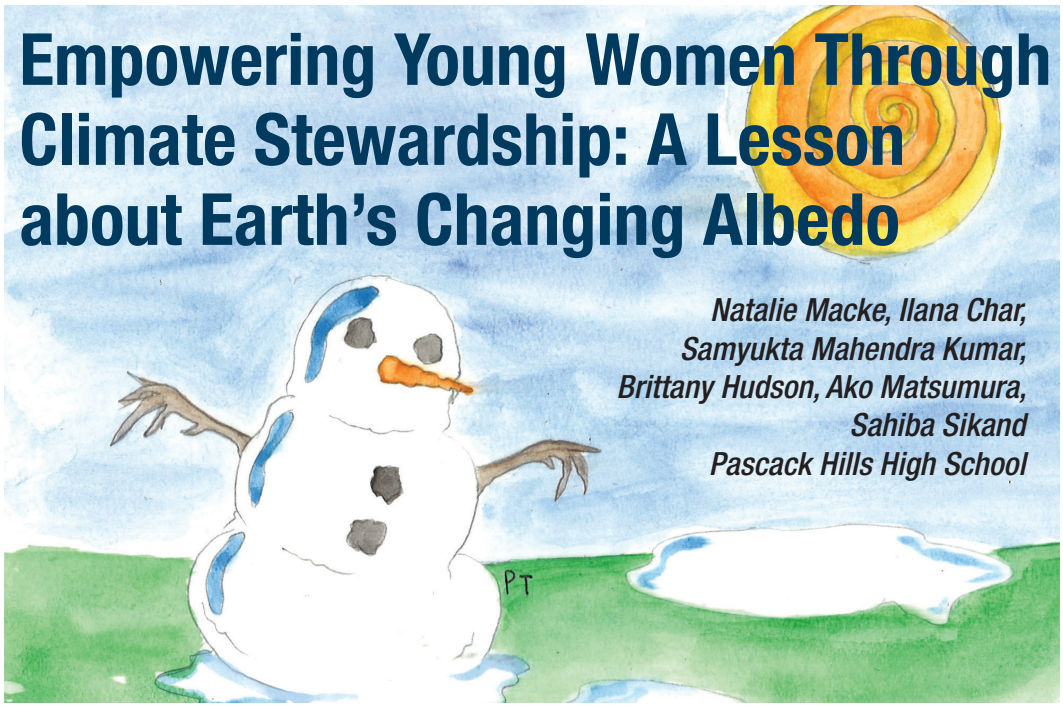
Empowering Young Women Through Climate Stewardship: A Lesson about Earth's Changing Albedo



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Abstract

A Climate Stewards Club, as part of the NOAA Climate Stewards Education Project (CSEP), was established as an after-school high school program to empower young women as community leaders who would be then, both willing and capable of addressing their peers and the public about issues related to global climate change. The student club identified the need to support climate literacy in the middle school by providing opportunities for learners to engage in hands-on activities that assisted in student understanding of how Earth's climate system works. The students and their mentor developed an engaging, hands-on lesson that allows students to learn about the feedback loop that describes the ice-albedo effect. The process of how a team of high school students developed the lesson and associated materials is described. The outcomes of this peer-facilitated lesson as well as the benefits of the after school club focused on climate stewardship are discussed.

Introduction

Finding opportunistic and meaningful ways to connect students with STEM education has often been a challenge. In the NOAA Climate Stewards Education Project, an educator is charged with engaging young people in climate literacy via a climate stewardship activity. In response, an after school Climate Stewards Club was initiated in the Pascack Valley Regional High School District community in Montvale, New Jersey to engage and empower teenage girls to solve relevant problems associated with global climate change. The group was created specifically to provide young women, who are interested in learning more about global climate change, the opportunity to socialize, learn and ultimately give back to their community. As described by the National Research Council, a successful STEM program should consist of a supportive and social environment that engages young people on an intellectual, social and emotional level (National Research Council; Committee on Successful Out-of-School STEM Learning, 2015, p. [Page 21]). Creating a group solely for teenage girls has allowed for a special camaraderie as well as seriousness of purpose that has resulted in a variety of successful public endeavors and learning opportunities for the young

women. In the end, the group decided that it was important for their stewardship activity to teach younger learners about how climate change is both serious and solvable.

Informal Education with Student Driven Goals and Objectives

The Climate Stewards Club started in 2013 with a small group of sophomore girls, age sixteen. When they were approached about their questions, concerns and interests associated with global climate change, their immediate response focused on two criteria: 1) lowering their carbon footprint and 2) engaging younger learners in climate education. The immediate efforts of the group focused on engaging stakeholders at the high school about the potential for solar energy and specifically, the construction of a solar charging station dedicated for student use to charge their school laptops and other personal electronic devices. The team conducted a needs assessment of the students, collaborated with students enrolled in engineering classes, and reached out to a variety of community resources to learn more about solar energy. This outreach manifested in both a field trip to a local company that conducts research to improve photovoltaic cell efficiency and also a visit from a solar energy instructor from a local technical school. Ultimately, the requirements of the project required resources beyond the scope that the team initially anticipated. Having publicly presented the project to the local Board of Education, the team is hopeful that the solar charging station will be challenge adopted by the Climate Stewards at the school in years to come. The group never branded the experience as a failure. Instead, when asked, each of the young women recognized specific learning opportunities the group experienced that they identified as helpful to their emotional and professional growth. All of the group's participants identified the public presentations to the Superintendent of Schools and the local Board of Education, as well as the informal presentation via a videoconference with a school in Taiwan as highlights of their experience.

Figure 1. Climate Stewards Club member uses NASA satellite data to make the lesson maps.

Figure 2. Climate Stewards Club members making Climate Change lesson maps.

The following school year the Climate Stewards Club grew in size to eleven team members, which then included a new group of sophomore girls. The team's focus turned from altering their carbon footprint to engaging younger learners in climate education. All of the students recognized that they had engaged in limited or no formal education about climate change in their middle school years. This statement is supported by National Earth Science Teacher's Association's statistic that only 36% of educators at the middle school level include climate change lessons in their curriculums (NESTA, 2011). The team decided on the theme of "Climate Change is Serious and Solvable" for their lesson. The juniors, now our team's experts in their understanding of solar energy quickly chose the task of developing a lesson to fulfill the solvable portion, while the new sophomores members were charged with the challenge to develop one simple lesson that would demonstrate how serious global climate change was and why immediacy was needed in terms of acting.

The Lesson: Climate Change and Feedback Loops

Addressing the need to help students better understand Earth's climate system, a team of students developed a lesson entitled, *Feedback Loops and Climate Change* (1.usa.gov/1pqGiP8). This need was identified when all Climate Steward Club members were asked to complete The Climate Stewards Education Program Audience

Knowledge Survey (http://csknow.questionpro.com)prior to start of work on club activities. All members gave a rating of "Not very informed" for the question asking how well informed they were about how the Earth's "climate system" works. When the middle school audience was surveyed using the same tool, they too overwhelmingly indicated a lack of knowledge and understanding in this area. The team decided that the goal of the lesson should allow for students to discover how a feedback loop involving a melting cryosphere is impacting Earth's climate (Gardiner, 2007).

Three maps (approximately 4' x 3') modeling a melting cryosphere were drawn using available resources from NASA, NOAA and the National Snow and Ice Data Center (NSDIC) (Figures 1 and 2). Students accessed and used the MY NASA DATA Live Access Server (http://mynasadata.larc.nasa.gov/) to create the map projection and identified the current snow and ice extent in the northern hemisphere using the Atlas of the Cryosphere from the NSDIC (http://nsidc.org/cgi-bin/atlas_north) (NASA, nd.; Mauer, 2015). The estimation for percent ice and snow loss was taken from the NOAA 2012 and 2014 Arctic Report Cards. Decadal decreases in snow cover extent (SCE) were greatest in the spring months. Records show a decadal SCE loss of 17.6% and 19.8% in 2012 and 2014 respectively (NOAA, 2012) (NOAA, 2014). Models predicting future ice loss were created based on those percentages (Figure 3).

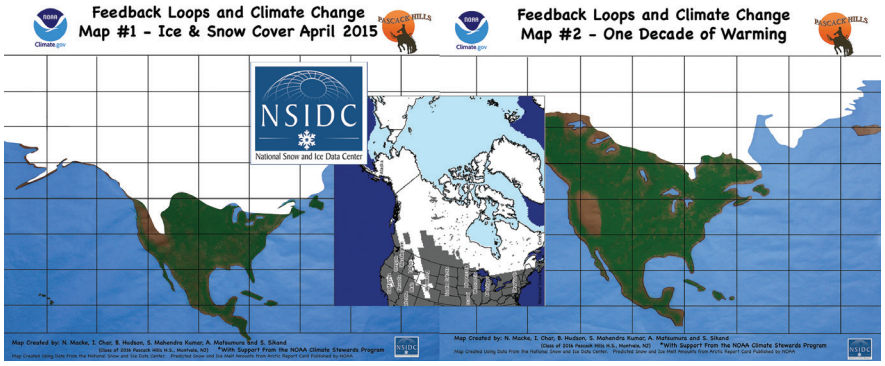

Figure 3. Examples of two maps created using combined data and information from NASA, NOAA and NSIDC.

This investigation, led by the Climate Stewards Club, initially prompted the middle school learners with the question: "How can changing amounts of snow cover in the cryosphere impact Earth's climate?" After an initial discussion, student teams were given PascoTM light sensor probes, a laptop and large maps of the cryosphere (current SCE, less 20% SCE and less 40% SCE). After the middle school students were introduced to the equipment, their teams were asked to identify and discuss the variables in the experiment. As a class, they were charged with developing a procedure that resulted in a controlled experiment. Students quickly identified that the position and angle that the probe was held changed the value recorded. But often, students needed some prompting to identify the light source as a variable that affected the data retrieved from their model. The teams commenced collecting data once the class agreed on a procedure that accounted for all necessary controlled variables (Figures 4 and 5). Students used this datasheet (1.usa.gov/1OVoKPv).

Figure 5. Climate Stewards Club members helping the middle school students collect data using the Pasco™ PASPORT Light Sensor.

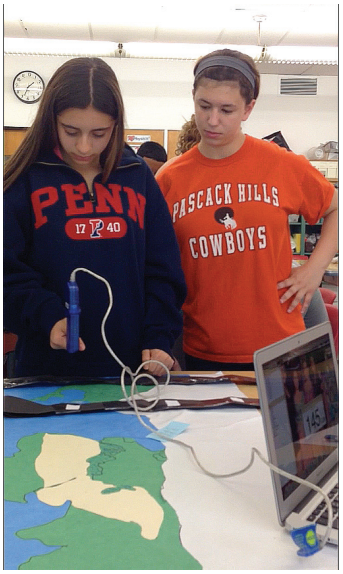

Figure 4. High school student helping middle school student collect data with the Pasco™ PASPORT Light Sensor.

Figure 6. Students arrange cards to discover how a melting Arctic is part of a positive feedback loop that impact Earth's climate.

Feedback Loops

The cause and effect relationship described in a feedback loop was an important crosscutting concept in the lesson. When student groups completed data collection and analysis, they were introduced to the concept of a feedback loop using examples from their daily life. Students were then issued the Feedback Loop card set and asked to organize the pictures (Melting Ice & Snow; Less Reflectivity (Lower Albedo); Warmer Temperatures on Earth) to demonstrate the feedback loop (Figure 6). Upon successful development of the model, students were handed the last card in the set; a car image with the writing, "Use of Fossil Fuels". The learners were then challenged with figuring out how to incorporate this card in their feedback loop model. It was requested that groups discuss their ideas as well as develop questions to ask the facilitators. The "Use of Fossil Fuels" card does not fit directly in the loop. The facilitators only answered questions, clarified misconceptions and kept students focused during this activity. This part of the lesson prompted students to engage in discourse about the impact of using fossil fuels and the role they play in Earth's climate system.

Results of a Climate Stewardship Lesson

This mentored, peer-facilitated lesson that was prepared and conducted with 160 middle school students as part of a NOAA Climate Stewards project, demonstrated successes and also identified future challenges for the group. When the middle school learners were surveyed in 2014 after the completion of the Feedback Loop and Climate Change lesson, 84% of respondents acknowledged that their understanding of Earth's climate system had improved. While the lesson was very well received, the time constraints of the program required the lesson to be edited. Time was devoted to two critical elements that are now part of the lesson. First, the students needed some time to develop an understanding of what the Pasco™ light sensor probes were actually measuring. In response, the lesson was adapted to allow for students to informally experiment with the probes prior to the map investigation, thus discovering the limitations of the measurement tool. Second, the concept of a feedback loop was new to the learners. They needed time to discuss and challenge their understanding of this concept in the context of climate change. In order to differentiate that experience, a discussion format that challenges students to ask questions of the peer teacher was added. This format also allows misconceptions about climate change to be addressed.

Learners were asked specifically about their understanding of the feedback loop concept in the post lesson survey in 2015. Students were asked to choose from a list all of the factors that contribute to Earth's changing climate. Out of 42 respondents 86% of students identified Earth's climate was part of the feedback loop and that the amount of solar light reflected was a contributing factor. This value declined to 74% for submissions that also included "warmer atmospheric temperatures". This indicates, that while most (if not all) students came away with the new vocabulary of "feedback loop", only 74% of them were able to completely parse out what that meant in terms of Earth's changing climate.

The true success of this Climate Stewardship project is the engagement of the young women participating in the Climate Stewards Club. Given the unique opportunity to return to their local middle school and engage young learners in a wanted discussion about the science of climate change, they each have an increased confidence when engaging with their peers or the public about climate change topics. Over two years, the group has identified the challenges they faced when conducting

the lesson and then modified it to address those needs. The ability for students to work over a long period to refine a product is unique to this type of informal education opportunity. The group has continued their efforts to improve the lesson, *Feedback Loops and Climate Change* as well as become involved with other climate research and stewardship activities.

Acknowledgements

The activities and lesson described in this paper were support by a NOAA Climate Stewards mini-grant. Beside the listed authors, student Brittany Van Velkinburgh also contributed to the development of the *Feedback Loops and Climate Change* lesson and supporting documents. Special thanks to Dr. Patricia Sullivan at Woodcliff Lake Middle School for welcoming our Climate Stewards Group to conduct our Climate Change is Serious and Solvable Program.

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Map Resources

Feedback Loop Card Dataset
1.usa.gov/1UYUcnr

Ice & Snow Coverage April 2015 Map
1.usa.gov/1U75tTd

One Decade of Warming
1.usa.gov/24ViuTV

Two Decades of Warming
1.usa.gov/1SGAYCx

About the Authors

Natalie Macke has been a secondary science teacher for more than 15 years in New Jersey. In 2012 her selection for participation in the NOAA Climate Stewards Education Project prompted her to establish a girl's STEM club focusing on Climate Stewardship at Pascack Hills High School. In addition, she developed a fifteen-week honors-level course on Climate Change offered by the Virtual High School (http://thevhscollaborative.org/). In 2015 she was the recipient of the Princeton Distinguished Secondary Teaching Award. Natalie can be reached at nmacke@pascack.k12.nj.us

Ilana Char, Samyukta Mahendra Kumar, Brittany Hudson, Ako Matsumura and **Sahiba Sikand** are all students at Pascack Hills High School in Montvale, New Jersey. These young ladies have been members of their school's Climate Stewards club since 2013 and are responsible for the development and implementation of the middle school lesson shared in this article about Earth's Changing Albedo. They will all graduate in 2016 and may be reached via their teacher, Natalie Macke.