

Building Strong Mentorship Ecosystems to Support Positive URE Student Outcomes

Janet Branchaw, Christine Pfund,
University of Wisconsin-Madison

Abstract

Mentorship ecosystems significantly impact undergraduate research experience (URE) student outcomes. Institutional, departmental, and research team cultures contribute to the mentorship ecosystem, but equally important are mentor-student relationships and the skills that mentors and mentees bring to their relationships. Research investigating the association between relational factors and URE student outcomes is needed to design optimal URE learning experiences. The mission of the Center for the Improvement of Mentored Experiences in Research (CIMER) is to advance research in this area and provide support to research students, mentors and institutions. This commentary highlights what research has revealed about research students, their mentors and the student-mentor relationship, and the evidence-based resources and training offered through CIMER to support scholars investigating UREs.

Keywords: *mentorship, mentor-mentee relationships, mentee training, mentor training, assessment*

doi: 10.18833/spur/8/4/1

Undergraduate research experiences (UREs) can be transformative. Though further research is needed to document causal links between UREs and outcomes (Crowe and Brakke, 2008; Haeger et al. 2020; Linn et al. 2015; NASEM 2017), there is mounting evidence that students who participate in UREs benefit in many ways. These include, but are not limited to, increased graduation rates and retention, increased sense of belonging, greater self-efficacy, and higher-order learning (Pearson and McClurken 2023; Robnett et al. 2016; Russell et al. 2007). Furthermore, there is evidence that UREs reduce the

equity gaps in four-year graduation rates for students of color, and students from low-income and first-generation backgrounds (Haeger et al. 2024).

Many factors linked to students, their mentors, and the learning environment contribute to the quality of UREs and therefore URE student outcomes. The knowledge, skills, and psychosocial attitudes, behaviors, and beliefs that students and their mentors bring to and develop during the research learning experience and their mentor-student relationships impact student outcomes. In addition, environmental factors, such as the structure of the research training program, the culture of individual research groups, departments and institutions, the availability of resources, and access to quality mentors, also impact outcomes. Together, these factors contribute to building “mentorship ecosystems” that research training program directors and institutions can optimize to support positive URE student outcomes (Mondisa et al. 2019).

Students, mentors and their mentoring relationships are important components of the mentorship ecosystem. This commentary focuses on how these components impact URE student outcomes and ways that undergraduate research offices, training program directors, and mentors can contribute to strong mentorship ecosystems at their institutions. Resources and training services to support students, mentors, and their relationships offered through the Center for the Improvement of Mentored Experiences in Research (CIMER, n.d.) and similar organizations are described.

Student Researchers

Supporting student success in UREs begins with defining the learning outcomes students should be striving to achieve. Several scholars have published researcher

development frameworks that define the knowledge, skill, and psychosocial attitude, behavior, and belief outcomes that undergraduate students develop when participating in UREs (e.g., American Library Association, 2000; Clemmons et al. 2020; Gess et al. 2019; Harsh et al. 2017; Singer et al. 2022; Willison et al. 2018). Branchaw and colleagues (2025) have recently analyzed 56 of these frameworks (including graduate student and postdoctoral scholar frameworks) published from 2000 to 2025 to create the Comprehensive Researcher Development Framework (CRDF), which defines 79 core learning outcomes for research training that transcend disciplines. The CRDF is organized into eight areas of researcher development that students and mentors can use to guide the research learning experience: foundational disciplinary knowledge, practical and cognitive research skills, ethical and responsible research practices, research communication skills, interpersonal research skills, researcher self-beliefs and attitudes, knowledge and skills to pursue a research or research related career, and knowledge and skills to administer and manage research projects and teams. Training is offered through CIMER to support students and their mentors in addressing these learning outcomes.

Opportunities for undergraduate students to develop the knowledge, skills, and psychosocial attitudes, beliefs, and behaviors outlined in the CRDF can come through hands-on experience with their faculty research mentor, as well as through courses and workshops that complement and support faculty mentoring. Undergraduate research centers and academic departments are key contributors to providing workshop and course support. In addition to traditional apprentice-style mentored UREs, course-based undergraduate research experiences (CUREs; Auchincloss et al. 2017) also provide structured learning environments and offer the added benefit of increasing access to and capacity for UREs. Like apprentice-style UREs, CUREs support positive student outcomes.

Regardless of the format, the nature of the research project that students engage in has a major impact on student outcomes. Osborn and Karukstis (2009) identified four main elements of projects that must be present for student success: originality, methodology, reporting, and mentorship. The first three elements refer to students making meaningful and authentic contributions through their work; students using techniques from their fields of study; and students creating a product that can be shared with others. The fourth element, mentorship, is arguably one of the most important, especially for novice researchers finding their way in the research environment for the first time. This is what CIMER was founded to support.

Research Mentors

Mentors play many important roles leading to positive URE outcomes (Pfund et al. 2016). They teach disciplinary

and technical skills, and construct research experiences that align with a mentee's skill level and interests. They offer psychosocial support, provide sponsorship, and serve as a trust sounding board and adviser. "Mentors can help students by bringing together ideas from different contexts to promote deeper learning" (NASEM 2017). Finally, mentors provide career guidance, serve as role models, and connect students to new learning opportunities.

Supporting the mentors of undergraduate researchers begins with defining the competencies they need to be successful. Pfund and colleagues have defined eight such competencies: aligning mentor-student expectations, maintaining effective mentor-student communication, fostering student independence, promoting student research self-efficacy, cultivating student ethical behavior, enhancing mentor cultural awareness, fostering student wellbeing, and promoting student professional development (Black et al. 2022; Butz et al. 2018; Pfund et al. 2006; Pfund et al. 2015). Training is offered through CIMER to support development of these mentoring competencies.

Though mentors play key roles in undergraduate researcher success, the roles they play vary with each individual relationship and across phases of relationships (Kram 1985). Consequently, a single mentor is not likely able to address all a student's needs, so most students need multiple mentors as they progress in their career. The composition of a student's mentoring network will have important impacts on their URE as well as their research career overall (e.g., Hernandez et al. 2023), so building a strong mentoring network is important. This can be challenging for beginning researchers, but mentors and training programs can help. Additional support resources also exist, for example, the free asynchronous online course for developing researchers available from the Science Communication Lab (n.d.).

Beyond the benefits of good mentoring to undergraduate students, mentors themselves benefit from being mentors. Mentor benefits include a sense of personal fulfillment through knowledge and skill sharing, enhanced leadership skills, and personal growth (Dolan and Johnson 2009). Moreover, mentors' research programs can benefit from the creativity, fresh ideas, and effort undergraduate researchers bring to the scientific enterprise. However, the benefits to themselves, their research teams, and their student mentees can only be fully realized when they learn how to effectively navigate their mentoring relationships.

Mentor-Student Relationships

Effective mentor-student relationships have been shown to lead to positive URE outcomes in many ways such as improving research self-efficacy, increasing a sense of belonging, elevating job satisfaction and enhancing

FIGURE 1. CIMER Services and Resources

Note: Used with permission from CIMER (n.d.).

productivity; all of which impact undergraduate persistence in research (NASEM 2019; Fuchs 2023). However, mentor-student relationships are complicated. No two are the same because they depend on the backgrounds, motivations, and personalities of the mentor and the student. Though guiding principles and best practices for navigating mentor-student relationships can be learned, they are idiosyncratic, and mentors and students must work together to create and maintain their relationship.

Our research has begun to reveal the complicated nature of the mentor-student relationship. We have shown that the quality of the mentor-student relationship impacts undergraduate researchers' perceptions of their mentor's effectiveness and their own research self-efficacy via the skills and career knowledge they gain during the research experience (Byars-Winston et al. 2015). These results suggest that "mentees' self-assessment of their own skills/knowledge is influenced by their mentor's ability to guide them; likewise, ratings of their mentor's effectiveness is impacted by mentees' self-assessment of the research skills and knowledge they gained while working with their mentor" (Byars-Winston et al. 2015). In other words, students' perceptions of mentor effectiveness impact their perception of their own abilities and performance in research.

Learning to be a productive partner in the mentor-mentee relationship is important to URE success. Mentors and mentees do not innately understand how to navigate mentor-student relationships effectively, but these skills

can be learned. Students can develop more advanced interpersonal and communication skills as well as expand their individual beliefs and attitudes in ways that enhance their mentoring relationships. Mentors can learn how to more effectively align expectations, foster independence, and build trust. Organizations like CIMER have made it their mission to advance the science and practice of mentorship through training students and mentors and providing support to institutions to build supportive mentorship ecosystems.

CIMER: Advancing Mentorship Ecosystems

The CIMER (Figure 1) is a national hub for the science and practice of mentorship. CIMER conducts research investigating factors that lead to effective research mentor-mentee relationships and offers evidence-based training for research mentees, mentors, and training program leaders based on their own and others' research findings. CIMER training and consulting services aim to advance productive working alliances between mentors and mentees, improve research training programs overall, and build mentorship ecosystems at institutions that support both mentor and student success.

CIMER Resources to Support Undergraduate Research Students

CIMER partners with the Wisconsin Institute for Science Education and Community Engagement (n.d.-a) at the University of Wisconsin-Madison to help individuals across the country augment their research training courses and programs for undergraduate researchers using

the Entering Research (ER) curriculum (Branchaw et al. 2020a) and the ER Learning Assessment (ERLA), which is available for free online (Butz and Branchaw 2020).

The ER curriculum is a collection of evidence-based active learning activities that have been tested at 20 sites across the country (42 unique implementations) with 78 facilitators and 565 undergraduate and graduate research trainees (Branchaw et al. 2020b). The ER activities are designed to be incorporated into courses and workshops to support undergraduate and early career graduate students achieve the CRDF learning outcomes. The curricular activities can also be used by individual research mentors with their research teams. All of the ER activities are available for free on the CIMER website.

The ERLA (Butz and Branchaw 2020) is a paired undergraduate research assessment instrument (mentee self-assessment and mentor assessment of mentee) based, in part, on previously published instruments that were designed to assess trainee learning and skill gains across multiple dimensions. These instruments, the Undergraduate Research Student Self-Assessment tool (Weston and Laursen, 2015), the Survey of UREs (SURE; Lopatto, 2004), and the Mentor Competency Assessment (MCA; Fleming et al. 2013) adapted for use with trainees, served as the starting point for development of the ERLA, which incorporates all areas of trainee development addressed in these instruments as well as additional areas that are missing in these instruments.

Beyond downloading individual ER curricular activities and the ERLA tools, CIMER (n.d.-b) also offers student training workshops using the ER curriculum and a Research Curriculum Development Institute (RCDI) for research training program/course directors. In the RCDI, professional facilitators guide research training program/course directors through a backward design process using the learning outcomes in the CRDF to design a customized research training program or course to meet their students' unique needs. RCDI participants also learn about ERLA and other assessment tools they can use to track their students' development.

CIMER Resources to Support Research Mentors

CIMER offers training for research mentors using the evidence-based entering mentoring (EM) curriculum, which was originally developed for and tested with the mentors of undergraduate researchers (Handelsman et al. 2005, Pfund et al. 2006). Since then, the EM curriculum has been adapted for and tested with mentors working across a wide range of disciplines and career stages. CIMER, in partnership with scholars across the country, has continued to develop and test new mentor training modules focused on new competencies such as promoting student research self-efficacy (Butz et al. 2018) and fostering mentor work-life integration

(Durbin et al. 2019). Recently, CIMER developed and tested a module for the mentors of undergraduates focused on enhancing cultural awareness, which was tested via a randomized controlled trial with the mentors of summer undergraduate researchers across 32 undergraduate research training programs (Black et al. 2022; Byars-Winston et al. 2023). In addition, an advanced mentor training workshop on Culturally Aware Mentoring is available (Byars-Winston et al. 2018; Womack et al. 2020). All EM training curricula are available for free on the CIMER website.

In addition to directly training research mentors, CIMER also offers train-the-trainer workshops to prepare and certify individuals across the country to implement the EM and CAM curricula at their own institutions (Pfund et al. 2015; Spencer et al. 2018). CIMER provides assessment tools for these trained facilitators to use to evaluate their local implementations, which includes the MCA (Fleming et al. 2013; Hyun et al. 2022). CIMER also provides connections for trained facilitators to support one another and links them to additional resources.

CIMER Resources to Support Research Mentor-Student Relationships

CIMER has curated a range of resources to support the mentor-student relationship including libraries of mentorship agreements, individual development plans, and assessment instruments. CIMER's website also includes links to other resources such as the NASEM mentorship online toolkit (NASEM n.d.) and other organizations, such as the Science Communication Lab and Professional Development Hub (n.d.). Finally, CIMER offers consulting services to work with programs, departments and institutions to advance their mentorship ecosystems in ways that optimally support research mentor-student relationships (e.g., Suiter et al. 2024).

Advancing UREs Through Rigorous Inquiry

The continuous improvement of UREs requires rigorous assessment of student learning gains and evaluation of program outcomes. Using assessment and evaluation instruments with evidence of validity and reliability in this work is important not only for improving individual programs, but more broadly when the results are published as contributions to the growing scholarship around UREs. Understanding ways to collect data and using common instruments with evidence of validity and reliability so that results can be compared across programs (e.g., Sancheznieto et al. 2025) is critical to identifying causal links between UREs and student outcomes.

CIMER and its partners are committed to supporting the URE community to do rigorous assessment and evaluation. They have already partnered with several NSF REU programs and offer freely available tools and links to other organizations to support assessment and evaluation of:

- Student learning experiences and development in UREs and the impact of mentoring relationships on students;
- Mentor learning experiences and development in UREs and the impact of mentoring relationships on mentors; and
- Mentor-student relationships in UREs using data from both mentors and mentees and connecting those ratings to research progress and outcomes.

Conclusion

UREs are high impact practices that can be enhanced through mentor and mentee training. There are many resources available to help programs to optimize the experience of mentors and mentees as well as assess the impacts. Montgomery et al. (2022) noted that “mentorship is central to the research ecosystem, and it must be treated as such. Mentorship takes skill, time, effort, resources, and dedicated individuals who should be adequately trained, recognized, and valued.” We could not agree more.

Data Availability

Not applicable.

Institutional Review Board

Not required.

Conflict of Interest

The author declares no conflicts of interest.

References

- American Library Association. 2000. “Information Literacy Competency Standards for Higher Education.” Accessed August 1, 2025. <https://alair.ala.org/items/294803b6-2521-4a96-a044-96976239e3fb>
- Auchincloss, Lisa C., Sandra L. Laursen, Janet L. Branchaw, Kevin Eagan, Mark Graham, David I. Hanauer, Gwendolyn Lawrie, et al. 2017. “Assessment of Course-based Undergraduate Research Experiences: A Meeting Report.” *CBE—Life Sciences Education* 13 (1). doi: 10.1187/cbe.14-01-0004
- Black, Sherilynn, Angela Byars-Winston, Ivan Cabrera, and Christine Pfund. 2022. “Enhancing Research Mentors’ Cultural Awareness in STEM: A Mentor Training Intervention.” *Understanding Interventions* 13 (1): 36522
- Branchaw, Janet L. 2025. “A Researcher Development Framework to Guide Undergraduate Research Program Design and Assessment.” Presented at National Council on Undergraduate Research ConnectUR 2025, Grand Rapids, MI.
- Branchaw, Janet L., Amanda R. Butz, and Amber R. Smith. 2020a. *Entering Research: A Curriculum to Support Undergraduate and Graduate Research Trainees*. 2nd ed. New York: W.H. Freeman.
- Branchaw, Janet L., Amanda R. Butz, and Amber R. Smith. 2020b. “Evaluation of *Entering Research: A Customizable Curriculum for Undergraduate and Graduate Research Training Programs and Courses*.” *CBE—Life Sciences Education* 19 (1). doi: 10.1187/cbe.19-04-0073
- Byars-Winston, Angela M., Janet Branchaw, Christine Pfund, Patrice Leverett, and Joseph Newton. 2015. “Culturally Diverse Undergraduate Researchers’ Academic Outcomes and Perceptions of Their Research Mentoring Relationships.” *International Journal of Science Education* 37 (15): 2533–2554. doi: 10.1080/09500693.2015.1085133
- Byars-Winston, Angela M., Jenna G. Rogers, Nancy Thayer-Hart, Sherilynn Black, Janet Branchaw, and Christine Pfund. 2023. “A Randomized Controlled Trial of An Intervention to Increase Cultural Diversity Awareness of Research Mentors of Undergraduate Students.” *Science Advances* 9 (21): eadf9705. doi: 10.1126/sciadv.adf9705
- Byars-Winston, Angela M., Veronica Womack, Amanda Butz, Richard McGee, Sandra Quinn, Emily Utzerath, Carrie Saetermoe, and Stephen Thomas. 2018. “Pilot study of an intervention to increase cultural awareness in research mentoring: Implications for diversifying the scientific workforce.” *Journal of Clinical and Translational Science* 2 (2): 86–94. doi: 10.1017/cts.2018.25
- Butz, Amanda R., and Janet L. Branchaw. 2020. “Entering Research Learning Assessment (ERLA): Validity Evidence for an Instrument to Measure Research Trainee Development.” *CBE—Life Sciences Education* 19 (2). doi: 10.1187/cbe.19-07-0146
- Butz, Amand. R., Angela Byars-Winston, Patrice Leverett, Janet Branchaw, and Christine Pfund 2018. “Promoting STEM Trainee Research Self-Efficacy: A Mentor Training Intervention.” *Understanding Interventions* 9 (1).
- Center for the Improvement of Mentored Experiences in Research (CIMER). n.d.-a. “Advancing the Science and Practice of Mentorship.” Accessed August 1, 2025. <https://cimerproject.org/>
- CIMER. n.d.-b. “Research Curriculum Development Institute.” Accessed August 1, 2025. <https://cimerproject.org/research-curriculum-development/>
- Clemmons, Alexa W., Jerry Timbrook, Jon C. Herron, and Alison J. Crowe. 2020 “BioSkills Guide: Development and National Validation of a Tool for Interpreting the Vision and Change Core Competencies.” *CBE—Life Sciences Education*, 19(4). doi: 10.1187/cbe.19-11-0259
- Crowe, Mary, and David Brakke. 2008. “Assessing the Impact of Undergraduate-Research Experiences on Students: An Overview of Current Literature.” *Council on Undergraduate Research Quarterly*, 28 (4).
- Dolan, Erin, and Deborah Johnson. 2009. “Toward a Holistic View of Undergraduate Research Experiences: An Exploratory Study of Impact on Graduate/Postdoctoral Mentors.” *Journal of Science Education and Technology* 18: 487–500. doi: 10.1007/s10956-009-9165-3
- Durbin, Dennis R., Stephanie C. House, Emma A. Meagher, and Jenna G. Rogers. 2019. “The Role of Mentors in Addressing Issues of Work–Life Integration in an Academic Research Environment.” *Journal of Clinical and Translational Science* 3 (6): 302–307. doi: <https://doi.org/10.1017/cts.2019.408>
- Fleming, Michael, Stephanie House, Vansa S. Hanson, Lan Yu, Jane Garbutt, Richard McGee, Kurt Kroenke, Zainab Abedin, Doris M. Rubio. 2013. “The Mentoring Competency Assessment: Validation of A New Instrument to Evaluate Skills of

- Research Mentors." *Academic Medicine* 88 (7): 1002–1008. doi: 10.1097/ACM.0b013e318295e298
- Fuchs, Jannon L. 2023. "Undergraduate Research: Why and How Do We Mentor?" *Scholarship and Practice of Undergraduate Research* 7 (1): 21–24. doi: 10.18833/spur/7/1/4
- Gess, Christopher, Christoph Geiger, and Matthias Ziegler. 2019. "Social-Scientific Research Competency." *European Journal of Psychological Assessment*. 35 (5) 737–750. doi: 10.1027/1015-5759/a000451
- Haeger, Heather, John E. Banks, Camille Smith, and Monique Armstrong-Land. 2020. "What We Know and What We Need to Know About Undergraduate Research." *Scholarship and Practice of Undergraduate Research* 3 (4): 62–69. doi: 10.18833/spur/3/4/4
- Haeger, Heather, Elia H. Bueno, and Quentin Sedlacek. 2024. "Participation in Undergraduate Research Reduces Equity Gaps in STEM Graduation Rates." *CBE—Life Sciences Education* 23 (1): ar11. doi: 10.1187/cbe.22-03-0061
- Handelsman, Jo., Christine Pfund, Sarah M. Lauffer, and Christine M. Pribbenow. 2005. *Entering Mentoring*. Madison, WI: The Wisconsin Program for Scientific Teaching.
- Harsh, Joseph, John J. Esteb, and Adam V. Maltese. 2017 "Evaluating the Development of Chemistry Undergraduate Researcher' Scientific Thinking Skills Using Performance-Data; First Findings from the Performance Assessment of Undergraduate Research (PURE) Instrument." *Chemistry Education Research and Practice* 18 (3): 472–485. doi: 10.1039/C6RP00222F
- Hernandez, Paul R., Megan S. Patterson, Juliet M. Nyanamba, Amanda S. Adams, Rebecca T. Barnes, Brittany Bloodhart, Melissa Burt, et al. 2023. "Webs of Science: Mentor Networks Influence Women's Integration into STEM Fields". *Frontiers in Ecology and the Environment*, 21 (9): 404–410.
- Hyun, So Hee, Jenna G. Rogers, Stephanie C. House, Christine A. Sorkness, and Christine Pfund. 2022. "Revalidation of the Mentoring Competency Assessment to Evaluate Skills of Research Mentors: The MCA-21." *Journal of Clinical and Translational Science* 6 (1): e46. doi: 10.1017/cts.2022.381
- Kram, Kathy. 1985. "Mentoring at Work: Developmental Relationships in Organisational Life." *Administrative Science Quarterly* 30 (3). doi:10.2307/2392687
- Linn, Marcia C., Erin Palmer, Anne Baranger, Elizabeth Gerard, and Elisa Stone. 2015. "Undergraduate Research Experiences: Impacts and Opportunities." *Science* 347 (6222): 1261757. doi: 10.1126/science.1261757
- Lopatto, David. 2003. "The Essential Features of Undergraduate Research." *Council on Undergraduate Research Quarterly* 24: 139–142.
- Mondisa, Joi-Lynn, Becky Wai-Ling Packard, and Beronda L. Montgomery. 2021. "Understanding What STEM Mentoring Ecosystems Need to Thrive: A STEM-ME Framework." *Mentoring & Tutoring: Partnership in Learning* 29 (1): 110–135. doi: 10.1080/13611267.2021.1899588
- Montgomery, Beronda L., Fátima Sancheznieto, and Maria L. Dahlberg. 2022. "Academic Mentorship Needs a More Scientific Approach." *Issues in Science and Technology* 38 (4): 84–87.
- National Academies of Sciences, Engineering, and Medicine (NASEM). n.d. "The Science of Effective Mentorship in STEM." Accessed August 1, 2025. <https://nap.nationalacademies.org/resource/25568/interactive/index.html>
- NASEM. 2017. *Undergraduate Research Experiences for STEM Students: Successes, Challenges, and Opportunities*. Washington, DC: The National Academies Press. doi: 10.17226/24622
- NASEM. 2019. *The Science of Effective Mentorship in STEM*. Washington, DC: The National Academies Press. doi: 10.17226/25568
- Osborn, Jeffrey M., and Kerry Karukstis. 2009. "The Benefits of Undergraduate Research, Scholarship, and Creative Activity." In *Broadening Participation in Undergraduate Research: Fostering Excellence and Enhancing the Impact*, ed. M. Boyd and J. Wesemann. Washington, DC: Council on Undergraduate Research.
- Pearson, Ellen H., and Jeffrey W. McClurken. 2023. "Undergraduate Research in the Humanities." In *High-Impact Practices in Online Education*. New York: Routledge.
- Pfund, Christine, Angela Byars-Winston, Janet Branchaw, Sylvia Hurtado, and Kevin Eagan. 2016. "Defining attributes and metrics of effective research mentoring relationships." *AIDS and Behavior* 20: 238–248. doi: 10.1007/s10461-016-1384-z
- Pfund, Christine, Christine Maidl Pribbenow, Janet Branchaw, Sarah Miller Lauffer, and Jo Handelsman. 2006. "The Merits of Training Mentors." *Science* 311 (5760): 473–474. doi: 10.1126/science.1123806
- Pfund, Christine, Branchaw, Janet, and Handelsman, Jo. 2015. *Entering Mentoring*. 2nd Edition. New York, NY: W.H. Freeman.
- Pfund, Christine, Kimberly C. Spencer, Pamela Asquith, Stephanie C. House, Sarah Miller, and Christine Sorkness. 2015. "Building National Capacity for Research Mentor Training: An Evidence-Based Approach to Training the Trainers." *CBE—Life Sciences Education* 14 (2): ar24. doi: 10.1187/cbe.14-10-0184
- Professional Development Hub. n.d. "PD Hub." Accessed August 1, 2025. <https://www.pdhub.org/>
- Robnett, Rachael D., Martin M. Chemers, and Eileen L. Zubriggen. 2015. "Longitudinal Associations Among Undergraduates' Research Experience, Self-Efficacy, and Identity." *Journal of Research in Science Teaching* 52 (6): 847–867. doi: 10.1002/tea.21221
- Russell, Susan H., Mary P. Hancock, and James McCullough. 2007. "Benefits of Undergraduate Research Experiences." *Science* 316:548–549. doi: 10.1126/science.1140384
- Sancheznieto, Fátima, Christine M. Pribbenow, and Christine Pfund. 2025. "Tools for Coordinating Measurement Use in Science Education and Training." *Journal of Microbiology & Biology Education* 0: e00060-25. doi: 10.1128/jmbe.00060-25
- Science Communication Lab. n.d. "Build Your Research Community." Accessed August 1, 2025. <https://sciencecommunicationlab.org/research-skills/science-mentorship/>
- Singer, Jill, Daniel Weiler, Bridget Zimmerman, Sean Fox, and Elizabeth Ambos. 2022. "Assessment in Undergraduate Research: The EvaluateUR Method." In *The Cambridge Handbook of*

Undergraduate Research, ed. Harald A. Mieg, Elizabeth Ambos, Angela Brew, Dominique Galli, and Judith Lehmann. Cambridge: Cambridge University Press. doi: 10.1017/9781108869508

Spencer, Kimberly C., Melissa McDaniels, Emily Utzerath, Jenna G. Rogers, Christine A. Sorkness, Pamela Asquith, and Christine Pfund. 2018. "Building a Sustainable National Infrastructure to Expand Research Mentor Training." *CBE—Life Sciences Education* 17 (3): ar48. doi: 10.1187/cbe.18-03-0034

Weston, Timothy J., and Sandra L. Laursen. 2015. "The Undergraduate Research Student Self-Assessment (URSSA): Validation for Use in Program Evaluation." *CBE—Life Sciences Education* 14 (3): 1–10. doi: 10.1187/cbe.14-11-0206

Willison, John, Kerry O'Regan, and Sara K. Kuhn. 2018. "Researcher Skill Development Framework (US English Edition)." *Open Educational Resources* 6. <https://commons.und.edu/oers/6>

Wisconsin Institute for Science Education and Community Engagement. n.d. "Entering Research Curriculum." Accessed August 1, 2025. <https://wiscience.wisc.edu/resources/faculty-staff-resources/entering-research-curriculum/>

Womack, Veronica Y., Christine V. Wood, Stephanie C. House, Sandra C. Quinn, Stephen B. Thomas, Richard McGee, and Angela Byars-Winston. 2020. "Culturally Aware Mentorship:

Lasting Impacts of a Novel Intervention on Academic Administrators and Faculty." *PloS one* 15 (8): e0236983. doi: 10.1371/journal.pone.0236983

Janet Branchaw

University of Wisconsin-Madison, branchaw@wisc.edu

Janet L. Branchaw is an associate professor of Kinesiology in the School of Education and the Faculty Director of the Wisconsin Institute for Science Education and Community Engagement at the University of Wisconsin–Madison. Her research and programming focus on the development, implementation, and evaluation of innovative approaches to science education at the undergraduate and graduate levels, with special emphasis on research training and mentoring, assessment of student learning, and broadening participation in science. She teaches courses in physiology and college science teaching methods.

Christine Pfund is a researcher at the University of Wisconsin-Madison. With a strong network of colleagues and collaborators, her work focuses on developing, implementing, documenting, and studying interventions to optimize research mentoring relationships across science, technology, engineering, mathematics, and medicine.