PROJECT REPORT

Starting with SENCER:

A First-year Experience Framed by the Science and Civic Issues of the Chesapeake Bay

MICHELLE PARRY
Longwood University

WADE ZNOSKO
Longwood University

ALIX DOWLING FINK
Longwood University

MARK FINK
Longwood University

KENNETH FORTINO
Longwood University

MELISSA RHOTEN
Longwood University

SARAI BLINCOE
Longwood University

Abstract

In 2017, Longwood University launched the LIFE STEM Program, a holistic program girded by best practices in STEM teaching: cohorts of students, summer bridge program, genuine community building, intentional faculty-student mentoring, focused academic support and professional development, early research experiences, engagement with challenging civic issues, and, importantly, financial support for students. The first-year experience is critical in establishing the academic expectations of the LIFE STEM Scholars, supporting their development as a community of learners, and engaging them in real work of scientists. That yearlong journey opens with a one-week summer bridge program on the Chesapeake Bay. While on the Bay, the Scholars begin to frame scientific questions tied to key civic issues and grapple with intersections of science, economics, and politics. In a two-semester Entering Research course sequence, Scholars expand on key questions, process field-derived samples, analyze data, and consider the meaning of their work in this complex and contested civic context.

Introduction

The LIFE STEM Program (Longwood Initiative for Future Excellence in STEM) was created to provide wrap-around support for academically talented science students with financial need. With funding from the National Science Foundation's Scholarships in STEM (S-STEM) program (Award #1564879), the LIFE STEM Program is supporting, through curricular, co-curricular, and financial elements, the four-year college experience of two cohorts of 12–14 students representing Longwood's four natural science majors (Biology, Chemistry, Integrated Environmental Sciences, and Physics).

In the 2017–2018 and 2018–2019 academic years, the first two multidisciplinary cohorts of LIFE STEM Scholars completed the first-year experience, which serves as the foundation on which the rest of the LIFE STEM Program builds. Recognizing the important challenges of the transition to college (PCAST, 2012), the program immediately connects the incoming Scholars with peer and faculty mentors and invests heavily in intentional community building. The fall course schedule of the Scholars includes cohort sections of the introductory chemistry course (CHEM 111), a first-year seminar focused on the transition to university work (ISCI 100), and a second seminar focused on research (ISCI 120; Table 1).

The context for the Scholars' first-year research activities—almost from the minute they arrive on campus—is the Chesapeake Bay, the largest of over 100 estuaries in the United States (US) and the third largest in the world. Throughout the written history of the US, the Bay has provided vital resources (e.g., blue crabs [*Callinectes sapidus*], oysters [*Crassostrea virginica*], and menhaden [*Brevoortia tyrannus*]) and has fueled robust local and regional economies. In fact, still today, the small town of Reedville ranks first in the contiguous US for fish landings (by weight of catch; NMFS, 2017). A focus of intensive conservation efforts since the 1970s, the Bay's key health indicators have improved, but overall it continues to earn a barely passing grade of D+ (CBF, 2018). With a watershed encompassing more than 64,000 square miles, the Bay is affected by land management practices extending from northern New York to southern Virginia. Furthermore, the watershed is home to more than 18 million people who have direct and indirect impacts on the Bay and the complex natural systems within it (CBF, 2018; CBP, 2019).

Clearly, this body of water presents almost endless potential for scientific research at all levels. Indeed, scholars in higher education and government service have invested careers in studying these natural systems. With its incredible jurisdictional complexity—six states and the District of Columbia and nearly 1,800 local jurisdictions (i.e., towns, cities, counties, and townships; CBP, 2017)—the Bay offers another level of scholarly engagement at the intersections of science and civic issues. For the LIFE STEM Scholars, the Bay is a study site in which they collect a variety of scientific data, but they also experience it as a home to the human communities that depend on it. Furthermore, many of our Scholars have a personal connection to the Bay, as it is an area where they and their families live. It is a contested space

TABLE 1. Overview of the LIFE STEM Program

Initial Immersion	Focus on the First Two Years: Cohort Building, Academic Success, Research Experiences				Support Through Graduation
Summer	Semester 1	Semester 2	Semester 3	Semester 4	Semesters 5-8
Chesapeake Bay-focused summer bridge (1 week)	LIFE STEM Seminar 1 (ISCI 100) (1 cr.)	Entering Research 2 (ISCI 121) (2 cr.)	LIFE STEM Seminar 2 (ISCI 220) (1 cr.)	Required enrichment activities	LIFE STEM Seminar 3 (ISCI 320) (1 cr.; Semester 5)
Honors Leadership Retreat (4 days)	Fund. of Chemistry (CHEM 111) (4 cr.)				Required enrichment activities
	Entering Research 1 (ISCI 120) (1 cr.)				
Intensive faculty mentoring and focused peer support throughout					

in many ways, and it has been for generations. Thus, the LIFE STEM Scholars do not start the college experience with prepared lab exercises at the bench, activities with known outcomes. Instead, they begin with an immersion in a complex civic issue, one where scientific study can offer new insights but for which science alone cannot offer solutions.

This focus on the Chesapeake Bay for the first-year experience grew from Longwood University's long-running engagement with the SENCER program (Science Education for New Civic Engagements and Responsibilities). The SENCER approach to teaching and learning (SENCER Ideals)

- robustly connects science and civic engagement "through" complex, contested, capacious, current, and unresolved public issues "to" basic science;
- invites students to put scientific knowledge and the scientific method to immediate use on matters of immediate interest to students;
- helps reveal the limits of science by identifying the elements of public issues where science does not offer a clear resolution;
- shows the power of science by identifying the dimensions of a public issue that can be better understood with certain mathematical and scientific ways of knowing;
- conceives the intellectual project as practical and engaged from the start;
- locates the responsibilities (the burdens and the pleasures) of discovery as the work of the student;
- and, by focusing on contested issues, encourages student engagement with "multidisciplinary trouble" and with civic questions that require attention now. (SENCER, 2017)

The LIFE STEM Scholars' yearlong exploration of the challenging issues of the Chesapeake Bay was designed to intentionally operationalize the SENCER Ideals in each of the cornerstones of the first-year experience.

Cornerstones of the First-year Experience

Immersion Experience on the Chesapeake Bay

In the two weeks prior to the start of the fall semester, the LIFE STEM Scholars participated in a summer bridge program. The first week of that program was an immersion experience at the Chesapeake Bay for which Longwood University's 662-acre field station, Hull Springs Farm (HSF), situated on tributaries to the Potomac River and just a short distance from the Bay proper, served as the center of operations.

One important goal of the HSF week was to set the stage for a guided interdisciplinary research project in the Scholars' first year. That project intentionally incorporated the SENCER Ideals and, in so doing, expanded on Longwood's previous SENCER projects focused on non-science majors and the general education curriculum. Using the place-as-text approach to learning (Braid and Long, 2000), Scholars explored issues that link scientific and civic discourses, such as water quality (e.g., stormwater runoff, eutrophication, dead zones) and resource use (e.g., oysters, blue crab, menhaden). During their explorations on Tangier Island, Scholars engaged with members of the local community in order to begin to understand the complex intersections of civic and scientific issues (e.g., sea-level rise) and to connect them to the individuals

TABLE 2. Summer Bridge Activities That Engage Students in the Complex Issues of the Chesapeake Bay

Learning Activities	Key Outcomes for Scholars
• Full-day outing with a life-long waterman on a traditional Chesapeake Bay deadrise boat, including a tour of oyster processing and aquaculture facilities • Place-as-text exploration on Tangier Island • Presentation by Chesapeake Bay Program scientist • Collection of water and sediment samples and associated environmental data to be used in first-year course work • Culminating team presentation on the summer bridge experience and the state of the Chesapeake Bay	• Use foundational quantitative skills to address scientific issues • Explain how science can be used to understand problems • Explain how different scientific disciplines contribute to scientific knowledge • Examine the complexity of an environmental problem using multiple lenses • Use evidence to formulate questions and support answers • Collaborate with faculty and peers in an academic setting

who must live with them. As a culmination to the week, a scientist from the Chesapeake Bay Foundation presented data on the state of the Bay, supporting Scholars' development of their final projects and their team presentations, which focused on civic and science engagement (Table 2).

Honors Leadership Retreat

The second week of the summer bridge integrated the Scholars with the Cormier Honors College (CHC) students for the annual Honors Leadership Retreat, an on-campus "mini-bridge" program. The CHC has facilitated this retreat and its embedded peer mentoring for more than a decade and has had great success in building a cohesive community. During the Honors Leadership Retreat, Scholars participated in activities to promote leadership skills, community building, an academic mindset, and identification with a group of students for whom intellectual challenge and curiosity are shared values. Each LIFE STEM Scholar was paired with an experienced honors science major (for the first cohort of Scholars) or a current LIFE STEM Scholar (for the second cohort of Scholars), who served as a peer mentor. The retreat provided Scholars with opportunities for personal growth and connection to a larger cohort of academically talented students with whom they lived in the honors residence hall.

Coursework

In order to promote a strong cohort of Scholars, a sense of community, a scientific mindset, and the successful transition to college, the LIFE STEM curriculum has a deliberate focus on the first semester during which all Scholars are required to take three courses together (see Table 1). Two of those courses (CHEM 111 and ISCI 120) have explicit scientific connections to the bridge experience, including the analysis of water and sediment samples and associated environmental data, while the other course (ISCI 100) focuses on the transition to college. In addition to those common courses, Scholars also complete introductory courses in the major. During the second semester, Scholars focus primarily on their major course requirements but continue in ISCI 121, the second half of the two-semester course focused on promoting a scientific mindset and developing scientific skills. These courses are taught by members of the LIFE STEM Leadership Team, all of whom attended at least one HSF summer bridge. Thus, a strong sense of scientific community was initiated during the summer bridge and continued throughout the Scholars' first year.

Fundamentals of Chemistry I (CHEM 111)

Fundamentals of Chemistry I (CHEM 111) is a required course for science majors and a common stumbling block for first-year students. This course is taught using an inquiry-based model and utilized the POGIL (Process-Oriented Guided Inquiry Learning) pedagogy (Hein, 2012; De Gale & Boisselle, 2015) in both lecture and laboratory components. The collaborative POGIL environment is intended to help students learn, understand, and remember more while practicing skills essential for future success in the classroom, laboratory, and beyond. Connections to the summer bridge program were incorporated into the classroom component of the course as appropriate (e.g., polyatomic ions, molecular bonding, intermolecular forces, solubility, etc.). During the last five weeks of the laboratory portion of the course, the Scholars in the first cohort participated in "The Nitrate Analysis Project." The Scholars used a spectrophotometric method to determine nitrate concentrations in a series of simulated Chesapeake Bay water samples. The second cohort participated in a final laboratory project focused on harmful algal blooms. In this project, the Scholars grew cultures under differing conditions to determine the effect of nutrient levels on algal growth. Algal growth was determined using a fluorescence technique to measure the chlorophyll content.

LIFE STEM Seminar I (ISCI 100)

Scholars completed a one-credit freshman seminar course that blended an introduction to academics with the transition to college life. Scholars were expected to demonstrate critical thinking skills necessary for college success, learn the importance of a digital professional presence, begin the development of a four-year e-portfolio project, design a graduation plan, demonstrate an understanding of academic resources on campus, explore career opportunities through events on campus and guest speakers, and engage in activities with the college and local community.

Entering Research I (ISCI 120) and II (ISCI 121)

The first half of the Entering Research course sequence, adapted from Balster, Pfund, Rediske, and

Branchaw (2010), engages LIFE STEM Scholars in an authentic, albeit guided, research experience and supports their development of basic skills necessary for a successful research experience. The Chesapeake Bay serves as the research focus. It is a context broad enough to support a wide range of learning activities: field, bench, and modeling work by students in all four majors; literature searches and critical reading of relevant scientific articles; explorations of connections between science and society; and consideration of research ethics. Drawing on data collected during the summer bridge, Scholars developed research questions and hypotheses in multidisciplinary student teams. This experience culminated with project presentations that outlined all aspects of the project, from definition of the problem, formulation of the hypothesis, design of the experiment, collection and analysis of the

TABLE 3. The Entering Research Sequence: Student Outcomes for Key Skills, Weekly Course Topics That Support Development in Those Areas, and Student Research Products

Entering Research I (ISCI 120)	Entering Research II (ISCI 121)
Skill Objectives: students will be able to...	
• Differentiate between science and pseudoscience • Establish reasonable research expectations and mentor/mentee expectations • Find appropriate literature and apply concepts to a scientific question • Design and execute an experiment that tests a hypothesis • Critically evaluate data • Interpret models of scientific processes • Communicate scientific information in written and oral formats	• Find appropriate literature and apply concepts to a scientific question • Critically present a scientific paper to peers, focusing not only on content and results but the merits of the study • Design and execute an experiment that tests a hypothesis • Critically evaluate data • Interpret models of scientific processes • Communicate scientific information in written and oral formats • Continue to examine different research opportunities on Longwood's campus
Weekly Topics	
• The nature of science: science or pseudoscience? • Introduction to biological inquiry: the scientific method • Communicating science: information literacy • How to read scientific articles • Research experience expectations • Finding a research mentor • Mentor/mentee expectations • Background information and hypothesis/research question • Discussion with experienced undergraduate researchers • Case study: "Frustrated" • Collection of data • Analysis of data • Making charts, graphs, and figures • What's to discuss?: how to write the discussion of a paper • Communicating science with posters and presentations	• Scientific article review: practical reading strategies • Finding articles • Discussion of science in society • Introduction to research proposal • Proposal introduction: crash course • Article presentations (multiple) • Proposal-specific aims: crash course • Research case studies (multiple) • Peer reviews (multiple) • Proposal significance: crash course • Creating a research contract • CV vs. résumé • Research opportunities • Research: faculty members' perspectives • Developing proposal presentations • Discussion revisited: science in society
Student Research Projects (ISCI 120) and Proposals (ISCI 121)	
• Calculating levels of chlorophyll in the Chesapeake Bay • Determination of dissolved oxygen levels within the Chesapeake Bay • Concentration of microplastics in the Chesapeake Bay • Analyzing organic material found in sediment throughout the Chesapeake Bay	• Human impacts on the eastern oyster (*Crassostrea virginica*) in the Chesapeake Bay • The detrimental effects of the snakehead fish (*Channa argus*) in the Chesapeake Bay • Microplastic pollution in the Chesapeake Bay • Impacts of external forces on the area of Tangier Island: the effects of urbanization on the health of the Chesapeake Bay ecosystem • The effects of agricultural chemical runoff on water quality and benthic species • Invasive species in the Chesapeake Bay • Rays in the Bay: climate change and Rhinoptera bonasus behavior in the Chesapeake Bay

data, and drawing of the conclusions (Table 3). Several experiences within this course added to the breadth of content that continues to define the Scholars' e-portfolios.

Entering Research II reinforces and expands upon the knowledge and skills practiced in Entering Research I. Scholars continue to hone their skills in reading and comprehending primary literature by making a formal oral presentation of the background and findings of a scientific paper in their field of choice, thus allowing flexibility of interest in this multidisciplinary group. In addition, continuing the focus on the Chesapeake Bay, Scholars design formal proposals for research—from posing a question through final presentation—in a multidisciplinary team. This process challenges Scholars to practice experimental questioning and implementation, expand their thinking to consider the larger scope of a research proposal, and establish a strong argument to convince an audience of the significance of a project (Table 3).

Mentoring

Each LIFE STEM Scholar was paired with a faculty mentor prior to the Scholar's arrival on campus. This mentoring relationship, which is intended to grow and mature over four years, is a core component of the LIFE STEM experience. Mentoring is intensive in the first two years with weekly and biweekly meetings; regular but less frequent meetings continue during the third and fourth years as the Scholars develop more independence. Fourteen faculty members from the two science departments mentored at least one Scholar, with most mentoring two Scholars, one from each cohort. To prepare for this individualized work with Scholars, mentors participated in a workshop provided by Dr. Janet Branchaw of the University of Wisconsin's Institute for Biology Education. In addition to faculty mentors, Scholars also benefited from student peer mentors either from the CHC (cohort 1) or a current LIFE STEM Scholar (cohort 2). Although the structure was informal, peer mentors were often able to better understand and assist with the struggles associated with college life.

Student Voices: Reflections on the First-year Experience

Four LIFE STEM Scholars provided reflections on their experiences in the program: Samuel Morgan and Charlotte Pfamatter, Class of 2021 Integrated Environmental Sciences majors; Kelsey Thornton, Class of 2021 Biology major; and Cecily Hayek, Class of 2022 Biology major. These Scholars' voluntary narratives (for which no specific directions were given) articulated insights on their learning in the affective domain. Drawing on a framework outlined by Trujillo and Tanner (2014), we tie their reflections to three key constructs related to the successful transition to the college environment and subsequent academic success: a sense of belonging in an academic community; identity as a professional and, more specifically, a scientist; and self-efficacy. Importantly, the development of their understanding of the connections between science and civic issues also was highlighted.

Sense of belonging

Students' sense of belonging affects academic motivation, academic achievement, and well-being (Trujillo & Tanner, 2014), and first-year college students who experience more peer support performed better academically and had lower levels of stress, depression, and anxiety (Pittman & Richmond, 2008). LIFE STEM Scholars highlighted their early, meaningful, and persistent connections.

> "The immediate connections and opportunities we were afforded upon arrival to Longwood have had a lasting impression on my time here, thus far. I was able to develop friendships before other college students, which made the transition less intimidating." (Kelsey)

> "I cannot think of too many better ways that I could have started off college than going on my freshman summer bridge program. Meeting so many bright students and adults who shared my interest for science was an unexpected delight. What has been even more remarkable has been how I have kept my friendships and connections for almost two years and they have only gotten stronger. I have teamed up with many of my LIFE STEM friends for presentations, posters, and conferences, and each time, I know that

I am able to rely on my cohort for sterling work and helpful insight."

"While my duty is to my assigned mentee, I see both cohorts as one community where we are all trying to help each other get through college and make it out with a brighter future. Besides partnering with them on projects, I have enjoyed many one-on-one conversations on making it through college. I have gotten to bond over dinners and lunches, and I have benefitted from a few late-night study groups. I see this community best exemplified when many of us go back each semester to Hull Springs to beautify the area through gardening. We get to spend a weekend doing some service while also bonding. We get to self-lead and organize ourselves while giving back to the university that granted us this excellent program in the first place." (Samuel)

"My LIFE STEM peer mentor has been so kind and supportive this year that I decided to apply to be a peer mentor for the next cohort. I know that these relationships that I have formed over this past year will continue to grow, and I am so thankful that I have been able to create such a great support system." (Cecily)

The development of sense of belonging is not limited to peer interactions: connections to faculty members also are important in promoting students' sense of belonging in the university context (Freeman, Anderman, and Jensen, 2007).

"I believe that the faculty-student connections we made upon arrival, and continue to make to this day, are the best reward of this program. Being able to go to any science faculty member and ask them about anything, whether it be in regard to academics or just life, they already know you and they are there and willing to help." (Kelsey)

"The LIFE STEM faculty have been able to make Chichester (our science building) feel like home. I have gone to so many faculty STEM mentors for guidance on school projects, and I will always be thankful for the many opportunities they have afforded me." (Samuel)

"Other than academic success, this program has also given me many great mentors who have been integral in helping me plan out my future. My faculty mentor is always there to give me advice on anything I ask about and is even assisting me in contacting people in my desired field." (Cecily)

Identity as a scientist

A student's identification as a scientist is linked to persistence, and students who left the sciences often did not adopt that professional identity (Trujillo & Tanner, 2014). Science identity can be framed as a composite of multiple factors, including performance, recognition, and competence (Carlone & Johnson, 2007). Those dimensions are evident in the following statements by LIFE STEM Scholars:

"I have become a strong leader and a confident biologist in the making. I am excited to move forward in this program, meet and connect with future cohorts, and continue growing as a student and as a Citizen Leader." (Kelsey)

"One of my proudest titles at Longwood is being a LIFE STEM Scholar. . . . LIFE STEM has been pivotal for me not only as a student but as a young professional. . . . Also, LIFE STEM has brought me confidence as an aspiring scientist. Coming to college, I had limited experience in science and had only brief exposure to it in high school. I was not knowledgeable on scientific writing and presentations. The LIFE STEM courses have groomed me to become a professional in the STEM world through step-by-step writing and presenting exercises, while providing many opportunities for practice. This program has equipped me with the tools I need to be a competitive student in my major, which will help me thrive in a

STEM career and graduate school after Longwood." (Charlotte)

"I hope to continue to grow as a student and forge even more connections that will allow me to further my education as a biologist." (Cecily)

Self-efficacy

A student's self-efficacy is the belief or confidence that his/her/zir actions can affect outcomes and have desired effects (Bandura, 1997). It is an ingredient that can move students beyond the "raw materials" of knowledge and skills to academic success (Klassen & Klassen, 2018). LIFE STEM Scholars' reflections indicate that the program's scaffolded academic experiences and early research immersion supported students' confidence in moving forward positively to more advanced work.

"This program helped me to grow in many aspects, both professionally and personally. In my first year, I learned how to do scientific research and had the opportunity to improve my public speaking skills. The second year was predominately learning how to be a scientist; that is, how to read articles, how to synthesize, and how to report to different audiences. These were all skills that were challenging at the time; however, I was grateful to have learned them in the LIFE STEM Program classes. Once the cohort started taking classes outside of the program, I was personally able to see how far ahead we were compared to other students in regard to simple skills such as writing and public speaking." (Kelsey)

"As a mentor to the second cohort of LIFE STEM students, I have been able to grow in my leadership skills. In my first year, I was provided with lots of help, advice, and opportunities, but, as a mentor in my second year, I got to provide those things to my mentees." (Samuel)

"LIFE STEM has helped me gain momentum in pursuing undergraduate research. This academic program is designed for students to learn about undergraduate research, with the hope of actually taking on a research opportunity. The courses have exposed me to examples of some of the faculty's work, while also being able to meet face to face with professors to learn what research entails. Because of LIFE STEM, I was able to take on research in my sophomore year and the summer before my junior year. LIFE STEM prepared me with professional communication skills, which landed me an opportunity to do research for the duration of my time at Longwood." (Charlotte)

"Coursework as a Biology major can be challenging, and I was pleased when I found myself performing much better on assignments and assessments than other students that are not in the program. This success is because of the skills and knowledge that LIFE STEM Scholars are exposed to within the first semester. I have been able to improve my writing immensely and even broaden my skills in researching and reading scientific articles. I believe that this program has opened doors for me within the scientific field as well as my other courses." (Cecily)

Connections between Science and Civic Issues

The LIFE STEM Scholars begin their university careers immersed in a complex and contested civic issue that at first is framed as a scientific problem. Their "engagement with 'multidisciplinary trouble' and civic questions that require attention now" (SENCER, 2017) has prompted students to reevaluate their perceptions of their identities and their responsibilities as citizens and scholars.

"As I spent time on the Chesapeake Bay, I realized that an environmental scientist's purpose cannot be to merely understand the relationship between a community of organisms and the landscape they inhabit, or to work to preserve beneficial ecosystems. Instead, an environmental scientist's job is to lend their knowledge and skills to a cooperative effort of maintaining and improving a society's relationship with the natural world. The Bay is much more than

a tidal estuary for crabs, oysters, pelicans, and shad. The Bay has historical, economic, and recreational significance, and serves as a home to millions of people. Sometimes natural preservation conflicts with keeping these other values. An environmental scientist's purpose must involve attempting to preserve all of society's values." (Samuel)

Conclusion

Although it is still in the early stages of the evaluation process, initial assessment by Virginia Commonwealth University's Metropolitan Educational Research Consortium (MERC) suggested that the LIFE STEM Program has been successful in achieving its objectives. From first to second semester, LIFE STEM Scholars were retained at a higher rate than their peers in the science majors (Table 4). Additionally, Scholars reported feeling academically supported through the program and expressed gratitude for the opportunity to connect with a cohort of science peers and faculty through the summer bridge, mentoring program, and LIFE STEM coursework (MERC unpublished data). Scholars from the first cohort also informally reported to the LIFE STEM Leadership Team that as they transitioned to upper-level courses, they perceived themselves to be better prepared for scientific writing and oral presentations than their peers. They attributed that to the Entering Research course sequence. Longwood University also recognized the successes of the program by providing institutional funding to enroll a third cohort of LIFE STEM Scholars, which extends the positive impacts of the program to continue beyond the timeline initiated in the NSF S-STEM award.

Though the program is off to a strong start, it is not immune to both program- and institutional-level challenges such as faculty workload and sustainability. To address that, some members of the LIFE STEM Leadership Team applied and were accepted to the 2019 ASCN (Accelerating Systemic Change Network) Systemic Change Institute. The team's major goals for the institute were to develop a realistic plan for engaging faculty from the science departments in discussions about lessons learned and opportunities for implementation beyond LIFE STEM, learn about proven strategies for engaging faculty in scaling up nascent efforts, identify strategies for engaging faculty and staff in recruiting efforts, and consider program elements that might support different funding opportunities, including the Howard Hughes Medical Institute's Inclusive Excellence program.

As the LIFE STEM Leadership Team and MERC continue to learn about the program's successes, identify areas for improvement and growth, and pursue opportunities for scaling beyond the small cohorts, the Scholars' first-year immersion at the intersection of science and civic issues continues to serve as a foundation for the Scholars' academic and co-curricular efforts. The SENCER Ideals are infused into the upper-level LIFE STEM coursework, and Scholars are pursuing leadership roles on campus that again position them at that intersection (e.g., Eco-Reps in the university's Office of Sustainability).

TABLE 4. Retention Rates* of Longwood University Undergraduates (UG) for the Two Classes in Which the LIFE STEM Cohorts Are Embedded

Term	All UG	All UG Retention (%)	All Science Majors	Science Retention (%)	LIFE STEM Scholars	LIFE STEM Retention (%)
Incoming Class of 2021 (Fall 2017)						
Fall 2017	1016	.	101	.	12	.
Spring 2018	899	88	86	85	11	92
Fall 2018	759	84	73	85	10	91
Spring 2019	740	97	66	90	9	90
Incoming Class of 2022 (Fall 2018)						
Fall 2018	993	.	97	.	16	.
Spring 2019	869	88	79	81	14	88

** Retention is defined here as students who return to the university in the following term; these data were provided by the Longwood University Office of Assessment and Institutional Research. Cohort tracking includes only students who enter as first-time, full-time freshmen.*

Authors

Michelle Parry is associate professor of physics in the Department of Chemistry and Physics (C&P). She serves as the LIFE STEM Program coordinator and teaches the LIFE STEM Seminar I course that focuses on the successful transition to college. She also serves as the physics area coordinator and is responsible for program assessment and for leading curriculum change.

Wade Znosko is associate professor of biology in the Department of Biological and Environmental Sciences (BES). He leads the two-semester sequence of Entering Research for the LIFE STEM Program. His research on the effects of impaired waterways on the development of vertebrates helps to inform some of the data collection and analysis techniques during this sequence.

Alix Dowling Fink is dean of the Cormier Honors College for Citizen Scholars and professor of biology in BES. She has been involved with SENCER for more than 15 years and, with Michelle, developed a SENCER Model Course, The Power of Water. Collaborating with colleagues across the disciplines, she also developed a transdisciplinary student program in Yellowstone National Park focused on the stewardship of our public lands. Her commitment to the SENCER Ideals continues to shape her work with students in the classroom, in the field, and through her administrative efforts.

Mark Fink is the chair of BES and associate professor of biology. Since 2011, he has facilitated immersion learning experiences on the Chesapeake Bay, first with teacher candidates and in-service teachers and currently with students from all majors. In those programs and his life science course for future K–8 teachers, Mark has sought to engage students in learning science concepts by using relevant, timely, and challenging civic contexts.

Kenneth Fortino is an associate professor of biology in BES, where he teaches courses in introductory biology, ecology and evolution, ecosystem ecology, and introductory environmental science. His current research is on the factors that affect organic matter processing in freshwater ecosystems.

Melissa Rhoten is a professor of chemistry in C&P. Her research interests include topics in chemical education, bioanalytical electrochemistry, and biosensors. Melissa has been involved in pedagogical activities focused on the implementation of inquiry-based learning in Longwood's chemistry curriculum. She currently serves as the director of Longwood's new Civitae Core Curriculum.

Sarai Blincoe is an associate professor in the Department of Psychology and is the discipline-based educational researcher for the LIFE STEM Program. She regularly teaches undergraduate courses in research methods and social psychology and publishes research on disrespect, trust, and the scholarship of teaching and learning. Sarai serves as assistant dean of curriculum and assessment in the Cook-Cole College of Arts and Sciences.

Student Contributors

Cecily Hayek is a biology major who graduated from Lake Braddock Secondary School in Fairfax, VA, in May 2018. In June 2019, she attended the Mid-Atlantic Marine Debris Summit that sought to find solutions for marine litter and subsequent problems such as microplastics. Cecily plans to pursue a career in veterinary medicine.

Samuel Morgan is an integrated environmental sciences major who started his studies at Longwood University in August 2017. Since then, he has been a LIFE STEM mentor as well as a student collaborator on faculty research focused on allelopathy.

Charlotte Pfamatter is an integrated environmental sciences major who graduated from Monacan High School in North Chesterfield, VA, in May 2017. In the summer of 2018, Charlotte participated in the School for Field Studies program in Turks and Caicos Islands that explored issues in marine conservation.

Kelsey Thornton is a biology major who graduated from Thomas Dale High School in Chester, VA, in May 2017. In the summer of 2019, she participated in the Longwood University study abroad experience examining conservation and economics in Ecuadorian Amazon. Kelsey's professional goal is to become a veterinarian.

References

Balster, N., Pfund, C., Rediske, R., & Branchaw, J. (2010). Entering research: A course that creates community and structure for beginning undergraduate researchers in the STEM disciplines. CBE Life Sciences Education, 9(2), 108–118. Retrieved from http://www.lifescied.org/content/9/2/108.long

Bandura, A. (1997). Self-efficacy: The exercise of control. New York: Freeman.

Braid, B., & Long, A. (2000). Place as text: Approaches to active learning. National Collegiate Honors Council. Retrieved from http://digitalcommons.unl.edu/nchcmono/3/

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of women of color: Science identity as an analytical lens. Journal of Research in Science Teaching, 44(8), 1187–1218.

Chesapeake Bay Foundation (CBF). (2018). State of the Bay report. Retrieved from https://www.cbf.org/document-library/cbf-reports/2018-state-of-the-bay-report.pdf

Chesapeake Bay Program (CBP). (2017). Facts and figures. Retrieved from https://www.chesapeakebay.net/discover/facts

Chesapeake Bay Program (CBP). (2019). Bay barometer. Retrieved from https://www.chesapeakebay.net/documents/2017-2018_Bay_Barometer.pdf

De Gale, S., & Boisselle, L. (2015). The effect of POGIL on academic performance and academic confidence. Science Education International, 26(1), 56–79.

Freeman, T. M., Anderman, L. H., & Jensen, J. M. (2007). Sense of belonging in college freshmen at the classroom and campus levels. Journal of Experimental Education, 75(3), 203–220.

Hein, S. M. (2012). Positive impacts using POGIL in organic chemistry. Journal of Chemical Education, 89(7), 860–864.

Klassen, R. M., & Klassen, J. R. L. (2018). Self-efficacy beliefs of medical students: A critical review. Perspectives on Medical Education, 7(2), 76–82.

National Marine Fisheries Service (NMFS). (2017). Commercial fisheries statistics. Retrieved from https://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/other-specialized-programs/total-commercial-fishery-landings-at-major-u-s-ports-summarized-by-year-and-ranked-by-dollar-value/index

President's Council of Advisors on Science and Technology (PCAST). (2012). Engage to excel: Producing one million additional graduates with degrees in science, technology, engineering, and mathematics. Retrieved from https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_2-25-12.pdf

Pittman, L. D., & Richmond, A. (2008). University belonging, friendship quality, and psychological adjustment during the transition to college. Journal of Experimental Education, 76(4), 343–362.

Science Education for New Civic Engagements and Responsibilities (SENCER). (2017). SENCER Ideals. Retrieved from http://sencer.net/sencer-ideals/

Trujillo, G., & Tanner, K. D. (2014). Considering the role of affect in learning: Monitoring students' self-efficacy, sense of belonging, and science identity. CBE Life Sciences Education, 13, 6–15. Retrieved from https://www.lifescied.org/doi/full/10.1187/cbe.13-12-0241