Use of GLOBE Protocols to Promote the Next Generation Science Standards*

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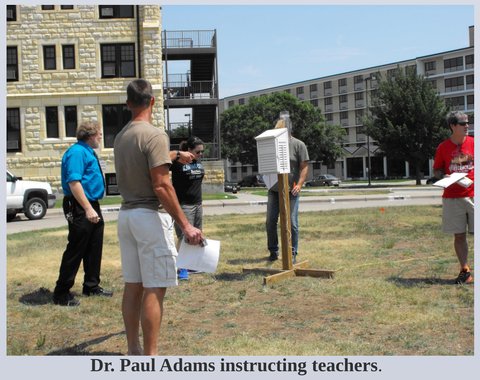
PURPOSE

Across the country, states are in the process of considering the adoption of the Next Generation Science Standards (NGSS). Kansas was the third state to adopt the NGSS as its state science standards. These standards reflect more than twenty years of research on science teaching and learning regarding what and how we should be teaching science in the classroom. A major shift is the focus on the ability to demonstrate understanding of science content, science and engineering processes, and cross-cutting concepts through performance expectations. Critical to this process is the development of the pedagogical content knowledge of teachers to teach topics on climate change. Pedagogical content knowledge (PCK) is the practical knowledge of how to teach a specific discipline – the knowledge of processes, effective strategies, student knowledge and misconceptions; it is the blending of core content knowledge with effective pedagogy for teaching that content.

Climate change as a classroom topic has not been a central part of the PCK of teachers. Coupled with the need to provide instruction on climate change is a significant shift in the way science is to be taught to align with the NGSS. The changing emphasis is best illustrated by a sampling of the standards in earth science in the NGSS. Note that Table 1 does not provide a complete listing of the standard; it only provides the performance expectations**.**

Examination of these standards illustrates the shift to students being able to show their knowledge, reason from data, conduct analysis, and collect data to support their knowledge claims with evidence. Students themselves create understanding using data. In order to achieve the dual vision of empowered citizens and teachers who have the PCK to teach in a manner consistent with climate change education and the NGSS there is a need to provide professional development that can lead to teachers who can teach in a manner that engages students in doing science.

The GLOBE program (www.globe.gov) provides materials, methods, data, and protocols that teachers can readily adopt and adapt to meet the NGSS vision of student learning and address the need for a more informed populace on climate change. The project described in this poster targeted underserved and underrepresented rural schools in Kansas. The intent of the workshop was to increase teacher content knowledge on climate change, provide training on GLOBE protocols that align with the NGSS, and develop an implementation plan for the NGSS with GLOBE for AY 2015-16.



Dr. Paul Adams instructing teachers.

TABLE 1: Selected NGSS Standards Related to Climate Change
MS-ESS2-2 *Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.*
MS-ESS2-4 *Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and forces of gravity*
MS-ESS3-5 *Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century*
MS-ESS2-6 *Develop and use a model to describe how unequal heating and rotation of the Earth cause patters of atmospheric and oceanic circulation that determine regional climates.*
HS-LS2-6 *Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organism in stable conditions, but changing conditions may result in a new ecosystem.*
HS-ESS2-2 *Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.*
HS-ESS2-4 *Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate*.
HS-ESS3-5 *Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.*
HS-ESS3-6 *Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.*

ACTIVITIES AND PROTOCOLS

NGSS – high school standards, 3D Learning, using data for performance expectations

GLOBE Protocols

Defining a Site and shelter location, GPS Protocol

Atmosphere Protocols

- What are the objectives for Atmosphere training?
- What can data tell you about seasonal cycles?
- What are GLOBE's Basic Atmospheric Protocols?
    - Cloud cover
    - Cloud Type
    - Maximum and Minimum air temperature
    - Errors
    - Precipitation Data
    - Relative Humidity
- How can data be entered into the GLOBE data archive?

Advanced Atmosphere Measures

- Surface Temperature
- Sun Photometer

Phenology

- What is a season?
- What do temperature and precipitation data reveal about seasonal patterns?
- How can seasons be monitored?

Land Cover

- What are the objectives for Land Cover training?
- What types of land cover have you observed?
- How do we classify land cover in the field?
- How are Land Cover data collected?

Globe Investigations – Data Visualization

Development of a GLOBE Implementation Plan with the Next Generation Science Standards

Science teachers collecting data.

SAMPLE IMPLEMENTATION PLAN

Month	Concepts Benchmarks, Standards, Norms, Goals	Approach Current Activity, Lesson	Using GLOBE Protocol/Learning Activity as a substitute
Aug	Earth as a system, introduce atmospheric interactions MS-ESS1-1 MS-ESS2-6 MS-PS – 1-6 MS-PS-4-2	Classes are divided into groups, each taking a measurement, enter the data on clipboards, GLOBE and class LoggerPro Ongoing measurements, relate to seasons/tilt of axis	30 x 30 plot and Weather station protocols: Daily temperature (air/surface), daily precipitation, relative humidity, clouds Earth as a system: Modeling the reasons for Seasonal Change Cloud percentages activity Surface temp (IRT) Soil temperature
Aug to May	Ongoing atmospheric data collection	Data collection at Station	Data collection at Station.
Aug	MS-ESS1-1		Earth as a system: Seasonal Change on Land and Water
Sep	Earth as a system: biosphere		Green-down – fall plants
Dec	ESS1-1 PSS3-3		Winter – bud-burst project activity to prep for greenup
Feb/Mar	Earth as a system: plants and animal relationships with sunlight, moisture, temp requirements by plants MS -ESS2-6 MS-LS-1-5 MS-LS-1-6		Spring- budburst, greenup Seed germination Soil temperature
Apr	MS-PSS3-3 MS- PSS3-4 MS- ESS1-1		Use GLOBE data to compare solar energy in latitudes
May	MS-ETS1- 1-4		Design an atmospheric system that will let in energy and create a greenhouse effect. Ideas: create a cloud system to shield an area but let in certain (given) percentage of light to accomplish a goal/simulate cooling from cloud cover i.e. enough energy for seedling germination without evaporating water in a dish. Or…. provide enough sunlight for plant growth, but the shield protects an animal from overheating.

PARTICIPANT INFORMATION

The summer 2015 GLOBE Workshop was held at Fort Hays State University. Twelve teachers from Kansas attended the workshop. Statistics related to the participants.

Teacher Statistics

Gender: Female (6), Male (6)

Area: Urban (4), Suburban (1), Rural (7)

Number of Schools Served: 16

Number of School Districts Served: 11

SUMMARY

One of the measures of the impact of the week-long workshop was to determine its impact on teachers' understanding of the science related to the climate change. To assess this the teachers took a pre-, post- exam using the *Greenhouse Effect Concept Inventory* (Keller, 2007). A one-tailed matched pair t-test was used for the analysis of the average score; there was a significant gain ($p<0.0001$) indicating the participants had a better understanding of some of the science undergirding climate change. Of greater significance was the development by the teachers of implementation plans to incorporate GLOBE protocols and data for teaching the NGSS earth and space science standards as shown in the Sample Implementation Plan. Future work related to this project involves a follow-up workshop in April 2016 and survey on use of the workshop material in the classroom during AY 2015-16.

REFERENCES

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