Furthering careers in cyberinfrastructure and polar science

Dr Linda Bailey Hayden is a professor of computer science at Elizabeth City State University, North Carolina, and is also a director of the Center of Excellence in Remote Sensing and Research. Her current work includes a project that provides research experiences to undergraduate students, graduate students and aspiring teachers in the polar regions and scientific gateways, with the aim of advancing the careers of a diverse group of future science gateway users, gateway developers and polar scientists. She is responsible for over $25 million in funded projects.

The polar regions are the most distant reaches on our planet, and are largely untouched by our influence. They are inhospitable, often facing extreme weather conditions and experiencing wide variations in light levels throughout the year, meaning that the polar regions are not as well understood as other areas of the Earth. The Arctic and Antarctic are vulnerable to climate change, and the increasing temperatures associated with global warming cause polar ice sheets to melt and break. This is an issue as it can impact the habitat available to polar species, as well as influence sea levels, rendering polar research highly important. Historically, polar science and the broader STEM field has seen limited diversity in the workforce, but as social understanding has advanced, increasing numbers of women and those from minority groups have entered STEM careers. Dr Linda Hayden of the Elizabeth City State University has spent a long career in polar and cyberinfrastructure research, and has conducted numerous programs to encourage women and minority students to enter further study and careers in STEM by providing training, research experiences, and field work opportunities in polar science and cyberinfrastructure.

CYBERINFRASTRUCTURE AND POLAR RESEARCH

A suite of programs, CReSIS, Polar Grid, and AaA, funded by the National Science Foundation, are addressing the problems associated with the impact of melting ice sheets on sea level rise. CReSIS, the Center for Remote Sensing of Ice Sheets, led by Dr Gogineni, was founded in 2005 with the goal of developing and supporting technology and computer models that monitor the mass balance of ice sheets. The Polar Grid project, which commenced in 2007, led by Dr Geoffrey Fox, aimed to develop a cyberinfrastructure from the North to the South Poles, which consisted of a computer grid of rugged laptops and clusters in the polar regions and two large-scale clusters at the Indiana and Elizabeth City State Universities. Polar Grid made it possible for researchers to collect and analyse data without making multiple trips to these regions, reducing the cost of polar research. The REU Site: Arctic and Antarctic (AaA-REU) Project with Research Experience for Teachers, led by Dr Hayden, began in 2013 and aimed to integrate education and research in the poles to drive a diverse group of students into polar careers. This has successfully improved the research skills and confidence of the participating students, encouraging them to consider pursuing further study or careers in STEM. The research experiences that this project provides also allows them to work closely with other students and established scientists, which facilitates interaction between students, developing a more collaborative research environment.

Similarly, the Science Gateways Community Institute, founded in 2016, is at the forefront of cyberinfrastructure (CI). The SCGI greatly enhances the ability of students and scientists to use science gateways (web-based interfaces that allow remote access to storage systems), significantly improving the productivity of researchers by providing easy access to specialised, shared resources for scientific or engineering disciplines. The SCGI also incorporates Workforce Development, which aims to inspire, educate, and train the next generation of science gateway users and developers. Its mission is to educate and train a diverse population of graduate/undergraduate students, faculty, and IT personnel, and to provide training opportunities for undergraduate students as a pathway to graduate education. This will be achieved by providing financial support, workshops, internships, mentoring and access to a Young Professionals Network to both students and educators to support their growth in the field.

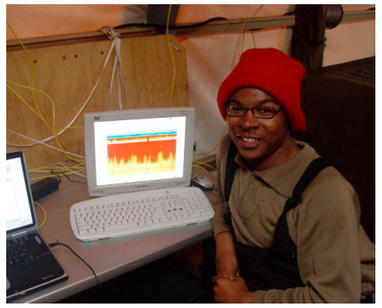
WORKFORCE DEVELOPMENT

Dr Hayden can be found at the forefront of both polar science and CI, helping to shape the workforce development efforts and aggressively reaching out to women

Polar Grid made it possible for researchers to collect and analyse data without making multiple trips to these [polar] regions

and underrepresented minority students, broadening the diversity of the STEM workforce. Dr Hayden currently leads the Workforce Development component of the SGCI, providing support for students and IT developers, and encouraging community engagement.

The model of engagement for all projects includes research training, professional development activities and field work or internships, providing students with a range of skills needed for polar and cyberinfrastructure research while working closely alongside their peers and experienced scientists in those fields. This has kickstarted the careers of hundreds in scientific research, 80% of whom were African American or Native American, and 55% of whom were women, all of which are groups that have been underrepresented in STEM fields. Although the SGCI has only been operating for approximately one year, it is expected that the internships and programs it offers will inspire a wide range of students to pursue gateway development as a career path. Such programs are important as, in the past, many talented aspiring scientists have been overlooked, or their careers in STEM discouraged due to their background. Engagement models have made valuable research experiences available and viable for talented and bright minority students, or those of a lower socio-economic status, ultimately encouraging them to remain in STEM and pursue careers in this field.



All three images show Jerome Mitchell during his Antarctic field work. While completing his PhD in computer science at Indiana University, Jerome has redirected his CReSIS work and serves as a trainer for the next generation, on Gateway and HPC development tools.

A VALUABLE EXPERIENCE

Jerome Mitchell's academic career is one instance of the pathway that students have followed due these collaborations. Jerome was an undergraduate computer science (CS) major at ECSU, when he completed two CReSIS supported internships at the University of Kansas. He spent Christmas, his 21st birthday, and the new year on the West Antarctic Ice Sheet. Jerome went on to complete his Master's degree in CS at the University of Kansas and is now in the final stage of completing his PhD in CS under Dr Fox at Indiana University.

Jerome says: "Having spent two consecutive summers at The University of Kansas conducting polar ice research, I was familiar with the threats and concerns of the coastal regions. CReSIS, which has a partnership with Elizabeth City State University to increase the awareness of minorities in the areas of remote sensing, has multiple teams to contribute to the area of studying glaciology; these areas include robotics, sensors, intelligent systems, communications, radar, and geography. While I was at the West Antarctic Ice Sheet (WAIS) field camp, my responsibilities centered on operating the plane-wave radar, which measures the annual accumulation of snow for determining its net balance, and digging snow pits to accurately test the results of the plane-wave radar by density snow core samples." One of Jerome's duties was to ensure that the radar was calibrated to the satellites that relayed pertinent data to researchers at the camp using similar software to the programs he used at ECSU.

Jerome is one of many students that have benefitted from the projects mentioned in this article, and who have entered further study or careers in the STEM field. Dr Hayden's workforce development efforts have proven to be vital for encouraging the next generation of scientists in the polar and computer science fields so that STEM will become more inclusive and a viable career path for all.

Engagement models have made valuable research experience available and viable for talented and bright minority students

Q&A

What are some of the common challenges in conducting research in the polar regions?

Traditionally, data collected during polar research expeditions could not be extensively analysed until expedition scientists returned to their home labs. Scientists could not evaluate data accuracy and quality until an expedition had ended, and experiments could not be repeated or expanded until returning to the field the following year. Polar Grid helps to improve data quality and reduce the time between data collection and scientific discovery.

How valuable are research experiences, such as the ones discussed here, for aspiring scientists?

Polar and CI research and educational experiences are the foundation of the program. The vision for this project is driven by the compelling need to draw on the integration of research and education. Equally important is that it encourages undergraduate students to pursue graduate school in a STEM field. The research experience not only provides discipline-area knowledge, but also involves undergraduates in collaborative, interdisciplinary teams that they might not otherwise experience during their undergraduate education programs. In previous years of executing REU programs, mentor-relationships with technical and scientific research staff, faculty, and graduate students have proven to be an extremely important component of successful REU experiences, and may be the determining factor in whether or not a participant opts to attend graduate school. Training also includes seminars on the code of ethical research; formatting a professional paper; preparing for graduate school; writing a professional statement; resume writing; and designing a research poster.

How has your university and SGCI benefitted from your Polar research?

The products of these experiences have resulted in astonishing research and education results. Note that a group of students under the direction of Dr Malcolm LeCompte and Dr Linda Hayden at Elizabeth City State University conducted a research project to quantify ice margin changes in the Amundsen Sea region, using LIMA as a benchmark. They discovered a small ice shelf that had gradually shrunk from 1972 to 2003 and has failed to reform. The feature was named by US-Advisory Committee on Antarctic Names (ACAN) Board of Geographic Names (BGN) for Elizabeth City State University in Elizabeth City, North Carolina. The name "Elizabeth City State University Bay" has been approved for use on maps and other products of the Federal government. Few institutions have geographic features named in honour of their research. I certainly could not turn down the opportunity to have similar impact with other students. Such is the opportunity offered by the Science Gateway Community Institute.

What is the legacy of CReSIS AaA for future collaboratives including the Science Gateway Community Institute?

The final review team for CReSIS wrote that: "CReSIS leaves a legacy in a number of areas. These include the sensors and platforms that they developed to improve the quality and coverage of the geophysical measurements that they collected; the archived data products and satellite observations of the Greenland and Antarctic ice sheets that have led to a more complete understanding of those ice sheets and how they are changing; the modelling and analysis efforts that have contributed to an understanding of the physical processes that shape how ice sheets evolve and how changes in the ice sheets contribute to sea level rise; a large group of undergraduates and graduates who have gone on to industry and academic careers in the field and K-12 programs involving students and teachers to engage students in pursuing geoscience careers and becoming science literate citizens." Future collaborations including the Science Gateways Community Institute will use the extensive and effective outreach infrastructure that has been created.

Detail

RESEARCH OBJECTIVES

Dr Hayden is currently working towards providing research experiences to undergraduate and graduate students as well as aspiring teachers in the polar regions and scientific gateways, with the objective of advancing the careers of the future generation of a diverse group of science gateway users, gateway developers and polar scientists.

FUNDING

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COLLABORATORS

- Center for Remote Sensing of Ice Sheets (CReSIS): Drs Sivaprasad Gogineni, Geoffrey C Fox (Indiana University), Andrea Lawrence (Spelman) USA.
- IEEE Geoscience and Remote Sensing Society Chapter numbers 03191 and 66221.
- Elizabeth City State University (ECSU): Dr Malcolm LeCompte and Andrew Brumfield.
- Science Gateway Collaborative Institute (SGCI): Nancy Wilkins-Diehr (SDSC), Katherine Lawrence(UMich), Michael Zentner (PURDUE), Marlon Pierce (IU), Maytal Dahan (TACC).

BIO

Dr Hayden is a Director of the Center of Excellence in Remote Sensing Education and Research (CERSER) on the campus of Elizabeth City State University in north eastern North Carolina. She has been awarded the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM) by the NSF. She currently leads the Workforce Development component of the NSF Science Gateways Community Institute.

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