High-Impact Teaching Practices: Guidelines for Instructors of Undergraduate Research Experience Courses

For faculty members that serve as mentors/instructors for students enrolled in undergraduate research experience courses (i.e. CHEM 470, BIO 498, etc.), there can be a tendency to believe that because these courses engage students in primary research, they provide students with high-impact experiences by their very nature. However, for a course to truly provide a high-impact experience to students, it must implement practices that have been demonstrated in the literature to be high-impact. Below is a list of practices that can be implemented in an undergraduate research experience course to ensure that the course is in fact providing a high-impact experience to students. It is important to note that while all the suggested practices are valuable, a course may provide a high-impact experience without every point below being implemented.

1) Before meeting with the student(s), determine general research goals for each student for the designated term.

- Goals can vary greatly between students depending on their experience level, number of previous research credits earned, etc., and may be altered throughout the course of the term, but it is much more difficult for an instructor to communicate the goals of the course to the students if they have not reflected on these goals themselves
- Instructors should identify plans for how the student(s) can be engaged in the design of the research project, how the student will collect and analyze data, and how the student may eventually disseminate their research results
- Identify a path for the student to generate authentic scholarship

2) Meet with the student(s) individually at the start of the term to set clear and well-scaffolded expectations.

- Prior to this meeting, students should be provided with sufficient context to understand how their research results will fit into the larger context of the research program and the field. This may mean providing assigned readings from the literature, discussion of previous work that preceded the students' project, etc.
- Instructors should ensure that students' expectations for scheduling, hands-on work, data storage, safety, etc. are made clear
- Ensure that the student has a clear view of their research goals. Students should be engaged in the design of the research project to the greatest extent possible
- Provide syllabi with clear expectations
- Discuss the guidelines for student research success in the field

3) Ensure training in the foundational skills, methods, and techniques of the discipline.

- Students must be provided with the tools necessary for independent research success, including an understanding of the expectations of research in a specific discipline
- Students may not realize or report when they have not be sufficiently trained in a given skill or technique that is essential for their research success
- Training may be carried out by the instructor, or other senior students/researchers.
- Emphasize the importance of ethical standards and safety

4) Set regular meeting times (at least weekly) to "check-in" with students

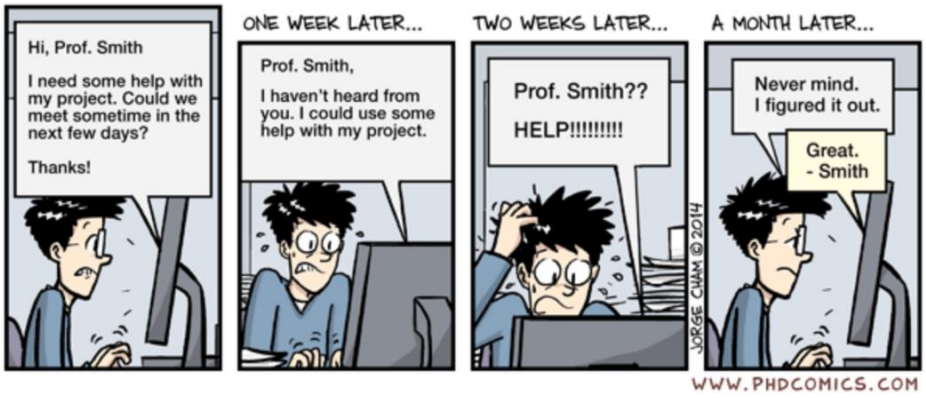
- Provide positive and constructive feedback
- Ensure expectations are commensurate with student's level of skill and experience
- Remain approachable to minimize anxiety and foster an environment where students are not afraid to ask questions

5) Consider forming small "teams" of students to pursue common research goals

- With limited laboratory hours for each student, implementing a team structure can facilitate the pursuit of more complex research goals in some cases
- Scaffold the project for intentional team development and equitable participation by all team members

6) Be present and available to the maximum extent possible

- Ensure that students feel they can ask questions outside of regularly scheduled meeting times
- When the instructor personally participates in training/research, they can provide timely and personalized feedback/suggestions to overcome specific challenges. This often helps students overcome false assumptions regarding their ability and progress



7) Increase student ownership in their research project over time

- Discuss regularly how specific results relate and contribute to the overall research program and research goals, and how students' results may impact future directions for the research
- Ask students to form hypotheses about specific experiments, assist in planning experiments, and welcome students' opinions about the project and research results
- Ask students to connect their results to previous work in literature
- As students gain experience, allow them to participate in planning the next steps in the research project/program

8) Engage students in aspects of the field/profession outside of the laboratory

- Ensure training in the skills required to search for relevant information in the existing published literature
- Encourage students to join professional associations, attend professional meetings, etc.
- Facilitate and encourage networking opportunities for students with more senior members of the field/profession

9) Engage experienced students in training new members of the research group

- Provide opportunities for students to gain mentorship skills
- Provide guidance for expectations of both mentor and mentee students

10) Identify opportunities for students to publicly disseminate their research results

- Dissemination may occur in small group meetings, at university or departmental events, or at professional meetings, and should be scaffolded appropriately to allow students to develop scientific presentation skills
- Diverse audiences can help students develop their skills
- Students should be provided opportunities to attend professional presentations before presenting their own work
- Dissemination should be considered from project inception

11) Ask students to reflect on their research experience at the end of each term

- Opportunities should be provided for students to reflect on what they have learned, on the scholarship that they have produced, how their scholarship fits into the bigger picture of their research program and their field, and what the next directions will be for their research
- See attached for example reflection assignment

Sample Undergraduate Research Experience Reflection Assignment

The goal of this assignment is for students to reflect on their experience in primary research. Students should write about different aspects of their research experience, including the skills they have developed and the techniques they employed, any challenges that were faced and how they were addressed/overcome, as well as the results that they generated and how they contribute to overall research goals. In this way, students will identify and articulate their strengths and areas for improvement, and how their experience in undergraduate research has impacted their academic and career goals.

Suggested Questions for Written Reflection

- What were the goals of your research project and what were the outcomes/results of your work?
- What knowledge existed on your research question before you started, and how have your results added to the existing knowledge base?
- What skills did you acquire or improve during your research experience?
- How did your research experience differ from what you expected? Do you see yourself continuing in primary research?
- What challenges did you encounter in your research and how did you address/overcome them?
- How did your instructor/supervisor support you in your research and in what ways could that support be enhanced?
- How was your research experience connected to your own academic and career goals?
- In what ways did your research experience help prepare you for future challenges?
- What aspects of your research experience did you enjoy the most and what aspects did you enjoy the least? Why?
- What tasks in research did you find came naturally to you and which posed the most significant challenges? What did you learn about yourself through your research experience?
- What are the next steps for your research project, and how are those next steps connected to your own research results?

Example Rubric for Assessment of Written Reflection Assignment

	Student Level

Student Learning Outcome (SLO)	Accomplished (4)	Competent (3)	Developed (2)	Beginning (1)
Student describes the importance of their research project within the context of the research program/ field (ICC SLO 4.6)	Report describes relevant previous work in detail and provides a thorough discussion of how the current project will advance knowledge in the field	Report provides some discussion of previous work and provides discussion on how the current project will advance knowledge in the field	Report lacks detail in the discussion of previous work and in the discussion of how the current project will advance knowledge in the field	Significant additional detail is required in the discussion of previous work and in the discussion of how the current project will advance knowledge in the field
Student explains relevant issues (i.e. research goals, challenges, results, conclusions) within the context of the research project (ICC SLO 4.4)	Report provides thorough explanation of research goals, issues, results and conclusions within the context of the project	Report provides somewhat thorough explanation of research goals, issues, results and conclusions within the context of the project	Report lacks detail in the explanation of some relevant issues (research goals, issues, results and conclusions) within the context of the project	Report lacks detail in the explanation of all relevant issues (research goals, issues, results and conclusions) within the context of the project
Student explains how their research results impact society/knowledge in the field (ICC SLO 4.5)	Report provides a thorough discussion of how student results advance the knowledge in the research program/field	Report provides a somewhat thorough discussion of how student results advance the knowledge in the research program/field	Report lacks detail in the discussion of how student results advance the knowledge in the research program/field	Significant additional detail is required in the discussion of how student results advance the knowledge in the research program/field

Works Cited

Linn, Marcia C.; Palmer, Erin; Baranger, Anne; Gerard, Elizabeth; Stone, Elisah. “Undergraduate Research Experiences: Impacts and Opportunities.” *Science* **2015**, *347*, 1261757.

https://doi.org/10.1126/science.1261757.

Lopatto, David "The Essential Features of Undergraduate Research." *Council on Undergraduate Research Quarterly*, **2003**, 139–142.

https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=8b47f05fecb485b85b17d9c371607a3422a822de

Lopatto, David "Undergraduate Research as a High-Impact Student Experience." *Peer Review* **2010**, *12*, 27–30.

https://www.aacu.org/publications-research/periodicals/undergraduate-research-high-impact-student-experience

Shanahan, Jenny Olin; Ackley-Holbrook, Elizabeth; Hall, Eric; Stewart, Kearsley; Walkington, Helen. "Ten Salient Practices of Undergraduate Research Mentors: A Review of the Literature." *Mentoring & Tutoring: Partnership in Learning* **2015**, *23*, 359–376.

https://doi.org/10.1080/13611267.2015.1126162.

Walkington, Helen; Hall, Eric; Shanahan, Jenny Olin; Ackley, Elizabeth; Stewart, Kearsley. "Striving for Excellence in Undergraduate Research Mentoring: The Challenges and Approaches to Ten Salient Practices." In *Excellence in Mentoring Undergraduate Research*, (Eds. Vandermaas-Peeler, Maureen; Miller, Paul; Moore, Jessica L.) **2018**, 105–30. Washington, D.C.: Council on Undergraduate Research.

Walkington, Helen; Ackley, Elizabeth; Shanahan, Jenny Olin; Stewart, Kearsley; Hall, Eric E. "Undergraduate Research: Ensuring a High-Impact and Resilient Experience for All" *Elon University – Center for Engaged Learning* **2020**

https://www.centerforengagedlearning.org/undergraduate-research-ensuring-a-high-impact-and-resilient-experience-for-all/#:~:text=Increase%20student%20ownership%20of%20the,Practices%20of%20Undergraduate%20Research%20Mentors

Walkington, Helen; Stewart, Kearsley A.; Hall, Eric E.; Ackley, Elizabeth; Shanahan, Jenny Olin. "Salient Practices of Award-Winning Undergraduate Research Mentors – Balancing Freedom and Control to Achieve Excellence." *Studies in Higher Education* **2020**, *45*, 1519–1532.

https://doi.org/10.1080/03075079.2019.1637838.