GCCE program to all teachers in the state who are in attendance. They will describe the goals and objectives of the GCCE modules and partnership with ASIM. Posters will also be displayed with specific activities from each of the content areas. This will serve to educate teachers and inform them when ASIM will undertake GCCE training in their region. Third, the GCCE partnership with ASIM will be announced to all ASIM specialists in the state through the ASIM list serve and at their quarterly meeting. Fourth, the ASIM/teacher pair will present the modules at the National Science Teachers Association meeting, as well as, other discipline-specific meetings at the national or regional level. Last, the modules and podcasts developed by this initiative will be posted on the www.amsti.org (ASIM web site) for distribution to all teachers in the state of Alabama.

Table 1. Overview of GCCE educational biology, chemistry, and physics modules

Science content areas	Main themes	Module topics
Biology	The three C's: carbon dioxide, climate change and carbon	1. Biogeochemical cycles and traveling carbon passport 2. Photosynthesis and respiration 3. Biomass/global climate change perspective 4. An eye on global carbon
Chemistry	Effects of climate changes on water resources	1. Effects of temperature on solubility of salt 2. Micro-density, ocean circulation, and climate change 3. Stream-flow measurement 4. Acid rain, water pollution, and climate change 5. Chloride measurements – climate change and water quality
Physics	Fluid physics, saltwater intrusion, and climate change	1. Understanding forces in fluids 2. Tank simulation of saltwater/freshwater Interaction 3. Computer modeling of sea level rise and saltwater intrusion

6. PROGRAM ASSESSMENT AND EVALUATION

The overall goal of the GCCE project is to enrich the knowledge and understanding of students and teachers in the basics of climate change so that they can achieve a deeper awareness of related issues and understand the potential impacts on physical environments and human society. The assessments included in the GCCE project's evaluation plan serve three purposes: (1) provide feedback among the scientists, specialists, and teachers, (2) provide guidelines for refining the modules, and (3) improve the

training model. The evaluation instrument already being used by ASIM is modified to include a qualitative component and serve as the summative evaluation for this project. During years 2 and 3 the geographic region will change and the assessment of the implementation will remain constant. The assessments will be used for assessing the modules in each subject area: physics, biology, and chemistry. Once the modules and specific activities have been developed, two external evaluators will review the content, pedagogy and learning of objectives of the activities. Evaluators will determine whether module design is effective in getting students to retain key climate change concepts in the immediate timeframe of the activity. We will continue to work with evaluators on methods to determine how effective the activities are over time. In addition to the evaluators' assessment, participating students and teachers will be asked to complete short surveys on the event activities, so that we may compile their suggestions for improving future module activities and better focusing the individual modules. The teachers will provide input on whether the content of each module is complete, clear, and sufficient for meeting curriculum standards and classroom time constraints. Various evaluation procedures are summarized below:

6.1 Module Checklist

To assess the content, the checklist is based on the outline provided by ASIM for module development and the national science curriculum standards. The scientists and specialists across all areas cross-examine modules as well as science content and education experts. Then the teachers provide input on whether the content of each module is complete, clear, and sufficient for meeting curriculum standards and classroom time constraints.

6.2 Module and Training Satisfaction Assessment

An assessment designed to determine how well teachers rate each module for applicability and ease of use in their classroom, content clarity, probability they will use the module in the classroom, time and resource limitations, and how to improve the training sessions. For validity purposes, the qualitative and quantitative data will be collected immediately following summer training for each module from this project.

6.3 Module Implementation Evaluation

After implementation in the classroom, the teachers have an opportunity to assess each module. All data collected will be qualitative. After year 1, this will become the qualitative component of the ASIM Implementation Evaluation.

6.4 Observation Checklist

To further investigate how to refine the modules based on the input from all evaluations, the teachers will be videotaped while implementing a module in the classroom. Using an observation checklist, aspects of each module can be refined by the scientists and ASIM specialists and the video may also be used during the summer training where applicable. During years 2 & 3, the Observation Checklist will be used by the specialists during follow-up site visits but videotaping will not occur. At the conclusion of the last two years, data will be collected state-wide from the ASIM specialists via email to determine which modules from this project were implemented by the teachers throughout their region.

6.5 ASIM Implementation Evaluation

The current quantitative ASIM evaluation will be modified to include a qualitative component by adding the Module Implementation Evaluation after year 1 and then used as the summative evaluation for this project.

7. CONCLUSIONS

Final project evaluation and summary will be shared with the leadership team as well as the state ASIM coordinator and supervisor. The ASIM coordinator will promote use of the modules by ASIM specialists state-wide at their quarterly ASIM meetings. ASIM specialists are required to log usage of laboratory exercises by their teachers. Our goal is to have 50% of the science teachers in the state using 2 modules by year 3, and 80% of all ASIM year 3 teachers using 3 modules by year 5. By the end of the fifth year we would expect to see increased student achievement in noted areas of deficiency (i.e., Areas 3, 14, 15, 16) of the Alabama High School Graduation Exam. At the culmination of the project we will convene a final project meeting and include the AMSTI Director, to disseminate the final evaluation results and plan for sustained delivery of GCCE modules by ASIM personnel.

A preliminary conclusion of this project is that high schools can effectively partner with universities to offer students a meaningful and enriching science experience that increases their understanding of the concepts of Earth's system and climate change, and underscores the need to take action. Such a project can give these students access to expertise and equipment, thereby strengthening the connections between the universities, state education administrators, and the community.

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