Peer Review of Entries in the CURE Collection

The mission of CUREnet is to support CURE resource sharing within the undergraduate science education community. In order to provide the community with high quality examples of CUREs, CUREnet developed and pilot tested a peer review process. During the pilot review, seven reviewers representing different institution types, disciplines, and perspectives tested a draft review rubric and provided significant feedback to improve it. The following is the finished rubric that will be used in peer review of entries in the CURE Collection.

The review process is grounded in published descriptions of what makes CUREs distinctive as learning experiences (Auchincloss et al., 2014; Brownell & Kloser, 2015; Dolan & Weaver, 2021). Specifically, CUREs engage students in science practices, provide students with opportunities to make discoveries that have the potential to be relevant to stakeholders outside of the classroom, and are iterative by nature meaning that students build off of prior literature, one another's work, or their own work over time. Iteration reflects the fact that science builds on science, not that any single student has to repeat aspects of their work.

CURE entries are evaluated and rated according to these criteria and with respect to principles of backward design as well as feasibility of implementing the CURE (Cooper et al., 2017; Dolan & Weaver, 2021; Wiggins & McTighe, 2005).

Criterion 1: Engagement in Science Practices. Complete CURE entries will include descriptions of how the CURE engages students in the practices of science, which are also called core competencies, including: asking research questions, developing and using models, planning and carrying out investigations and/or experiments, analyzing and interpreting data, using mathematics and computational thinking, constructing explanations, engaging in argument from evidence, and/or obtaining, evaluating, and communicating scientific information (National Research Council, 2012). It is unlikely that a single CURE will engage students in all of these practices, but superior designs engage students in more than one practice in order to provide a more complete experience. For instance, students may plan and carry out investigations, but their learning will be limited if they don't have opportunities to construct explanations about their results or make arguments about what their data mean.

- **Exemplary:** The description **clearly explains** the potential for the CURE to engage students in **two or more** science practices / core competencies.
- **Good:** The description **explains** the potential for the CURE to engage students in **at least two** science practices / core competencies.
- **Limited:** The description **does not include sufficient information** about the range and types of science practices to be carried out by students, or limits students' engagement to only one science practice.

Criterion 2: Inclusion of Research Elements. Efforts to define CUREs and delineate what makes them distinctive from traditional and inquiry lab courses have identified three distinguishing elements that make them research experiences: discovery, relevance, and iteration. Complete entries will describe how the CURE engages students in doing work that has the potential to generate novel research results (discoveries) that are unknown to the broader community (not just to the students). Complete entries will describe how research results are relevant to stakeholders outside the classroom and how results are communicated to stakeholders in some way (relevance). Finally, complete entries will describe how the CURE affords opportunities for students to engage in the iterative work of research, including trouble-shooting, problem-solving, building on the work of others, or repeating aspects of their work in order to improve the research results (iteration).

- **Exemplary:** The description **clearly explains** how the CURE is designed for students to make **discoveries** that are built off and can contribute to a larger body of knowledge. The description articulates the **stakeholders** for the students' research results as well as how results are being shared

with them. The CURE is designed to engage students in **iterative work**, such as trouble-shooting, problem-solving, building off others' work, and/or repeating or replicating aspects of their work to improve the research results.

- **Good:** The description **explains** the potential for students' work to generate **discoveries**, but it is not clear how the students' research results will be shared with **stakeholders** outside the classroom. There are opportunities for students to do **iterative work** –trouble-shoot, problem-solve, build off others' work, or repeat aspects of their research – but these opportunities appear limited.
- **Limited**: The description **does not include sufficient information** to determine if students' research has the potential to generate **discoveries**. It is not clear whether the students' work is built off or has the potential to contribute to a body of knowledge. It is not clear if there is an audience or group of **stakeholders** for the students' research results. There is little if any time for students to engage in the **iterative work** of research.

Criterion 3: Evidence of Instructional Design. Complete entries will describe how the CURE is designed to ensure strong alignment between the research and student goals for the CURE, the tasks that students will carry out to make progress in achieving the goals, and the ways student and research progress will be assessed. Entries should include enough detail for other instructors or researchers to understand how the CURE will foster student learning and development AND research progress. The description should also address how the CURE is structured to ensure full participation and maximize equity and inclusion, ensuring that all students have opportunities to achieve the goals of the CURE.

- **Exemplary:** The description includes a series of clear and carefully designed **tasks that align with both research and student goals**. The tasks are described in ways that are specific, observable, and student-centered. Strategies for **ensuring full participation** and **maximizing equity and inclusion** within the course are described. The ways that student and research progress will be **assessed** are clearly described and well aligned to the tasks and to the goals.
- **Good:** The description includes **tasks for students to carry out that are relevant to both research and student goals**. The tasks are described but would benefit from greater detail to make the alignment clear and the approach adaptable by other CURE instructors. The CURE is designed to ensure **all students can participate fully**. The ways that student and research progress will be **assessed** are described but would benefit from greater specificity or tighter alignment with the goals.
- **Limited: The research and student goals are disconnected**. It is not clear how completing the tasks will allow students to make progress toward achieving either the research or student goals. The CURE is designed in ways that could **limit full participation**. The ways that student and research progress will be **assessed** are unclear.

Criterion 4: Feasibility of Implementation. Complete entries will be written in way that helps other instructors understand how the CURE is taught. Descriptions should be easy to understand and provide sufficient information to allow other instructors to adapt or adopt the CURE, or elements of it, for use with their own students. All of the components of the entry should be provided, including instructional materials, assessments, and advice for implementation.

- **Exemplary:** The description includes a **clear and complete** explanation of the CURE context and implementation. The description includes a robust set of instructional materials, assessments, advice, and other resources that are likely to be helpful to other instructors in teaching the CURE or developing their own CURE. The abstract provides an easy-to-understand overview of the CURE. The target audience, duration, core competencies, and nature of the research are included and reflective of the CURE.
- **Good:** The description includes **sufficient** information to understand the CURE context and implementation. The description includes some instructional materials, assessments, advice, or other resources that other instructors might find useful in teaching the CURE or developing their own CURE. The abstract is a good overview of the CURE, but could be clearer and more complete or succinct. The

target audience, duration, core competencies, and nature of the research are included and reflective of the CURE.

- **Limited:** The description **does not include sufficient** information to understand the CURE context and implementation. Some instructional materials, assessments, advice, or other resources are included, but they are insufficient to provide a clear sense of how to implement the CURE or design a similar CURE. The abstract is missing descriptions of key aspects of the CURE or is otherwise difficult to read and understand (e.g., too much jargon, too short or long). Any or all of the following descriptors are missing: target audience, duration, core competencies, and nature of the research.

Auchincloss, L. C., Laursen, S. L., Branchaw, J. L., Eagan, K., Graham, M., Hanauer, D. I., Lawrie, G., McLinn, C. M., Pelaez, N., Rowland, S., Towns, M., Trautmann, N. M., Varma-Nelson, P., Weston, T. J., & Dolan, E. L. (2014). Assessment of Course-Based Undergraduate Research Experiences: A Meeting Report. *CBE-Life Sciences Education*, *13*(1), 29–40. https://doi.org/10.1187/cbe.14-01-0004

Brownell, S. E., & Kloser, M. J. (2015). Toward a conceptual framework for measuring the effectiveness of course-based undergraduate research experiences in undergraduate biology. *Studies in Higher Education*, *40*(3), 525–544. https://doi.org/10.1080/03075079.2015.1004234

Cooper, K. M., Soneral, P. A. G., & Brownell, S. E. (2017). Define Your Goals Before You Design a CURE: A Call to Use Backward Design in Planning Course-Based Undergraduate Research Experiences. *Journal of Microbiology & Biology Education*, *18*(2). https://doi.org/10.1128/jmbe.v18i2.1287

Dolan, E. L., & Weaver, G. C. (2021). *A Guide to Course-based Undergraduate Research* (1st ed.). Macmillan Higher Education. https://www.macmillanlearning.com/college/us/product/A-Guide-to-Course-based-Undergraduate-Research/p/1319367186

National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. National Academies Press: Washington, DC. https://www.nap.edu/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts

Wiggins, G. P., & McTighe, J. (2005). *Understanding by Design*. ASCD: Arlington, VA.