2021-2022
CASTLE Annual Report

Center for Advancing Scholarship
to Transform Learning

TABLE OF CONTENTS

AY 9/1/21 – 8/31/22

Mission Statement

The Center for Advancing STEM Teaching, Learning and Evaluation fosters rigorous, discipline-based STEM education research, providing infrastructure and opportunities for interdisciplinary collaboration. It supports both foundational scholarship of discovery and scholarship of pedagogy, teaching and learning, including transformational educational practices. CASTLE seeks to broaden participation in science, technology, engineering, and math communities through outreach, research, and programmatic innovations.

Vision Statement

CASTLE strives to create a vibrant community of discipline-based STEM education researchers in Schools and Colleges across RIT, working together to address issues of critical regional and national importance. CASTLE seeks to model interdisciplinary collaboration, developing partnerships across the disciplines necessary to address complex issues of teaching, learning, and inclusion in today's educational landscape. Above all, CASTLE embodies the aspirations of the community, supporting each other in scholarship endeavors.

Diversity, Equity, and Inclusion (DEI) Statement

CASTLE builds continuous awareness and growth toward the practice of social justice, equity, inclusivity, anti-racism, and diversity into its programs and research initiatives. The Center endorses the path toward equal recognition of those historically marginalized in science, technology, engineering, and math, welcomes faculty and students from all backgrounds and cultures and offers opportunities for faculty, staff, and students to work together to build an equitable future for our campus and beyond.

CASTLE Faculty, Staff and Postdoctoral Researchers **Managing CASTLE Programs and Projects**

Jennifer Bailey
Senior Lecturer
Kate Gleason College of Engineering

Kelly Norris Martin
Assistant Professor
School of Communication
College of Liberal Arts

Scott Franklin
Director, CASTLE
Professor, School of Physics and Astronomy

Emily Mehlman
LA Program Coordinator
Center for Advancing STEM Teaching, Learning and Evaluation

Leslie Kate Wright
Associate Professor
Thomas H. Gosnell School of Life Sciences

Dina Newman
Director, SMERC
Associate Professor
Thomas H. Gosnell School of Life Sciences

Tony Wong
Assistant Professor
School of Mathematical Sciences

Dina Zohrabi Alaee
Postdoctoral Researcher
School of Physics and Astronomy

Benjamin Zwickl
Associate Professor
School of Physics and Astronomy

Not pictured
Matthew Sayre (Senior Staff Specialist)

AFFILIATED PERSONNEL

Managing or Contributing to CASTLE Programs or Projects

Tina Chapman DaCosta
Director of Diversity Theater
Office of Diversity and Inclusion

Jeanne Christman
Associate Professor
College of Engineering Technology

Christina Goudreau Collison
Professor
School of Chemistry and Materials Science

Paul Craig
Professor
School of Chemistry and Materials Science

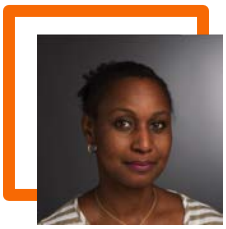
Juilee Decker
Associate Professor
College of Liberal Arts

Elizabeth Hane
Associate Professor
Thomas H. Gosnell School of Life Sciences

Jeyhan Kartaltepe
Women in Science (WISe) Chair
Assistant Professor
School of Physics and Astronomy

Kara Maki
SMASH Director
Associate Professor
School of Mathematical Sciences

Casey Miller
Associate Dean for Research and Faculty Affairs
Professor
School of Chemistry and Materials Science



Ifeoma Nwogu
Assistant Professor
Department of Computer Science

Kristen Shinohara
Assistant Professor
Golisano College of Computing and Information Sciences

Not pictured
Kaitlin Stack Whitney
Poornima Padmanabhan
Eleanor Sayre

RESEARCH INITIATIVES

Science & Mathematics Education Research Collaborative (SMERC)
Dr. Dina Newman (Director)
The primary Center research activities occur within the Science and Mathematics Education Research Collaborative, a multidisciplinary group of Discipline-Based Education Researchers (DBER). DBER research advances fundamental knowledge of how people learn, and develops general theory that can be applied in practice. SMERC faculty maintain individual research labs, described below.

I. Photonics and Optics Workforce Education Research (POWER)
Dr. Ben Zwickl and Dr. Kelly Norris-Martin

POWER is a project led by Dr. Ben Zwickl. POWER unites higher education, discipline-based education research, and workforce development in order to investigate core aspects of typical undergraduate STEM programs: scientific content, mathematics, and communication. This project is funded through a National Science Foundation Education & Human Resources Core Research (ECR) grant DGE-1432578. In the Photonics Careers Project, the early careers of technicians, engineers, and researchers are being studied to better understand the transition from school to jobs. With perspectives drawn from employees and managers, PhD students and their supervisors, researchers are identifying key math, physics, technical and communication skills that are essential for success. This foundational research supports stronger bridges between school and work and between the industry advocates for workforce development and the academic communities focused on education research. The Photonics Careers Project is providing additional research-based clarity that informs national discussion and policy around STEM workforce preparation. Findings have highlighted the importance of cross occupational communication (rhetorical/situational flexibility with groups distinct in background, training, and occupational role) in the optics and photonics workforce and now a replication study is being conducted with EMPOWER data to validate whether or not views about competent communication varies by industry.

II. Molecular Biology Education Group (MBER)
Dr. Dina Newman and Dr. Kate Wright

MBER is a collaborative research lab co-led by Dr. Dina Newman and Dr. Kate Wright, faculty in the Gosnell School of Life Sciences at RIT. The team studies how students think about molecular biology concepts and develops tools for improving biology education. Research focused on visual literacy in molecular biology and developing tools to improve student learning outcomes. Highlights are listed below.

1. An REU project from the past two years comparing student and expert conceptions of the terms “gene” and “gene expression” provided new insight into why students struggle with molecular genetics concepts. The work resulted in the a publication: Newman, Dina L, Coakley, Aeowynn*, Link, Aidan*, Mills,

Korrine*, Wright, L. Kate. Punnett squares or protein production? The expert-novice divide for conceptions of genes and gene expression. (2021). CBE Life Sciences Education. Vol. 20(4). https://doi.org/10.1187/cbe.21-01-0004

2. Another successful REU student project focused on the development and testing of a model-based activity to improve understanding about the process of Meiosis, at the molecular level. The work resulted in the following publication: Wright, L. Kate, Cortez, Paulina*, Franzen, Margaret A. and Newman, Dina L. Teaching Meiosis with the DNA Triangle Framework: A Classroom Activity that Changes How Students Think about Chromosomes. (2021). Journal of Biochemistry and Molecular Biology Education, 1-11. https://doi.org/10.1002/bmb.21583
3. The MBER team continued their investigation of visual representations in Molecular Biology and developed a new framework for teaching, learning and research called the "DNA Landscape". The work resulted in the following publication: L. Kate Wright, Emily Wrightstone*, Lauren Trumpore*, Julia Steele *, Deanna M. Abid* and Dina L. Newman. The DNA Landscape: Development and application of a new framework for visual communication about DNA (2022). CBE Life Sciences Education. Vol. 21(3). https://www.lifescied.org/doi/epdf/10.1187/cbe.22-01-0007
4. The MBER team embarked on three new projects this summer (2022), one in collaboration with Biomedical Engineering Faculty Dr. Jennifer Bailey. Summer projects explored spatial reasoning skills, the ability of learners to connect textbook images with video resources of molecular processes and using analogies to probe critical thinking skills. The team also expanded on their work in visual representations in Molecular Biology and Biochemistry with the development and application of a new framework for visual representations of protein images called the Protein Landscape.

III. Research Experience for Undergraduates (REU)
Dr. Dina Newman and Dr. Kate Wright

DBER REU is a program that brings students from all over the U.S. to learn about STEM Education Research and undertake cutting edge projects in the field (https://www.rit.edu/castle/research/reu). SMERC members Kate Wright (PI) and Dina Newman (Co-PI) led the seventh cohort of participants of the NSF funded REU program in the newly funded: Research Experiences for Undergraduates: Multidisciplinary Research on Student Success in STEM at the Rochester Institute of Technology. NSF DUE: 2149957.

The Spring/Summer 2022 program session was led with students from around the country:
Allison Dennis (Texas A&M University)
Cole Dwyer (University of Arkansas at Little Rock)

Constantine Kapetanakis (Rowan University)
Diana Ryder (University of Colorado Boulder
Needle Wang (University of Rochester)
Philip Reutter (Le Moyne College)
Sarah Abdo (Chapman University)
Isaac Wood (University of Georgia)
Taylor Hopkins (Duquesne University)
Victoria Sanberg (Binghamton University)

We first established our multidisciplinary Discipline-Based Education Research (DBER) REU program at RIT in 2015 and have since mentored 7 cohorts of students (n=71, total). One of the great strengths of our REU is the multidisciplinary nature of the program; students interact with Biology, Chemistry, Physics and Math Education researchers and the students themselves come from a variety of STEM backgrounds. Due to the Covid-19 pandemic we ran our 2020 and 2021 programs using a virtual format. Regardless of implementation (in-person or virtual), our REU programs have been highly beneficial for participants and faculty mentors. Our REU alumni have gone on to graduate programs, have become Middle/High School science educators or have gone on to other STEM careers. Our program has enhanced the culture and prestige of STEM Education Research at RIT and has greatly advanced the research trajectories of the STEM Education Research faculty at our institution. To date 20 peer-reviewed publications have resulted from the research conducted as part of the REU program with 2 additional papers currently in review.

IV. Graduate Admission and Retention Research
Dr. Casey Miller

Former postdoc Lindsay Owens conducted interviews with 17 physics faculty from 4 institutions and focus groups with 54 graduate students from 23 institutions. Those interviews were analyzed for the ways in which faculty and students explained factors that cause graduate students to leave their PhD program. The analysis was assisted by DBER REU student Kelli Shar and has resulted in a manuscript “Exploring faculty and student perspectives on retention in physics graduate programs: Student deficits versus sense of belonging” which is currently under review.

Mike Verostek, a graduate student from the University of Rochester and advised by Ben Zwickl, was supported by Dr. Miller’s NSF award 1633275 and 1834516.

V. Franklin Physics Education Research Lab
Dr. Scott V. Franklin

Dr. Scott Franklin supervises a variety of physics education research projects. Current projects include novel statistical technique, including Markov chain and stochastic modeling, that better characterize students' progression through their academic careers, qualitative research into students sense of how their careers "ought" to proceed, studying the interaction of student identities with the physics culture, and working with emerging education researchers to develop and refine effective research questions. Read More

VI. Zwickl Physics Education Research Lab
Dr. Ben Zwickl

The Zwickl PER Group has been very active in quantum education and PER over the past year. Dr. Ben Zwickl was a Co-PI and lead of Education and Workforce Development for RIT's Quantum Leap Challenge Institute Conceptualization grant for a Quantum Photonic Institute (PI Don Figer, Future Photon Initiative). Ben collaborated with Heather Lewandowski and Michael Fox at CU-Boulder to study workforce needs in the quantum industry, which was published in Physical Review PER and received attention from APS Research News and Communications of the ACM. Ben also participated in the Kavli Quantum Smart Workforce meeting at UCLA in November 2019 and co-authored part of the report on Achieving a Quantum Smart Workforce, published in the journal Quantum Science and Technology. Ben also co-organized and chaired a Focus Session at the 2021 American Physical Society March Meeting in conjunction with the APS Division on Quantum Information entitled "Teaching Quantum Information at All Levels" and is organizing a similar session for the 2022 APS March meeting as well. Locally at RIT, Ben is leading the development of a new minor in Quantum Information Science and Technology.

Postdoctoral researcher Dr. Dina Zohrabi Alaee continued her work with the Zwickl Lab as a postdoc on Ben's NSF CAREER Award studying Learning in Context-Rich Environments. Dina planned and carried out a large multi-week study of physics majors participating in remote NSF-funded REU programs, which is a model both for the depth of data collected, but also in a unique environment forced by coronavirus. Dina conducted weekly interviews (94 in all) covering all aspects of the research experience, including how students approach learning within the REU, their mentoring and social network, and the impact of the experience on their career plans. Dina has developed a new model of how undergraduate research experiences develop students' sense-of-belonging, identity, and career decision-making. A conference proceeding analyzing the experience of one student has been accepted and a longer paper is currently under review.

Mike Verostek continued his work on graduate admissions metrics as predictors of graduate GPA and whether graduate GPA mediated PhD completion. An analysis of 1,955 physics graduate students from 19 PhD programs shows that undergraduate grade point average predicts graduate grades and PhD completion more effectively than GRE

scores. Students' undergraduate GPA (UGPA) and GRE Physics (GRE-P) scores are small but statistically significant predictors of graduate course grades, while GRE quantitative and GRE verbal scores are not. We also find that males and females score equally well in their graduate coursework despite a statistically significant 18 percentile point gap in median GRE-P scores between genders.

VII. Reformed Experimental Activities (REActivities)
Principal Investigator: Christina Goudreau Collison, Dina Newman, Douglas Tusch, Jeremy Cody

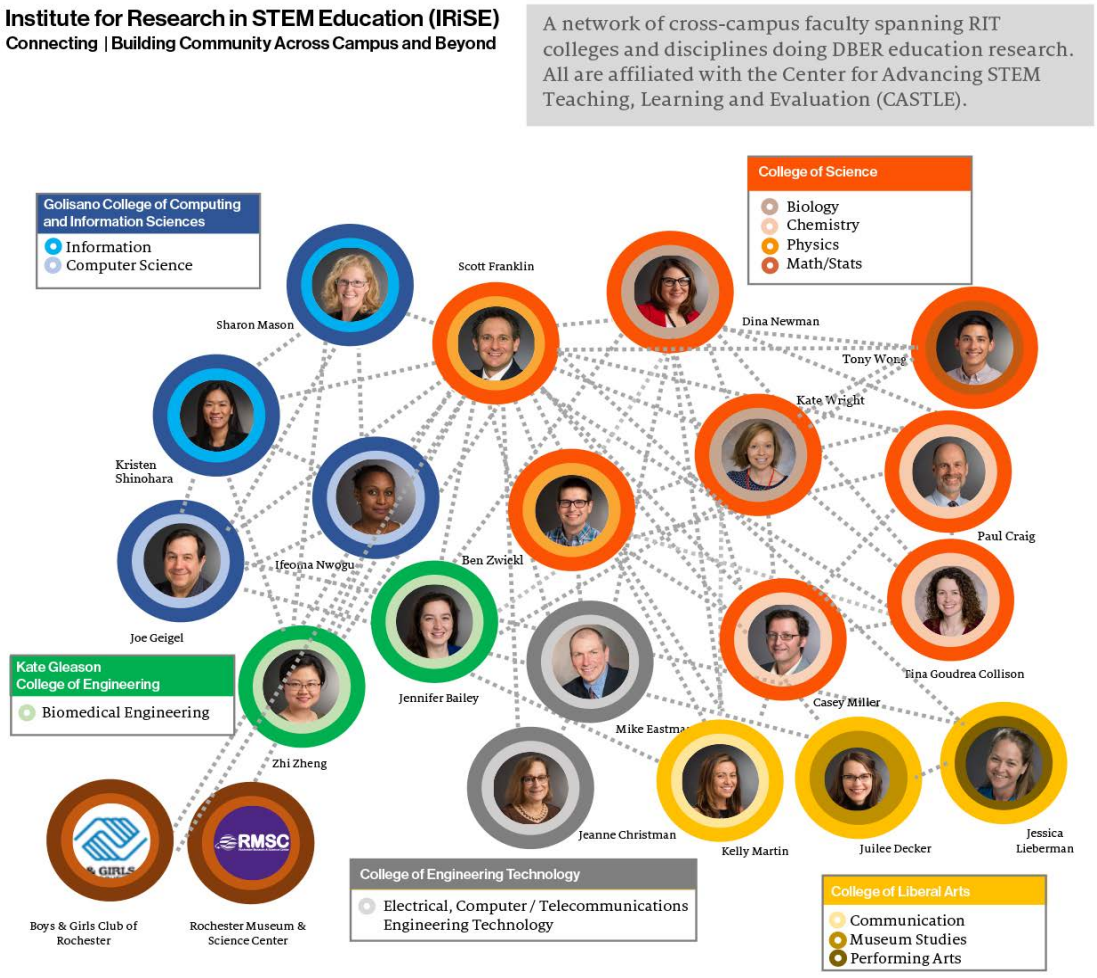
Dr. Tina Goudreau Collison leads a collaborative effort focused on a reformed chemistry curriculum for teaching undergraduate organic chemistry laboratories using a guided inquiry approach. Reformed Experimental Activities (REActivities) incorporates inclusivity, continuity, and engaged student learning in early chemistry experiences. Dr. Goudreau is looking for undergraduate students to join in REActivities research this coming spring. Read More.

REActivities website: www.reactivities.org
YouTube channel: https://www.youtube.com/c/REActivities
Facebook Page: https://www.facebook.com/groups/1685322984913199
Amazon: https://www.amazon.com/REActivities-Organic-Chemistry-Workbook shrinkwrapped/dp/159399642X/ref=sr_1_1 dchild=1&keywords=reactivities+goudreau+collison&qid=1611154380&sr=8-1

Paper Published: Christina Goudreau Collison, Dina L. Newman, Julia Qingli Biehler*, Micaela Nelson*, Paige O'Brien Daly*, Matthew Jackson*, Cameron Isaac*, Madeline Tebrugge*, Jason Anderson, Brian Edelbach, Douglas Tusch and Jeremy Alan Cody "Reformed Experimental Activities (REActivities): Gauging the Fidelity of Implementation in a Reformed Undergraduate Organic Chemistry Laboratory", J. Chem. Educ. 2022 doi: https://doi.org/10.1021/acs.jchemed.1c00998

RESEARCH ACTIVITIES

I. Institute for Research in STEM Education (IRiSE)
Connecting | Building Community Across Campus and Beyond



In February of 2018, CASTLE, along with College of Engineering Technology formed an interdisciplinary collaboration forum. Under the direction of the College of Engineering Technology (CET) Associate Dean Dr. Mike Eastman and CASTLE faculty Drs. Dina Newman and Ben Zwickl, STEM education research groups across campus met to present, share ideas, and further common research goals. Within just two years the campus-wide scholarship community grew, focusing on removing silos of those researching STEM education scholarship. It has connected education research faculty, forming new partnerships, and encouraged working together on research themes and interests. The group also worked to support efforts in graduate education, e.g. the School of Physics and Astronomy's Ph.D. in physics.

During the academic year of 2020-21, grant proposal partnership grew to include key Rochester area educational institutions. Faculty from RIT's MAGIC Spells Studios, College of Liberal Arts, and Golisano College of Computing and Information Sciences partnered with the Rochester Museum & Science Center and Boys and Girls Club of Rochester on *Creating a Community, Academic and Museum Partnership for Informal STEM Learning Through Augmented Reality and Storytelling*, an NSF proposal for informal STEM learning centered around the 2024 eclipse. RIT math, biology, and physics faculty joined College of Science administration to propose *Integrating Stochastic Modeling and Real-time Experience Sampling Into Institutional Decision Making to Promote Student Success*, developing sophisticated new data collection and statistical analyses. COS and COLA faculty are collaborating on a new project researching ethical considerations and affordances STEM researchers (DBER and more traditionally disciplinary) bring to their research.

RIT Campus and Area Partnering Associations Include:

- Golisano College of Computing & Information Sciences
- Kate Gleason College of Engineering
- College of Engineering Technology
- College of Health Sciences and Technology
- College of Liberal Arts
- National Technical Institute of the Deaf
- College of Science
- School of Individualized Study
- MAGIC Spell Studios
- Rochester Museum & Science Center
- Boys & Girls Club of Rochester

II. SMERC Journal Club

https://www.rit.edu/castle/research/journal-club

The RIT Science and Mathematics Education Research Collaborative (SMERC) runs a weekly journal club open to all, especially faculty interested in incorporating research-based methods and assessment into their classrooms. Twenty-eight sessions were held in the AY2020-2021. Run by Dina Zohrabi Alaee, readings were selected by the group of regular attendees and came from a variety of discipline areas (life sciences, chemistry, engineering, computer science, physics, social sciences) and journals. Typically, the discussion was facilitated by whoever suggested the article. The articles were announced weekly via a listserv with 65 members, and 7-10 people attended on a typical week.

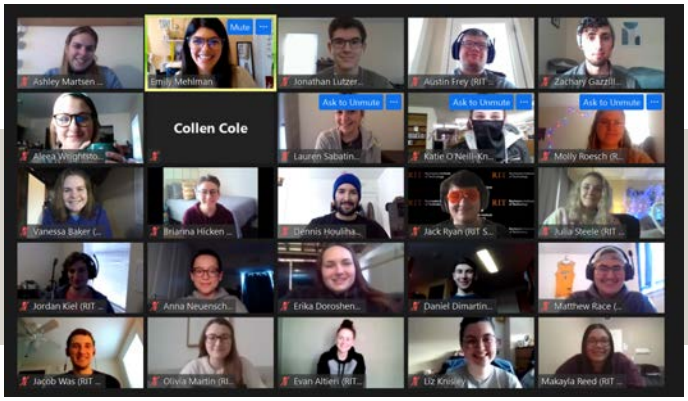
Programmatic Activities

Learning Assistant (LA) Program

https://www.rit.edu/castle/programs/learning-assistants/overview

Learning Assistant Aleea Wrightstone interacting with class participants in Biochemistry (left); Vanessa Baker (center in photo) interacting with Introduction to Biology students within small group lab discussion (right).

The **Learning Assistant (LA) Program** is a leader among national LA Programs across the country. This year, more RIT schools assumed a greater share of the cost of the program, showing a clear commitment and appreciation of the benefits to faculty and students alike. Despite the schools' assuming more of the cost, the College of Science saw an increased number of learning assistants. Courses transitioned to online and blended classroom models, with help from the LAs in designing course delivery using multiple modalities. Despite the challenge of navigating a virtual means of connecting, student LAs continued to support the goals of their faculty mentors through peer-to-peer small group facilitation and resourceful ways of connecting one-on-one. Active learning materials and out-of-class peer-learning sessions continued as in years past. LAs utilized skills and training, gained from the pedagogy class, that allowed them to reflect on classroom learning, make meaning from that reflection, and provide insight and ideas to work collaboratively with faculty to improve outcomes. In this way the program is uniquely different from traditional classroom support.



Orientations and end of semester wrap-ups were held virtually.

During this academic year, 80 learning assistant positions were filled, preparing them to assist in classroom instruction, peer-to-peer problem solving, and strengthen leadership skills while articulating and defending their ideas. These LAs supported campus-wide classes in the Gosnell School of Life Sciences, School of Mathematical Sciences, School of Chemistry and Materials Science, School of Physics and Astronomy, National Technical Institute for the Deaf (both American Sign Language and Interpreting Education and Cultural and Creative Studies), Electrical Engineering Technology, and Mechanical Engineering Technology. Through this process, LAs gained self-confidence utilizing this vehicle as a way to practice professionalism in the work place.

More than 80 Learning Assistants supported campus-wide classes in AY 2021-22.

Program Coordinator, Dr. Emily Mehlman led a [illegible] and dedicated faculty, the Learning Assistant Program Committee, with new members joining each year. The Committee focused on continuing to build a stronger and more inclusive program for students while supporting teaching goals of classroom faculty mentors.

As the program has grown, some students were LAs in more than one classroom, just as some faculty mentored LAs in two, three or four classrooms. For courses with a larger number of students (>100), two or more LAs were assigned.

During the Fall Semester 2020, the program had 39 learning assistants working with 29 faculty mentors in the four College of Science schools (GSoLS, SCMS, SMS, and SoPA), and 2 College of Engineering & Technology (Manufacturing & Mechanical Engineering Technology, Electrical Engineering Technology). The American Sign Language and Interpreting Education department and Performing Arts Department within NTID (National Institute for the Deaf) also had LAs and mentors in Fall Semester 2020.

During the spring semester of 2021, the mentors and LAs persevered with the challenges of virtual classroom connections and Zoom fatigue. There were 39 learning assistants working with 26 faculty mentors within the same College of Science schools.

Additionally, 6 learning assistants were placed in the Interpreting Department of NTID, adding new NTID faculty to the program. We were pleased to welcome a faculty member from the School of Mathematical Sciences during this semester as well.

The pedagogy course, an important component of the LA Program, was taught both semesters by program coordinator, Emily Mehlman, and provided training to 39 students (21 fall, 18 spring) focusing on helping practice facilitating small group discussion, carrying out pedagogical research, and supporting student engagement in the classroom through active learning. The program provided a resource to help faculty implement and sustain pedagogical change in their classrooms, while LAs gained experience teaching, to assess whether this is something they may be interested in pursuing as a career.

The LA Program website remains updated with clear and precise information for both student LAs and faculty mentors. An Additional Resources Page on the Faculty Mentor Information section of the website continues to provide publications, podcasts, videos and website links as resources to support student learning assistants, faculty working with LAs, or anyone interested in learning more about the LA Program or related pedagogies.

2020–21 Undergraduate Learning Assistants:
Nana Aikins, Evan Altieri, Vanessa Baker, Kelsey Beers, Jojo Bensa, Gage Blackwell. Brandon Bogner, Anton Bogovik, Haven Chady, Collen Cole, Victoria Covell, Lacey Dallum, Steven Dang, Aniya DeBride, Daniel DiMartino, Erika Doroshenko, Timothy Forst, Ian Freezman, Austin Frey, Zachary Gazzillo, Nadia Gunderson, Eugene Ham, Brianna Hicken, Dennis Houlihan, Seth Jones, Maha Khokhar, Jordan Kiel, Elizabeth Knisley, Ashley Lasko, Jonathan Lutzer, Emily Mahoney, Olivia Martin, Ashley Martsen, Jessica McNeely, Celia Mercovich, Nadia Moore, Anna Neuenschwander, Nikolas Nguyen, Katherine O'Neill-Knasick, Kristen Patten, Samara Patterson, Lexi Pyke, Matthew Race, Irtaza Razvi, Makayla Reed, Brayden Renslow, Molly Roesch, Jack Ryan, Lauren Sabatino, Benjamin Sander, Julia Steele, Joseph Testa, Nasheett Usman, Dominick Velez, Gabriel von Kessel, Abigail Von Plinsky, Jacob Was, Peter Wengert, Andrew Weston, Aleea Wrightstone, Emalee Wrightstone, Kelsey Zelaya

2020–21 Learning Assistant Mentors:
Alla Bailey, Dawn Carter, Michelle Chabot, Tony Chirico, Steven Ciccarelli, Matt Coppenbarger, Mary-Anne Courtney, Paul Craig, Elizabeth DiCesare, Kristina Driscoll, Andrew Ferrante, Scott Franklin, Michael Gleghorn, Josh Green, Ed Hach, Kathleen Holcombe, Marc Holland, Jeyhan Kartaltepe, Geo Kartheiser, Prema Kumar, Joseph Lanzafame, Jason Listman, Charlie Lusignan, Louis McLane, Samantha Moore, Shahla Nasserasr, Dina Newman, Sheth Nyibule, Suzanne O'Handley, Mark Olles, Shima Parsa, Michael Pierce, Lisa Prinzi, Michael Savka, Hyla Sweet, Greg Trayling, Ben Zwickl

The LA Program hosted two recruitment fairs, one in the Fall semester (November 13, 2020) and one in the Spring semester (April 2, 2021)—both held virtually, video recorded, captioned and posted to the CASTLE website.

Both recruitment fairs started with a presentation by program coordinator, Emily Mehlman, providing details on the program, including expectations and commitments. After a Q & A session a student panel of current learning assistants spoke about their experiences and the benefits of the program.

Learning Assistant Program Faculty Committee Members:
The AY 2020-21 brought new faculty members to the organizing committee from areas of the College of Science, and National Technical Institute for the Deaf (NTID). Committee members consisted of the following:

- Emily Mehlman (CASTLE LA Program Coordinator)
- Scott Franklin (School of Physics and Astronomy)
- Dawn Carter (Thomas H. Gosnell School of Life Sciences)
- Liz Bremer (Office for Diversity and Inclusion)
- Nate Barlow (School of Mathematical Sciences)
- Andrew Ferrante (School of Physics and Astronomy)
- Daniel Maffia (Department of ASL and Interpreting Education, National Technical Institute for the Deaf)

IMPRESS PROGRAM | ACCESS NETWORK

Metacognition classes engaging in self-reflection and small group discussion.

Integrating Metacognitive Practices and Research to Ensure Student Success (IMPRESS) incorporates metacognition into the study of science, technology, engineering and mathematics (STEM) studies. It is based on the awareness and understanding of one's own thought process.

In the past, the IMPRESS program has consisted of a summer bridge program for pre-freshman and a course in metacognition for first year students (ITDS 150: Metacognitive approaches to scientific inquiry). The IMPRESS program has adapted to changing funding sources and now consists of the first year metacognition course (two sections offered in fall) and a student run social group called Get Meta! (founded by 4 veteran IMPRESS students in Spring 2021). In fall 2020, two sections of the metacognition course were taught by Dr. Emily Mehlman in an entirely virtual platform, enabling multiple students in each class to participate virtually from locations outside of Rochester (44 students total; one section of 20 and one of 24 students). IMPRESS continues to evolve and expand its programming to meet the needs of RIT and its students with plans to increase the number of sections offered in order to support a College of Science-wide cohort building experience.

Summer 2021, for the first time, offered a course through the First Class Academy (FCA) entitled *Thinking About Thinking About Science: Metacognition*, which allowed 27 pre-freshman students to examine their own learning through written self-reflection, active learning during synchronous zoom meetings, and investigation of different perspectives through collaborative analysis of case studies—while fulfilling the ethical perspective requirement or a general education elective of 3 credits. The course was taught by Drs. Emily Mehlman and Rita Margarida Magalhães.

The new student group Get Meta! was founded by 4 veteran IMPRESS students with the hopes of spreading metacognitive skills and ideas throughout RIT. They also hope to provide networking opportunities and host socials to bring together students from across disciplines and colleges. Anyone can join the Get Meta! group, not just IMPRESS associated students. Already in spring 2021, even prior to official as a student group, these students hosted informal socials to recruit members to Get Meta! and share their passion for metacognition. Fall plans that have already been discussed include more socials such as a start of the year RIT campus scavenger hunt, off-campus “field trips” to Rochester venues such as The Memorial Art Gallery, and a fundraiser. This group is advised by Dr. Emily Mehlman, IMPRESS Coordinator.

IMPRESS is part of the Access Network, which consists of nine university-based programs co-working with graduate and undergraduate students across the country towards a vision of a more diverse, equitable, inclusive, and accessible STEM community. The core values of the network align with the IMPRESS program giving students a voice and ownership in their education, while providing authentic science practices and professional development. Between 4 and 6 IMPRESS students are selected for fellowships with the Access Network each year. Two main fellowship role are offered: Assembly Fellows and Network Fellows. 1-2 Assembly fellows are selected from the RIT IMPRESS cohort per year. Assembly Fellows (AFs) collaborate with other AFs from Access sites across the country to plan and put on a springtime event called the Access Network Assembly. At the Assembly, fellows and affiliates of Access gather to network, share resources, engage in education about diversity, equity, inclusion, and social justice, and collaborate to support the success of individual Access site programs, such as IMPRESS. The AF role is a unique opportunity for students to gain experience in networking, collaboration, professional development, and planning a professional event similar to a conference. In 2021, the Assembly was held virtually allowing these fellows the opportunity to reinvent prior year sessions for a virtual platform and incorporate attendees from a wider range of sites without consideration for travel costs. The AF from RIT for 2020 and 2021 was Mikayla Bulson.

In addition to the AF role, 2-4 Network Fellows (NFs) are also selected from the cohort of RIT IMPRESS students each year. NFs meet on bi-monthly video conference calls with other NFs from Access sites across the country to network, share resources, and support both the Access Network as a whole and the programs of individual sites. In past years, NFs would travel to other Access sites, but with COVID preventing safe inter-site travel, NFs developed novel ways to interact including hosting network wide virtual socials, establishing an Access newsletter, crafting blog posts on the Access Network website, establishing an Alumni database, and more. In January 2021, a cohort of NFs planned and hosted a virtual workshop on the practice of grant writing. This multi-day virtual workshop served to inform undergraduate and graduate students on the process of grant writing with the overall goal of demystifying how science is funded. The 2020 NFs were Kylie Johnson and Sydale John Ayi. The NF for 2021 was Merone Delnesa, These cohorts of NFs were mentored by Dr. Emily Mehlman (a Core Organizer [CO] of Access and the IMPRESS Coordinator at RIT) along with two other non-RIT Access COs.

During the COVID-19 pandemic, members of the Access Network noticed an increased and disproportionate financial, emotional, and social impact on AALANA students. To address this need, the Network established an emergency fund based on direct giving. The emergency fund ran for a total of 7 cycles and redistributed more than $33,000.00 to 40 unique individuals. The fund was intentionally guided by a set of Network defined principles to ensure equitable disbursement of funds. Reasons given for requesting financial support from the fund included paying for basic life needs (food, rent, etc), tuition, home mortgages due to parental loss of jobs, and medical bills/funeral costs. Dr. Emily Mehlman and Dr. Scott Franklin worked with a subset of Access Network leaders to collaboratively run the emergency fund. The Network is currently in discussion over the future of the emergency fund as it is currently inactive.

Over the past year, the Access Network has submitted two grants to the NSF soliciting further funding for the organization. One of these grants was funded to support the continuation of Network activities such as the mentoring of AF and NFs and the execution of the annual Assembly. Efforts are currently underway to seek additional funding to expand the Network and incorporate new sites, with a focus on Minority Serving Institutions. Dr. Emily Mehlman and Dr. Scott Franklin participate in grant preparation and general support of the Network as a whole.

As the IMPRESS program grows and evolves at RIT, more opportunities for RIT students to get involved with the Access Network will be made available. Inter-site travel will once again be safely possible and with a larger cohort of IMPRESS students, more RIT students will have the opportunity to network with other visiting NFs from Access. Pending funding, the Network will continue to grow and incorporate new sites, adding additional networking opportunities for RIT students.

Summer Math Applications in Science with Hands-On (SMASH) Experience for Girls

The SMASH Experience for Girls is a summer program designed to increase middle-school girls' engagement and interest in STEM. Unfortunately, during the summer of 2020 the program was cancelled due to the health risks posed by COVID-19.

In the past, this unique program has brought 36-40 rising eighth grade girls to RIT's campus from 10-12 different schools in the Rochester area. Almost half of the participants were awarded need-based scholarships. Participants spent a week working on mathematical modeling projects, designed to show the usefulness of mathematics in everyday life; self-affirmation activities created to build confidence in math; and daily recreational activities.

The experience always concludes with a hands-on event involving representatives from local companies demonstrating the role of STEM in their industries, and a parent symposium where participants present a problem plaguing their local community and how mathematics could be used to solve this problem. In preparation for the summer experience, RIT undergraduate and graduate students, with interests in K-12 STEM education, under the mentorship of a local teacher create, test, and then facilitate all SMASH activities.

Professional-development for Emerging Education Researchers (PEER)

https://www.rit.edu/castle/programs/peer/about

This year PEER offered virtual workshops, continuing to serve emerging education researchers interested in expanding their theoretical or methodological expertise, as

well as senior faculty looking to transition from traditional disciplinary research into STEM education research.

A workshop was held with the University of Cologne (Germany) in March, 2021, and an extended series of workshops with math faculty kicked off in February, with three 2-hour cohort sessions following in May and June. The experience closed with a weekend meeting June 25-27.

A University of Manchester field-school is currently scheduled for Ambleside, UK in September, 2022.

PEER continues to expand, with the recent grant award for a field school in Kazakhstan awarded by the Embassy of the United States of America in Kazakhstan—American Council for International Education.

Scott Franklin, professor in the School of Physics and Astronomy and director of RIT's Center for Advancing STEM Teaching, Learning and Evaluation (CASTLE), received funding to help establish a PEER field school in Kazakhstan. The grant was awarded by the Embassy of the United States of America in Kazakhstan, by the American Council for International Education. Franklin and PEER co-director, Eleanor Sayre of Kansas State University, together with others in the program, will improve STEM faculty members' pedagogical knowledge in English and prepare STEM faculty to measure student learning and development.

The PEER program continues to have an international presence with workshops on research life, ethics, getting started with research design, analysis methods, research communication, teaching, and colloquium-style talks. View available workshop topics here.

PEER Publications and Presentations
A compiled list of publications and presentations by individuals across the PEER host sites is available showing individual and collaborative research. View list here.

PEER World Locations
Rochester, NY, USA

Cologne, Germany
Kibungo, Rwanda
Monterrey, Mexico
Vancouver, BC
Kazakhstan

RESEARCH FUNDING

2021-2022 New CASTLE Affiliated Grants ($1,710,661)

Helping Computer Science Students Learn How to Build Accessible Computing Technologies ($167,623)
Creating accessible technology (i.e., technology that can be used by people with disabilities) is an important skill that is often left out of computer science curricula. When it is taught, it is frequently taught in elective courses such as Human Computer Interaction and Web Programming. However, we believe that all students should be familiar with accessibility and thus seek to integrate accessibility into foundational computer science courses. In particular, we propose to create and assess modules for core computing concepts that infuse accessibility in existing courses to: (1) effectively include accessibility-congruent technical skill and knowledge into computing topics; (2) facilitate accessibility know-how for faculty across a range of foundational computing topics, while (3) maintaining conceptual integrity in core topics. We will then make these modules available for use by other instructors.
Key Personnel: Kristen Shinohara (PI)

CAREER: Chirality and PolymerThermodynamics: Frustration and Amplification ($195,050)
Chirality is the feature where a material is not superimposable on its mirror image. Whether exhibited at the molecular length scale or mesostructural length scale, the interaction of the chiral material with light results in novel optical properties. In this proposal, we aim to understand the physics behind chirality transfer from smaller to larger length scales (molecule to mesostructure). A particle-based model is utilized, combined with thermodynamic principles, to interrogate two mechanisms: chiral frustration that inhibits chirality transfer and chiral amplification that promotes chirality transfer. This work will also bridge the gap between existing experimental and theoretical literature.
Key Personnel: Poornima Padmanabhan (PI)

Collaborative Research: Sustainable CURE implementation: Characterizing the role of flexible design and instructor supports across diverse institution types ($588,362)
The BASIL (Biochemistry Authentic Scientific Inquiry Lab) curriculum is designed as a Course-based Undergraduate Research Experience (CURE), where the students predict the function of proteins of unknown function. The project includes wet-lab and computational modules and is currently fully implemented on ten campuses nationwide; parts of the curriculum are also implemented on at least ten additional campuses. In Phase III of this project, we plan to (1) Identify the supports for and barriers to CURE implementation and sustainability across institution types; (2) Characterize the relationship between institutional context and variations in CURE implementation across institution types; and (3) Facilitate implementation and sustainability in diverse contexts through faculty development. One of our major tools

for building the BASIL community is a series of Recruiting, Implementation Support, Assessment and PEER (Professional-development for Emerging Education Researchers) workshops, combined with a mentoring program for both new and existing faculty members in the community, that will enable all of us to make increased contributions to education research that extend beyond our community, through future presentations, workshops, publications and proposals.
Key Personnel: Paul Craig (PI), Suzanne O'Handley (Co-PI)

Research Experiences for Undergraduates: Multidisciplinary Research on Student Success in STEM at the Rochester Institute of Technology ($398,271) The Rochester Institute of Technology (RIT) Science and Mathematics Educational Research Collaborative, an interdisciplinary Education Research group, will host an REU with annual cohorts of 10 students over three years. STEM students will apply their growing disciplinary knowledge to solve important problems in education. The program will be open to all students, but with targeted recruitment of underrepresented groups, including students of color and first generation college students. Intellectual merit is established by novel and rigorous research findings that will emerge during the three years (and beyond) of this project. The varied research topics include numerous aspects of undergraduate STEM Education and, thus, findings from our work will directly inform the larger community of STEM educators and researchers. The undergraduate researchers, themselves, will increase their own knowledge of discipline-specific content and research methodology. The REU will provide a variety of support structures for students, including: cohort-wide research methods workshops, smaller research group meetings, individual mentoring, Professional Development workshops, reflection opportunities and cohort-building events. The knowledge gained from these training sessions and workshops will directly benefit our participants and prepare them for future careers in STEM. The Broad Impact of this project lies in the 30 students directly involved in the program. We will continue to recruit and accept students who have been traditionally excluded from higher education opportunities including students of color, LGBTQ and first-generation college students. Whether REU Alumni pursue PhDs in DBER or STEM disciplines, teaching positions, or other careers, they will benefit from the research experience, professional skills development and networking. Through our program we will increase the number of STEM Education Researchers who will implement practices that promote learning and success of all STEM students. The participants will gain knowledge of inclusive and evidence-based strategies to improve their own skills as undergraduate educators-in-training (i.e. tutors and teaching assistants). Participants who go on to become K-12 teachers, Graduate Teaching Assistants and future faculty members will have knowledge of student-centered approaches and research-backed strategies to improve STEM learning in their own future students.
Key Personnel Leslie Kate Wright (PI), Dina Newman (Co-PI), Jennifer Bailey (Co-PI), Scott Franklin (Co-PI), Ben Zwickl (Co-PI), Christina Goudreau Collison (Senior Personnel), Kelly Norris Martin (Senior Personnel), Tony Wong (Senior Personnel)

Collaborative Research: Evaluating the Impact of the Promoting Active Learning and Mentoring (PALM) Network on Vision & Change Awareness and Implementation ($326,355)
The Promoting Active Learning and Mentoring (PALM) Network formed to increase the use of active learning in undergraduate courses. PALM fellows are mentored by experienced instructors to reform their teaching toward student-centered, evidence-based pedagogies—principles that are explicitly recommended in the Vision & Change report (V&C). This project will sponsor focus group workshops for PALM members to learn whether V&C influenced their motivation to join the PALM Network and how effective the PALM mentorship was in promoting the implementation of V&C principles in their home departments. Data gathered from the focus groups will be used to develop personas that describe the different types of people who joined PALM, how they interact with V&C, and whether the participants became change agents. Personas can be used to guide future decision making about recruitment to programs like PALM, inform institutional change initiatives, and outline a path to widespread teaching reform.
Key Personnel: Dina Newman (PI)

RIT Cornerstone: Analytic and Expressive Communication, $35,000
This proposal responds to Rochester Institute of Technology's unique character with initiatives that both satisfy our students' career-related needs and equips them to be civically engaged, empathically attentive thinkers. We have designed curricular pathways to attract students to transformative text-based humanities courses and to support their sustained work in humanities disciplines. In addition to providing a rich, first year experience for a significant portion of incoming students, we have developed an immersion which satisfies general education requirements, as well as a15-credit certificate named "Analytic and Expressive Communication" (AEC). Our AEC certificate includes options among several main course tracks, each of which is informed by our data on the needs of the university, and that STEM faculty identified as particularly urgent for their students. Our responsiveness to these recorded needs suggests that our initiative will benefit from the readiness of other academic programs to funnel students into the humanities. In response to the feedback we collected on what faculty believe students most lack and require in our general education curriculum, we developed tracks in Civic Engagement, Diverse Perspectives, and Ethical and Moral Reasoning.
Key Personnel:
Kelly Norris Martin (PI)
Katie Terezakis (Co-PI)

PUBLICATIONS and PRESENTATIONS

1. Dina Zohrabi Alaee, Micah K. Campbell, and Benjamin M. Zwickl (2021). Impact of virtual REU experiences on students' psychosocial gains during the COVID-19 pandemic. Chosen as an **Editors' Suggestion** in *Physical Review - Physics Education Research*.
2. Wright LK, Cortez P, Franzen M, **Newman DL** (2021)**.** Teaching Meiosis with the DNA Triangle Framework: A Classroom Activity that Changes How Students Think about Chromosomes. *Biochem Mol Biol Educ, 2021*.
3. **Newman DL**, Coakley AJ, Link A, Mills K, Wright LK (2021). Punnett squares or protein production? The expert-novice divide for conceptions of genes and gene expression. *CBE-Life Sci Educ*, 20(4):ar53, 1-10.
4. Mike Verostek, Casey Miller and Ben Zwickl. *Analyzing admissions metrics as predictors of graduate GPA and whether graduate GPA mediates Ph.D. completion*. Phys. Rev. Phys. Educ. Res. **17**, 020115. APS Physics writeup (2021)
5. Dina Zohrabi Alaee, Micah K. Campbell, and Benjamin M. Zwickl, *Impact of virtual research experience for undergraduates experiences on students' psychosocial gains during the COVID-19 pandemic.* **Editors' Suggestion** in *Physical Review - Physics Education Research*. Res. 18, 010101 (2022)
6. David Schwartz, *Making Games to Teach Physics and Mechanics*. Middle Atlantic ASEE Section Spring 2021 Conference (2021)
7. Kaitlin Stack Whitney et al.. Flexible and inclusive ecology projects that harness collaboration and NEON-enabled science to enhance student learning. *Bulletin of the Ecological Society of America*. Volume103, Issue2 April 2022. https://doi.org/10.1002/bes2.1963.
8. Kaitlyn Clark, Christina Goudreau Collison et al**.** *Sign Language Incorporation in Chemistry Education (SLICE): Building a Lexicon to Support the Understanding of Organic Chemistry*. Chemistry Education Research and Practice, Special Issue on Diversity, Equity, Inclusion, and respect in Chemistry Education Research and Practice. https://pubs.acs.org/doi/10.1021/acs.jchemed.0c01368
9. Wright LK, Wrightsone EA, Trumpore LJ, Abid DM, Newman DL (2022). The DNA Landscape: Development and application of a new framework for visual communication about DNA. *CBE LSE*.21:ar47. DOI:10.1187/cbe.22-01-0007
10. Goudreau Collison C, Newman DL, Biehler J, Nelson M, Daly P, Isaac C, Jackson M, Tebrugge M, Anderson J, Edelbach B, Tusch DJ, Cody J (2022). Reformed Experimental Activities (REActivities): Gauging the Fidelity of Implementation in a Reformed Undergraduate Organic Chemistry Laboratory. *J Chem Ed* 99(5):2032-2043. DOI: 10.1021/acs.jchemed.1c00998
11. Wright LK, Cortez P, Franzen M, Newman DL (2022)**.** Teaching Meiosis with the DNA Triangle Framework: A Classroom Activity that Changes How Students

Think about Chromosomes. *Biochem Mol Biol Educ* 50:44-54. DOI: 10.1002/bmb.21583

12. Bailey A, Takacs, G., (2022). Online Educational Experiences with Clean Energy: Hydrogen/Fuel Cells. Proceedings of the 2022 Hawaii University International STEM/STREAM and Education Conference.