Shaping Michigan's Next Generation of Environmental Scientists

SHAPE STEM



SHAPING MICHIGAN'S NEXT GENERATION OF ENVIRONMENTAL SCIENTISTS

The state of Michigan is experiencing numerous environmental threats, risking the health and wellbeing of its residents. STEM professionals are urgently needed to help solve these problems and mitigate the impending public health disasters. However, the number of students graduating with STEM degrees in the state has been declining. Researchers at Siena Heights University are addressing this need through their teaching and development program, SHAPE STEM, which aims to increase the recruitment and retention of low-income academically talented students in STEM subjects.

Environmental Crises in Michigan

Environmental problems plague the state of Michigan, threatening the health of both people and wildlife. The Flint water crisis, which began in 2014 as a result of switching the city's water supply to the contaminated Flint River, brought into focus the dire consequences of environmental mismanagement. Residents, including thousands of children, suffered ill health from consuming the lead-contaminated drinking water. Additionally, at least 87 people were affected by an outbreak of Legionnaires' disease, with 12 people losing their lives as a result.

The polluted waters of Flint are by no means an isolated issue. Lead-polluted air threatens the health of the residents in the metropolitan city of Detroit. Runoff from agriculture, industry and landfill sites contaminates the waterways of the Great Lakes surrounding the state. Agricultural products tainted with toxic herbicides have found their way to consumers. The Environmental Protection Agency has designated 89 sites in Michigan as 'Superfund hazardous waste sites' – requiring extensive, long-term action to clean up contaminants.

There is an urgent need for graduates of science, technology, engineering and mathematics (STEM) in the region to help solve these environmental problems and mitigate future public health crises. In 2015, the Michigan Department of Technology, Management, and Budget reported that STEM employment is growing by 4.3% per year in the area, and the Alliance for Science and Technology Research in America anticipates a growth of STEM occupations ranging from 7% to 23% between 2016 to 2025. Despite this, the number of STEM graduates has been declining. In 2016, the Michigan Farm Bureau estimated that 54,000 agricultural jobs will be available annually in Michigan, but only 55% of these openings will be filled by people with degrees from colleges of agriculture, life sciences, natural resources, or veterinary medicine.



A team of researchers and professors from Siena Heights University in Adrian, Michigan, are addressing these needs through a comprehensive training and mentoring project funded by the National Science Foundation's STEM scholarship program. The project, entitled Siena Heights: Applying Psychological Constructs and Student Supports to Improve the Education of Students in STEM (SHAPE STEM), aims to increase and retain the number of qualified graduates trained to address 'SHAPE STEM has the potential to generate evidence that can be used to improve motivation and learning in other Siena Heights University students. This support structure could also be adapted and used by other higher educational institutions.'



issues of environmental sustainability and health entering the Michigan workforce. With approximately 78% of Siena Heights University's STEM graduates remaining in the region after graduation, SHAPE STEM scholars will help to support this regional growth.

Psychological Support and Mentoring

The SHAPE STEM program awards scholarships to academically-talented undergraduate students from lowincome backgrounds majoring in biology, chemistry or environmental sciences at Siena Heights University. In addition to financial support, the program offers students a range of motivational and psychological support elements geared towards increasing persistence in the demanding STEM subjects.

The program's motivational supports build on the university's successful student support services aimed at improving retention and educational outcomes. SHAPE STEM aims to retain 20 students recruited to the program each year, graduate those retained, and help graduates secure STEM jobs or continue on to postgraduate courses. The National Academy of Sciences has suggested that increasing the number of employees from varied social and cultural backgrounds in the STEM workforce fosters inclusivity and can enhance innovation and productivity.

During their first two years, SHAPE STEM students participated in seminars, facilitated by Principal Investigator Dr Jun Tsuji, along with Drs Heather Moody and Steve Wathen, to introduce them to strategies to overcome the problems often experienced by low-income and first-generation students. On average, first-generation students achieve lower grades and have poorer retention rates than their peers. These students often lack a sense of belonging and the confidence to seek help or pursue opportunities. Psychological support seminars, provided by co-Principal Investigators Dr Patricia Rousselo and Dr Jeffrey Lindstrom, are integrated into the SHAPE STEM seminar series and aim to overcome these educational barriers. The 'Social Belonging' seminars offered to students in their first semester included panel discussions with a demographically-diverse group

of science majors at Siena Heights University, promoting the message that adversity is not inherent to their gender or socioeconomic background, but can be overcome. Seminars in 'Positive Psychology' helped the students identify personal strengths and adopt behaviours that contribute to their wellbeing. Finally, during their second year, students participated in a 'Possible Selves' panel discussion with working STEM professionals in the local area. These aimed to provide positive role models and help students to identify career goals.

During their second year, the SHAPE STEM seminars included professional skill development in addition to exploring career options led by career specialist Ms Melissa Tsuji. These activities have been found to increase academic achievement among students from underrepresented minorities. Seminars are supplemented with field trips, conferences, guest speakers and team-building activities.

The project team continually monitors the students' progression and psychological wellbeing. Additionally,



Dr Rousselo and Dr Lindstrom are evaluating the effectiveness of the psychological supports and mentoring offered to the students, with the aim of refining these strategies over the project lifespan and improving student support across the university and beyond.

'SHAPE STEM has the potential to generate evidence that can be used to improve motivation and learning in other Siena Heights University students,' explains Dr Tsuji. 'This support structure could also be adapted and used by other higher educational institutions.'

Gaining STEM Skills and Experience

Group work and undergraduate research are considered highimpact learning activities, and as such, SHAPE STEM students are encouraged to participate in group research projects. These projects, guided by Dr Tsuji and co-Principal Investigators Dr Heather Moody and Dr Steven Wathen, provide students with an opportunity to experience academic research that has realworld implications, as well as foster camaraderie within and between cohorts.

Three of the student group projects completed as part of the program so far were presented at the Michigan Academy of Science, Arts, and Letters annual conference as well as at the Siena Heights University Scholarship Symposium.

In one such project, students took advantage of the demolition of an old building on campus to monitor the effectiveness of measures to reduce airborne particulate matter, which can damage lung health. Another group explored the impact of climate change on the migration timing of monarch butterflies. By combining analysis of historical data with capture, tagging and release experiments, the students discovered monarch migration has been shifting later in the season. The third of these groups tested various water sources in south-eastern Michigan for microplastic contamination, by filtering water through special membranes. In addition to learning valuable skills, students have found the projects enjoyable and inspiring. 'The research project and everything related to it was really fun,' reported one student. 'I liked playing around with ideas and trying to find solutions. I immensely enjoyed having a broader knowledge, and ideas regarding research.'

SHAPE STEM students are also given the opportunity to undertake internships or independent research projects, depending on their individual interests. Mentors and career advisors work closely with the students to help them identify and apply for suitable opportunities. Students have conducted research in green chemistry and biology, and completed internships in sustainability and other environmental topics. Some of the students have participated in an environmental leadership experience during summer, which taught them about sustainable agricultural ecosystems and provided practical experience in permaculture – an agricultural technique that works with the surrounding ecosystems to improve environmental outcomes.

Responding to COVID-19

In March 2020, approximately two years into the five-year SHAPE STEM project, Michigan residents were ordered by the Governor to stay in their homes due to the COVID-19 global pandemic. As all students returned to their permanent residences, the project team worked quickly to adapt to delivering the program activities online. In particular, continuing the presentation of the psychological elements of the seminar series has helped the students cope with the stress and uncertainty of the developing situation and maintain motivation. The 'Positive Psychology' seminar, the 'Possible Selves' panel discussion, and the Siena Heights University Scholarship Symposium were all offered to students online, in addition to other SHAPE STEM activities.

In feedback following the 'Positive Psychology' seminar, one student said, 'I started doing things that were suggested on the positive psychology paper, such as writing in a journal, going on walks, and trying meditation. I found that it actually helped me when I was feeling lost or bored. It helped me focus on what I needed to do, whether that was schoolwork, or laundry, or something like that.'

'The positive psychology definitely helped,' reported another. 'It reminded me why I am doing what I'm doing and provided me with the motivation that I needed to overcome the stress that accompanied this global pandemic.'

Although the pandemic continues to affect education around the globe, the fast response of the SHAPE STEM project team has ensured that these students are still receiving the support, mentoring and activities that will help them succeed in their STEM courses, equipping them to become the environmental innovators of tomorrow.

Meet the researchers

Dr Jun Tsuji

Computing, Mathematics and Sciences Division Siena Heights University Adrian, MI

USA

Dr Jun Tsuji earned his PhD in Genetics in the Plant Research Lab at Michigan State University, and currently holds the position of Professor of Biology and Chair in the Division of Computing, Mathematics, and the Sciences at Siena Heights University. His research expertise includes behavioural studies of the Imported Cabbageworm, Pieris rapae, and he is the Principal Investigator on the SHAPE STEM program.

CONTACT

E: jtsuji@sienaheights.eduW: http://juntsujisienaheightsedu.weebly.com/

Dr Heather Moody

Environmental Science Department Siena Heights University Adrian, MI USA

Dr Heather Moody earned her PhD in Geography from Michigan State University, and currently holds the position of Professor of Environmental Science at Siena Heights University. Her research expertise includes the relationship of neighbourhood socioeconomic differences and racial residential segregation to childhood blood lead levels in metropolitan Detroit. Dr Moody also holds a postdoctoral position at Michigan State University, is a faculty advisor for the Siena Heights University Environmental Science student club, Greenlight, and is Co-PI on the SHAPE STEM program.

CONTACT

E: hmoody@sienaheights.edu W: https://sienaheights.edu/Preview-News-Academics/NewsArticleID/3511

Dr Steven Wathen

Department of Chemistry Siena Heights University Adrian, MI USA

Dr Steven Wathen earned his PhD in Chemistry from The Ohio State University, and is currently Professor of Chemistry at Siena Heights University. His research interests include Organic Chemistry, Biological Chemistry, and Cheminformatics for Green Chemistry Education. Dr Wathen is a member of the American Chemical Society, the Michigan College Chemistry Teachers Association, and the Lenawee Intermediate School District STEM Advisory Board. Dr Wathen is Co-PI on the SHAPE STEM program.

CONTACT

E: swathen@sienaheights.edu W: https://sienaheights.edu/Preview-News-Academics/NewsArticleID/4006

Dr Patricia Rousselo

Department of Psychology Siena Heights University Adrian, MI USA

Dr Patricia Rousselo earned her PhD in Clinical Psychology from the University of Toledo, and currently holds the position of Associate Professor of Psychology at Siena Heights University. She has over 20 years of experience in clinical work and teaching psychology courses at community colleges and universities. Dr Rousselo's research interests include social reactions and expression of emotion, and she is an expert in Positive Psychology and psychotherapy. She is Co-PI on the SHAPE STEM program, and is evaluating the psychological supports offered to students.

CONTACT

E: proussel@sienaheights.edu W: https://sienaheights.edu/Preview-News-Academics/NewsArticleID/6510

Dr Jeffrey Lindstrom

Department of Psychology Siena Heights University Adrian, MI USA

Dr Jeffrey Lindstrom earned his PhD in Social Psychology from Brigham Young University, and currently holds the position of Professor of Psychology and Chair of the Psychology Department at Siena Heights University. In addition to his research, Dr Lindstrom is faculty advisor for the Siena Heights University Psychology Club, the Psi Chi honours society, and the Student Government. He is Co-PI on the SHAPE STEM program, and is evaluating the psychological supports offered to students.

W: http://jlindstr.sienaheights.edu/E: jlindstr@sienaheights.edu

Melissa Tsuji

Career Services Siena Heights University Adrian, MI USA

Melissa Tsuji earned her MA in Art History from Bowling Green State University and currently oversees STEM experiential learning at Siena Heights University. She holds the Society for Human Resource Management Certified Professional credential, is the President of the Human Resource Association of Southeast Michigan SHRM chapter, serves on the Adrian Area Chamber Board of Directors, and has been teaching career preparation for over 20 years.

<u>FUNDIN</u>G

US National Science Foundation

