

# Preparing STEM Students for Post-Graduate Success

## Montclair State University's Science Honors Innovation Program Offers Unique Research Opportunities

By Ashwin Vaidya

### The Real Crisis in Education

There has been much discussion in the media about the US education system's failure to produce globally competent math and science majors. Program for International Student Assessment (PISA) data, which is often used to support this viewpoint, consistently shows American students failing to crack the top 20 of about 65 countries in the study<sup>1</sup>.

While there is a constant call to produce more STEM students and help them perform better on tests, the real issue is that higher education has not always kept up with workplace needs over the last few decades. Meghan Groome of the New York Academy of Science calls this disconnect between education and industry "the STEM Paradox,"<sup>2</sup> noting the problem results neither from the shortage of STEM graduates nor the lack of STEM jobs. A great majority of STEM jobs are unfilled because students lack comprehensive training and skills beyond their specific science majors.

### Closing the Educational Gap

As lecture-oriented instruction alone proves increasingly ineffective in educating the large number of students in today's classrooms, it is clear students need to gain ownership of their learning experience.

A gap exists between the understanding of the need for STEM instruction to encourage scientific inquiry and typical instructional strategies. For example, STEM learning<sup>3</sup> based on rote instructional practices seldom fosters creativity, which often leads to students dropping out of STEM fields. By and large, students, especially in introductory courses, are taught by lectures supplemented by predetermined laboratory experiments.

Lately, however, some institutions are replacing traditional lecture-style courses with inquiry-based teaching strategies that engage students more fully in the scientific process. Educators in different disciplines are personalizing the learning process so students find a natural connection to their life on the college campus and beyond. In the words of Ellen Langer,<sup>4</sup> "Information that is about ourselves, about the parts of ourselves that we really care about, is the easiest to learn."

### The Science Honors Innovation Program (SHIP) at Montclair State

Educators at Montclair State University believe a strong undergraduate research experience is the key to developing true creative potential through a very personal connection to education and learning. On most campuses, undergraduate research involvement is voluntary and driven by personal

desire. Research is considered a one-way street; after mastering basic material, research activities, often led in the direction of a faculty member's own interests, can follow. However, subject mastery and successful research work best as a feedback loop. Since 2010, Montclair State has taken this educational approach one step further with its Science Honors Innovation program (SHIP), the brainchild of College of Science and Mathematics (CSAM) Dean

Robert Prezant.

"From generating research proposals to writing final manuscripts for publication, the SHIP program was designed to get our students to think, act and produce like practicing scientists," explained Prezant. "With the wonderful outcomes of our SHIP alumni to date, it seems clear the program is succeeding."

SHIP offers the University's most promising students an upper level, two-year intensive science honors research program that hones them for their "next step." The quality of the students' work is akin to that of a Master's thesis, or higher, and the overall program experience exceeds offerings from even the best master's programs.

Typically, at the end of their sophomore years, top College of Science and Mathematics students are encouraged to seek mentors and submit research proposals to the program. Even before gaining entry into SHIP, students must think like scientists by both arguing for the merits and novelty of their proposed research and considering its costs. This application process is a harbinger of the SHIP experience.

The approximately twelve students accepted each year receive a generous stipend, funding to purchase necessary research supplies, and travel funding to present their work at national or international conferences. During their two years in the program,

SHIP cohorts participate in special workshops and seminars and present their work multiple times in academic settings, to folks from industry and to lay audiences. And it is productive partnerships with industry that makes this program a reality. Thanks to generous support from the Merck Foundation, the Roche Foundation and Celgene, SHIP offers Montclair State undergraduate students an unparalleled opportunity to engage with a global research community.

### A Rigorous Program

Students are required to publish their work in peer-reviewed journals, a very ambitious requirement for an undergraduate. All in all, SHIP scholars are rigorously trained in attributes demanded by a sophisticated 21st century scientific workforce. They are guided on a transition from a "learning"





mindset to one of “discovery.” SHIP nurtures student confidence in their new direction within their own multi-disciplinary community of scholars. Frequent SHIP community get-togethers give students a broader view of research, inspire ideas from cross-pollination, and spark innovative thinking and problem solving. SHIP prepares students for success in an entrepreneurial workplace.

What distinguishes SHIP from traditional honors programs is its primary emphasis on independent research from the start and hands-on learning that fosters creativity, adaptability and curiosity. It also naturally encourages interest in coursework through personalized learning. Unlike many other undergraduate research-based experiences, SHIP gives students both greater project ownership than would normally be expected at this stage of their lives and access to considerably more financial and other resources than are available to most undergraduate research students.

The impact of SHIP students’ work is enormous. They have: traveled to the Antarctic to study ice sheet dynamics; attempted to eavesdrop on the chirpings of the universe by working with the international LIGO project and its search for gravitational waves; studied the New Jersey ecosystem and worked to improve water quality. Students have also tackled challenging problems of a fundamental mathematical and scientific nature.

“SHIP allowed me to perform research at a professional level,” said recent graduate Erik Strandkov. “It definitely gave me an edge in terms of experience. Most graduating students have little experience in the field or in conducting their own research. SHIP gave me two years of both.”

Mariya Guzner ’15 is a research assistant in University of Minnesota’s master’s program in Natural Resource Science and Management. “Having the responsibility of heading a project got me accepted into this program and prepared me for the work I will do,” she said.

The success of the program, even in a short span of 5 cohorts, is immediately evident from students’ post-graduate achievements. SHIP has helped produce a strong and extremely qualified STEM workforce in a variety of scientific fields. While many of the SHIP graduates who were accepted by the program between 2010 and 2013, have been admitted to graduate school programs and medical schools, others have chosen careers in teaching, research laboratories and within the corporate and non-profit sectors.

Adriana Messyasz hopes to further her studies in environmental science or sustainability after she graduates. “SHIP is showing me the realities of scientific research,” she said. “I’m thankful for the support that allows us to make our ideas and plans a reality.” ■

#### References

<sup>1</sup><http://www.npr.org/sections/thetwo-way/2013/12/03/248329823/u-s-high-school-students-slide-in-math-reading-science>

<sup>2</sup><http://www.washingtonpost.com/blogs/she-the-people/wp/2014/09/26/the-stem-paradox-lack-of-skills-by-stem-graduates-and-not-enough-women/>

<sup>3</sup>National Research Council. 2011. *Scenario-, problem-, and case-based teaching and learning*. Promising Practices in Undergraduate Science, Technology, Engineering, and Mathematics Education: Summary of Two Workshops. Washington, DC: The National Academies Press.

<sup>4</sup>Langer, Ellen J. (1997). *The Power of Mindful Learning*. Reading, MA: Addison-Wesley

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