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The CASTLE Center for Advancing STEM Teaching, Learning & Evaluation is a network of faculty, projects and programs engaged in scholarship surrounding STEM education. Key Focus Areas are:

1) Scholarship of Pedagogy - CASTLE supports faculty efforts on pedagogical scholarship, evaluation and assessment, and foster innovation in the classroom.

2) Discipline-based Education Research (DBER) - The Science & Math Education Research Collaborative (SMERC) conducts rigorous discipline-based education research on issues involving postsecondary student learning, and members have a track record of peer-reviewed publications and external funding.

3) Educational Transformation - The Center promotes and fosters innovative curricula for national dissemination. The College hosts several model curricula, including: LivePhoto, VideoVignettes, and Explorations in Physics. The Center will aggressively seek external funding for these projects.

4) K-20 Teacher Recruitment, Preparation and Professional Development - CASTLE takes an active role in preparing the next generation of STEM teachers through undergraduate and graduate student education. Examples of activities include the RIT Learning Assistant program to recruit and prepare future secondary school teachers.

5) Education and Careers of Groups Historically Excluded from the STEM Disciplines - This includes collaborations with Women in Science (WISe), a CASTLE-affiliated program that seeks to engage women in the sciences and mathematics by offering information, equity and collaboration opportunities. The Center helps coordinate WISe activities, and supports efforts to secure external funding through foundations and local and national industries.

The Center’s Vision is to:

- Nurture a community of faculty, administrators, and staff interested in science and math education and pedagogy. CASTLE facilitates dialog about evidence-based practices, discipline-based education research, and methods of assessment and evaluation.

- Establish a robust and sustainable infrastructure that transforms science educational practices, supports discipline-based education research, and promotes K-20 teacher and faculty recruitment, preparation, professional development, and outreach.

- Foster innovations in education by integrating an interdisciplinary community of scholars; promoting, sustaining, and evaluating reform efforts; advocating for diversity and access; and influencing policy, fundraising, and public outreach.

Flagship programs include:

- The Science & Mathematics Education Research Collaborative, a leading innovator in discipline-based education research.

- The Learning Assistant program, which facilitates faculty efforts at transforming classrooms and attracts students toward careers in 9-12 STEM education.

- Project IMPRESS (Incorporating Metacognitive Research and Practice to Ensure Student Success), which seeks to improve learning through direct instruction in metacognition, including accurate self-assessment and sense-making.
CASTLE Center Members

Jennifer Bailey  
Lecturer, Kate Gleason College of Engineering

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

Adwoa Boateng  
COS Library Liaison, Research and Instruction Services

Kelly Norris Martin  
Assistant Professor, School of Communication

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

Corey Ptak  
Program Coordinator, LA Program and Lecturer, Thomas H. Gosnell School of Life Sciences

Dehui Hu  
Lecturer, School of Physics and Astronomy

Robert Teese  
Assistant Professor, School of Physics and Astronomy

Thomas Kim  
Director, SMERC and Associate School Head and Associate Professor, School of Chemistry & Materials Science

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

Anne Leak  
Postdoctoral Researcher, School of Physics and Astronomy

Benjamin Zwickl  
Assistant Professor, School of Physics and Astronomy

Affiliated Personnel

Elizabeth Cherry  
Associate Professor, School of Mathematical Sciences

Paul Craig  
School Head and Professor, School of Chemistry & Materials Science

Kara Maki  
Assistant Professor, School of Mathematical Sciences

Jeremy Cody  
Associate Professor, School of Chemistry & Materials Science

Tina Goudreau  
Associate Professor, School of Chemistry & Materials Science

Lea Vacca Michel  
Associate Professor, School of Chemistry & Materials Science
During the 2014 – 2015 academic year CASTLE has led or collaborated on thirteen different grants that total over $3.8 million. Center funding has risen dramatically over the past five years.

### Current CASTLE Funding

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<th>Dates</th>
<th>Total Funding</th>
<th>Funding Details</th>
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<tr>
<td>10/1/2011 – 9/30/2016</td>
<td>$215,989</td>
<td>Collaborative Research: LivePhoto Physics Interactive Video Vignettes; NSF-National Science Foundation; PI Robert Teese, Co-PI Thomas Reichlmayr</td>
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<tr>
<td>9/1/2012 – 8/31/2015</td>
<td>$299,393</td>
<td>RIT/NazEd Tech2Teach: Developing Institutional Commitment to STEM Teacher Preparation; NSF-National Science Foundation; PI Scott Franklin</td>
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<tr>
<td>6/1/2013 – 5/31/2018</td>
<td>$899,898</td>
<td>Metacognition: A Transformative Approach to Retaining Deaf/HoH and first generation STEM Majors; NSF-National Science Foundation; PI Scott Franklin, Co-PI Elizabeth Hane</td>
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<td>7/1/2013 – 6/30/2016</td>
<td>$199,980</td>
<td>Collaborative Research: Transforming the Organic Chemistry Experience: Development, Implementation and Evaluation of Studio-Based Modules; NSF-National Science Foundation; PI Christina Collison, Co-PI Thomas Kim</td>
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<td>9/1/2013 – 8/31/2015</td>
<td>$49,527</td>
<td>Collaborative Research: Inspiring Undergraduate Engagement in Advanced Laboratories Through Web-based Interactive Video; NSF-National Science Foundation; PI Robert Teese, Co-PI Thomas Reichlmayr</td>
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<td>9/1/2013 – 8/31/2016</td>
<td>$599,920</td>
<td>Incorporating Modeling into Upper-Division Physics Labs; NSF-National Science Foundation; PI located in CU Boulder, Co-PI Benjamin Zwickl</td>
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<td>9/1/2014 – 8/31/2017</td>
<td>$399,309</td>
<td>Transfer of Math, Physics, and Communication Skills Into the Entry-level Photonics Workforce; NSF-National Science Foundation; PI Benjamin Zwickl, Co-PI Kelly Norris Martin</td>
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<td>Dates</td>
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<tr>
<td>9/1/2014 – 8/31/2017</td>
<td>$372,580</td>
<td>Collaborative Research: Development and Assessment of Interactive Video Vignette Modules for Biology Teaching; NSF-National Science Foundation; PI Robert Teese, Co-PIs Leslie Kate Wright and Dina Newman</td>
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<tr>
<td>9/1/2014 – 8/31/2017</td>
<td>$133,868</td>
<td>Collaborative Research: Undergraduate Students’ Epistemology and Expectations of Experimental Physics; NSF-National Science Foundation; PI Benjamin Zwickl</td>
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<tr>
<td>10/1/2014 – 9/30/2017</td>
<td>$339,825</td>
<td>REU Site: Model-Based Reasoning and Representations in STEM Learning at the Rochester Institute of Technology; NSF-National Science Foundation; PI Leslie Kate Wright, Co-PI Dina Newman</td>
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<td>6/1/2015 – 5/31/2017</td>
<td>$80,962</td>
<td>Collaborative Research: Role of Undergraduate Biochemistry Education in Protein Function Assignment; NSF-National Science Foundation; PI Paul Craig, Co-PI Herbert Bernstein</td>
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<td>9/1/2015 – 8/31/2018</td>
<td>$270,225</td>
<td>The Access Network: Supporting Retention and Representation in Physics through an Alliance of Campus-Based Diversity Programs; NSF-National Science Foundation; PI Scott Franklin, Co-PI Corey Ptak</td>
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Pending CASTLE Funding

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<tr>
<td>6/1/2016 – 5/31/2020</td>
<td>$647,103</td>
<td>Collaborative Research: Exploring factors that shape education and workplace training on essential 21st Century Competencies: A translational study in Four High-STEM Job Regions; NSF-National Science Foundation; PI Benjamin Zwickl, Co-PI Kelly Norris Martin</td>
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CASTLE Center Events

1. The 2nd Annual CASTLE Symposium – May 20th 2015
   The second annual CASTLE Symposium was held on Wednesday, May 20th 2015 in RIT’s Student Innovation Hall. The symposium began with a poster session that showcased over 25 students and faculty research projects focused on improving STEM education. Scott Franklin, CASTLE Director, provided opening remarks and Provost Jeremy Haefner gave a keynote address. An award ceremony followed to honor recipients of the first “Science and Math Education Research Special Honor Award” and recognize the 2014 – 2015 academic year Undergraduate Learning Assistants.

   a. 2015 Science and Math Education Research Special Honor Award Recipients
      i. Dawn Carter (Thomas H. Gosnell School of Life Sciences)
      ii. Deana Olles (School of Mathematics & Statistics)
      iii. Corey Ptak (Thomas H. Gosnell School of Life Sciences)
      iv. Jillian Sirkis (Senior, Biotechnology)


2. CASTLE/SMERC Seminar Speakers
   a. Leanne Wells, Florida International University – Wednesday, September 10th 2014 – “Supporting your LA Program with data”
   c. Matthew Hora, University of Wisconsin Center for Education Research – Wednesday, November 5th 2014 – “Exploring the alignment between workforce needs and postsecondary education: Preliminary findings from a study of the biotechnology and advanced manufacturing sectors in Wisconsin”
   d. Ramon Barthelemy, Fulbright and University of Jyväskylä, Finland – Friday, January 23rd 2015 – “Gendered Experiences in Physics and Astronomy: Understanding Microaggressions and Hostile Sexism”
   e. Robin Wright, University of Minnesota – Wednesday, February 25th – “Beyond the classroom: Increase the impact of your education innovations by publishing your scholarly teaching materials”
f. Sarah Eddy, University of Washington – Tuesday, March 17th – “Gendered Experiences: Illuminating Hidden Inequities in Biology Classrooms”

g. Lin Ding, Ohio State University – Wednesday, April 1st – “It’s More than Just Statistics – Theoretical Framework in Quantitative PER Students”

h. Hannah Sevian, University of Massachusetts Boston – Wednesday, May 13th – “Capturing Abstraction in Chemistry Problem Solving

3. Learning Assistant Program Fall/Spring Recruitment Fairs
The LA Program hosted two recruitment fairs, one in the Fall semester (October 3rd) and one in the Spring semester (March 13th), and is a great opportunity for interested students. The recruitment fairs start with a presentation by the Program Director, Scott Franklin, and Program Coordinator, Corey Ptak, providing more details on the program including expectations and commitments. After the Q & A session during the presentation a student panel of current Learning Assistants speak about their experiences and the benefits of the program. Students are then encouraged to visit with a faculty mentor from the department they are interested in being an LA for.
CASTLE-Affiliated Programs

**SMERC (Science and Mathematics Education Research Collaborative):** A multidisciplinary group of faculty conducting education research in physics, biology, chemistry, biochemistry and mathematics. SMERC runs a weekly journal club and monthly seminar series and consults with faculty interested in incorporating research-based methods and assessment into their classrooms.

**DBER REU (DBER Research Experience for Undergraduates):** A hands-on research experience for undergraduates in the emerging area of Discipline-Based Education Research (DBER). DBER relates to the use of models and representations in STEM. This NSF-funded Research Experience for Undergraduates (REU) program accepted its first cohort in early January. Research mentors and ten REU students from across the country spent the January intersession in a virtual “January Jump-Start” designed to give research mentors and students a chance to meet and start project work before the onsite experience at RIT this summer. The 2015 REU student cohort were from the following colleges: Cal State University Fullerton, Jacksonville University, Kennesaw State University, St. Mary’s College of Maryland, SUNY Geneseo, Texas State University UMass Amherst and University of Central Arkansas. Biology, Biochemistry, Chemistry and Physics REU students spent time reading and discussing DBER literature with the entire group using an online reading/annotation tool. Mentors and students also engaged in Skype and email communication to discuss research interests, individual projects and research ethics. This “Jump Start” gave students the chance to become involved in the design of summer research projects and to get acquainted with each other. The program continued on June 7th when the students arrived at RIT for the nine week on-campus summer experience portion. They continued their mentored research projects but also participated in two weekly workshops, one focused on Professional Development and the other focused on DBER research methods, in addition to a number of social activities. Two students presented at their research projects at the 2015 AAPT Physics Education Summer Meeting in College Park, Maryland; all ten REU students presented at RIT’s Undergraduate Research Symposium on August 7th, the conclusion of the summer experience. This project is funded through National Science Foundation contract # DUE 1359262.

**Learning Assistant (LA) Program:** Dedicated to the transformation of STEM courses – the LA program creates environments in which students can interact with one another, engage in collaborative problem solving and articulate and defend their ideas. Undergraduate LAs facilitate small-group or other interactions in the classroom. RIT’s model is designed to: a) provide resources to help faculty implement pedagogical change in their classrooms, b) recruit and prepare talented STEM majors for teaching careers, c) engage faculty and departments in recruitment and preparation of future teachers and d) improve the quality of STEM education for all undergraduates. During the Fall 2014-15 semester the Program had 22 Learning Assistants working with 14 Faculty Mentors in four College of Science departments: Biological Sciences, Chemistry, Mathematics/Statistics and Physics. For the Spring semester there were 29 Learning Assistants working with 14 Faculty mentors within the same departments. Recruitment Fairs were held the previous semester to educate students on the Learning
Assistant Program and provide them an opportunity to speak with past and current LAs about their experiences. The LA Program also hosted two teacher roundtables, bringing teachers from local schools on campus to speak with students interested in the teaching career path. Faculty members Scott Franklin, Deana Olles and Corey Ptak traveled to Boulder, Colorado to participate in The University of Colorado Boulder’s Learning Assistant Program International Workshop. This project is funded through National Science Foundation contract # DUE 1239994.

IMPRESS (Integrating Metacognitive Practices and Research to Ensure Student Success): An intensive educational experience for first-generation and deaf/hard-of-hearing students that incorporates metacognition scientific inquiry. IMPRESS consists of (1) a Summer Experience, (2) First Year Courses and (3) the LA Program. During the summer, IMPRESS students spend two weeks together investigating complex, real-world problems. During the first-year IMPRESS students take select metacognition courses, while second year students are eligible for Learning Assistant positions. Throughout the 2014-2015 academic year IMPRESS hosted three mixers with activities that encouraged metacognition. This project is funded through National Science Foundation contract # DUE 1317450.

Summer Math Applications in Science with Hands-On (SMASH) Experience: An on-campus five-day summer math and science experience for girls entering eighth grade. Forty-three Rochester-area girls entering eighth grade were at Rochester Institute of Technology from July 13th – July 17th exploring mathematics as the language of science and solving problems through mathematical modeling. During the five-days they interacted with RIT undergraduate students and educators who have made careers in mathematics and science, and participated in problem-solving activities and experiments that included group discussion and self-reflection. The camp concluded with a hands-on event with representatives from Time Warner Cable, Corning Incorporated Foundation, Paychex, Gloucester Engineering and Pearl Technologies. The activities demonstrated to the girls the role of STEM in their industries.

Photonics and Optics Workforce Education Research (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 National Science Foundation contract # DUE 1317450.
Publications

The CASTLE Center had six publications between five faculty members during the 2014-2015 academic year.

1. **Franklin, S.** From Grassroots to Institutionalization: RIT’s CASTLE. Proceedings of Transforming Institutions conference. Indianapolis, IN 2014

2. Gardner S.M., Abraham J.K., Gormally C., **Newman D.L.**, Sirum K, et al. Tapping Cross-Disciplinary Expertise to Define Abilities for Competence in Biological Experimentation. (Submitted to CBE-LSE as a meeting report but rejected, currently considering revision or sending to a different journal.)


Presentations


5. **Franklin, S.** – From Grassroots to Institutionalization: RIT’s CASTLE. Transforming Institutions Conference, Indianapolis, IN (October 2014).


9. **Franklin, S.** – From Grassroots to Institutionalization: RIT’s CASTLE. Penn State University, College, PA (April 2015).


12. **Zwickl, B.** – Hands-on, brains-on and high-tech in lab courses. SALTISE, John Abbott College, Quebec Canada (June 2015).

13. **Zwickl, B.** – Preparing students for research excellence in optics and photonics. APS Division of Atomic, Molecular and Optical Physics, Columbus, OH (June 2015).


15. **Zwickl, B.** – Implementing the AAPT Recommendations for the Undergraduate Physics Lab. Laboratory Instruction Beyond the First Year of College II, College Park, MD (July 2015).


22. Franklin, Scott - Taking reflective teaching to the next level. University of Pittsburgh, PA (September 2015).

Students Mentored During 2014 – 2015 Academic Year

The SMERC group plays a large role in mentoring Rochester Institute of Technology undergraduate students, as well as undergraduate students from other universities, to support experiential learning. SMERC members’ consistent involvement with student-centered research aligns with RIT’s strategic plan of becoming a student-centered research university.

Scott Franklin

- DBER REU: Charles Bertram (University of Central Arkansas), Chasya (Eli) Church (UMass Amherst)
- RIT McNair: Ja’Nai Gray
- Brazilian Science Exchange: Debora daniela Wendland Amorim

Thomas Kim

- RIT: Charlie Ayotte, Daniel Saviola, William Marmor
- DBER REU: Ivy Todd (St. Mary’s College of Maryland), Alexander Rhoades (St. Mary’s College of Maryland)

Dina Newman

- RIT: Chris Snyder, Jordan Cardenas, Callie Donahue, Grace Morales, Sam Richheimer
- DBER REU: Kayla DeOca (Jacksonville University), Phyllis Liang (California State University, Fullerton), Chloe House (Kennesaw State University)

Leslie Kate Wright

- RIT: Nick Fisk, Joseph Discua, Hannah Weiss, Eric Franz
- DBER REU: Kayla DeOca (Jacksonville University), Phyllis Liang (California State University, Fullerton), Chloe House (Kennesaw State University)

Benjamin Zwickl

- DBER REU: Josh Deslongchamps (Texas State University), Jarrett Vosburg (SUNY Geneseo)
- RIT: Ryan Warner, Michael Rinkus, Kingston Chen, Garner Sammons
- Postdoc: Anne Leak (Hired July 13, 2015)
Other Notable Achievements

ACS Exams Institute: Biochemistry 2017 Exam (BC17) Committee Chair (Kim)

Editorial Board: Biochemistry and Molecular Biology Education (Kim)

Manuscript Reviewer for CBE-Life Sciences Education (Newman)

Member of the committee that plans and runs the annual Undergraduate Faculty Genetics Education Workshop for the American Society of Human Genetics (led one of the sessions) (Newman)

Abstract Reviewer for SABER (Newman and Wright)

Chair of Organizing Committee for the 2015 Physics Education Research Conference in College Park, MD (Zwickl)

Collaborating with Crystal Bailey and American Physical Society to help RIT School of Physics and Astronomy build tighter links to industry and prepare students for a broad range of careers. (Zwickl and Leak)

Collaboration with American Institute for Manufacturing Integrated Photonics to develop surveys with University of California, Santa Barbara and Massachusetts Institute of Technology (Zwickl, Martin, and Leak)
Web and Social Media Presence

The newly redesigned CASTLE website is located at castle.rit.edu. It serves as a home-base for all CASTLE-affiliated programs: SMERC, LA Program, IMPRESS, DER REU, SMASH and POWER.