Fertilizing ROSES through the STEM: Interdisciplinary Modules as a Pre-service Research Experience for Secondary STEM Educators

IMPRESS-Ed

Abstract ID: ED53C-0803

Introduction

IMPRESS-Ed is a program designed to provide authentic, full-time summer research experiences in the space, earth, and atmospheric sciences for pre-service K-12 STEM educators.

In 2011, the program was housed in the Physics Department at The College of New Jersey in Ewing, NJ and involved five students. The program took place over eight weeks during June and July, with recruitment occurring during the preceding academic year. The program was divided into two modules: A common core module and an individual mentored research experience.

The common module (two weeks) consisted of three units focusing on data-driven pedagogical approaches in astrophysics, geosciences, and atmospheric science, respectively. The common module also featured training sessions in observational astronomy, use of a 3D geowall, and state of the art visualization system designed and built by the IMPRESS-Ed team.

The individual mentored research module (6 weeks) matched student interests with potential projects and faculty mentors.

Participants in the program also offered the opportunity to utilize the available TCNJ facilities with their future students. Given that a large number of graduates from the TCNJ take positions in local New Jersey schools, the opportunity to make use of these facilities at a future time would be of great significance to them and their future students.

The research program was also incorporated into the framework of the TCNJ Mentored Undergraduate Summer Experience (MUSE), which provides weekly seminars and community-building activities for approximately 85 undergraduate summer researchers. This program concludes with a large research symposium in which all participants present the results of their research efforts.

Implementation, 2011

The IMPRESS-Ed program was advertised in March to all dual pre-service education and math, science, or technology students at TCNJ. Twenty students applied, representing a significant fraction of the approximately 75 eligible students at the college. The five students selected to participate came from the Physics and Secondary Education dual major program as well as the Math/Science/Technology and Elementary Education programs.

The program began with a kick-off barbecue, community building activities sponsored by MUSE, and the commencement of the two week common module. In astrophysics, students learned about active galactic nuclei; in geosciences, students learned about seismic and volcanic natural hazards; in atmospheric science, students learned about the state of the science in tornado and hurricane prediction. All common module elements included inquiry-based group exercises, including hands-on labs, simulations, computations, and observations. All exercises were developed with an eye toward future application in the K-12 science classroom. Program materials are available at www.tcnj.edu/~impress.

Research led by M.H. Benoit analyzed gravity data from the NASA-GRACE mission to find lithospheric density contrasts beneath the eastern US. A student working with N.B. Magee used data from NASA satellites CALIPSO, CloudSat, and AQUA-MODIS to study the dynamics of convective cloud tops. Research projects led by M. Kavic performed simulations to investigate the possibility of detecting superconducting cosmic strings using radio observations and also designed and constructed a radio interferometer based on the NASA-Jove program. P. Wita supervised a research project studying star-forming regions of active galaxies through analysis of images from the Hubble Space Telescope and NASA: GALEX.

Outcomes

- Initial evaluation (by Meredith Stone, external evaluator) of the program was highly positive. All five students demonstrated strong gains in earth and space science literacy compared to a baseline measurement and all five students reported enjoying the program and would recommend it to peers.

- Each student also reported gaining confidence to incorporate data and research-driven instruction in the space and earth sciences into the K-12 classroom setting.

- All five research projects were quite successful; four of the students have continued research during the fall of the 2011 academic year, two students are co-authors on research poster here at AGU and one student will be presenting her work during the January American Astronomical Society meeting. Several of the students are now considering advanced degrees in earth or space science to buttress preparation for a teaching career.

Acknowledgements

This project was supported by NASA-ROSES grant# 10-EPOESS-10-0047. We would like to thank Meredith Stone for her work as external evaluator and consulting experts, Dr. John Simonetti of Virginia Tech., and Dr. Matthew Cathell and Dr. Dashia Magee from TCNJ.

<table>
<thead>
<tr>
<th>Student</th>
<th>Degree Program (B.S.)</th>
<th>Research Mentor</th>
<th>Research Project</th>
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<tbody>
<tr>
<td>Data Disposto</td>
<td>Math/Science/Technology and Elementary Education</td>
<td>Michael Kavic</td>
<td>Construction, Operation, and Replicated Observations from TCNJ’s First Radio Interferometer (TFIR)</td>
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<tr>
<td>William Dybus</td>
<td>Physics and Secondary Education</td>
<td>Margaret Benoit</td>
<td>Spectral Analysis of Odorant Gravity Data in the Northeastern US Potential at Joel AGU</td>
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<td>Rachel Goldberg</td>
<td>Math/Science/Technology and Elementary Education</td>
<td>Nathan Magee</td>
<td>Comparative Azimuth Determination of Ozone Heating Tops in Severe Thunderstorms Potential at Joel AGU</td>
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<tr>
<td>Joanna Papadopoulos</td>
<td>Math/Science/Technology and Elementary Education</td>
<td>Michael Kavic</td>
<td>Observational Constraints on Radio Emissions from Binary Neutron Star Mergers Presenting at spring AAS</td>
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<tr>
<td>Thomas O’Dell</td>
<td>Physics and Secondary Education</td>
<td>Paul Wita</td>
<td>Characterizing Star Formation Region Using Gaia and Hubble Images</td>
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</tbody>
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The recruitment flyer was posted and delivered to potential faculty and student participants. 15 students attended the information session and 20 applications were received.

IMPRESS-Ed 2011 Participants:
Top Row, from left: Michael Kavic, Tom O'Dell, Will Dybus, Margaret Benoit
Bottom Row, from left: Paul Wita, Dana DiPeppe, Rachel Goldberg, Joanna Papadopoulos, Meredith Stone, and Nathan Magee

The TCNJ GeoWall, an HD, 3D visualization system was designed and built in partnership with IMPRESS-Ed.

The Radio Jove Installation on the campus of TCNJ was leveraged to construct a Radio Interferometer

The Science Complex at TCNJ, housing two observatory domes and the Physics Department where the IMPRESS-Ed program was housed.

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