Learn from your peers

There are now many iterations of research-inclusive courses across disciplines. While there are a myriad of routes to develop these courses, one common pathway follows. There is a linearity to these tasks but they can be executed in the order that suits you best.

Initial stages

1. Select research objectives and develop learning objectives from these.
2. Identify the course (new or converted) that will be used.
3. Select problem(s) to be investigated and techniques to be employed.
4. Plan the scope and scale of the course.

Administrative work

1. Solicit buy-in from appropriate administrator (e.g., department chair).
2. Identify needs, if any, beyond a conventional course and make the ask.
3. Assemble the necessary resources for the course (space, TAs, instrument time, etc.).
4. Assemble the necessary personnel (trained TAs, stockroom, faculty, etc.)
5. Devise any non-learning metrics of success.

Educational work

1. Using your objectives, design the course details (activities, assessment, etc.).
2. Develop an explicit plan to instruct students on research as an activity.
3. Include features that ensure the work is research (iteration, discovery, risk assessment, etc.)
4. Test the plan with a smaller group of students to ensure they are engaged in the targeted activities.

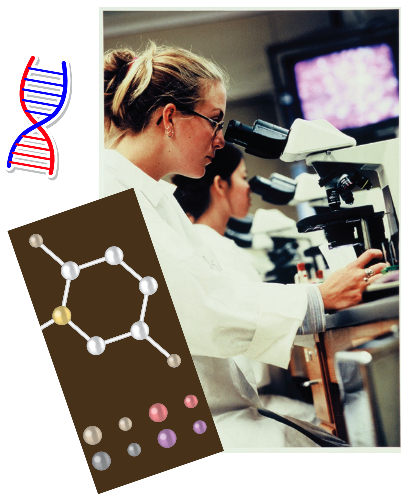
Execution

1. Be flexible in running the course; let the learning outcomes drive the curriculum.
2. Solicit feedback from students and/or faculty.
3. Evaluate against your learning objectives and any metrics of success.
4. Be prepared to make choices between research progress and student learning with attention to both.
5. Iterate the course and run again.

Resources

These are a few starting points to get documents and help for your planned course.

- CUREnet is a network dedicated to this practice: https://curenet.cns.utexas.edu/
- CIRTL supports development of new practices: https://www.cirtl.net/
- Definitions of CUREs: 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. Assessment of Course-Based Undergraduate Research Experiences: A Meeting Report. *CBE-Life Sci. Edu.* **2014**, *13*, 29–40.
- Changing to a CURE: Clark, T. M.; Ricciardo, R.; Weaver, T. Transitioning from Expository Laboratory Experiments to Course-Based Undergraduate Research in General Chemistry *J. Chem. Educ.* **2016**, *93*, 56–63.
- An example of a large-scale CURE: Wang, J. T. H.; Daly, J. N.; Willner, D. L.; Patil, J.; Hall, R. A.; Schembri, M. A.; Tyson, G. W.; Hugenholtz, P. Do you kiss your mother with that mouth? An Authentic Large-Scale Undergraduate Research Experience in mapping the human oral microbiome. *JMBE* **2015**, *6*, 50–60.



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Adding Research to a Class

Undergraduate research is a high impact practice, and adding a research component to a class may provide better access to those experiences for those students or help meet other learning objectives. Implementing research in coursework (sometimes called a CURE, Course-based Undergraduate Research Experience) can be difficult, but often the biggest challenge is getting started. This document is a brief guide to some of the critical issues you may encounter in exploring this option, and some initial resources to help navigate those issues.

Ask yourself some questions

1. What do you want to accomplish?

Do you want to engage students in a research experience, or is the research a means to meet other learning objectives? Are there other outcomes you would like to see occur like persistence in the discipline or self-efficacy? There are different ways to approach adding some amount of a research experience to a course, and those possibilities are detailed in the course types section.

2. Who is this for?

A research activity is appropriate for any level, but the degree to which that activity is structured and scaffolded changes with developmental stage. A few examples of research in coursework are presented for different levels in the course types section.

3. What will the students actually do?

It is important to consider both what the students will be attempting in the lab as well as what you expect them to produce or be assessed upon. Students will make more or less research progress based on the structure of the experimentation and their prior knowledge of techniques, but research progress may not be as important as skills acquisition or research design. Those critical choices inform what you need to evaluate in your course.

Tips from adopters

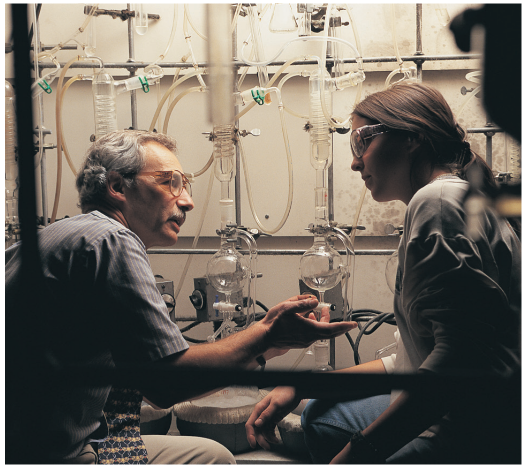
1. Get help! Help may come from a colleague with similar ambitions, an administrator who supports your plans, or an off-campus peer who has executed similar coursework (e.g., CUREnet), among others.
2. Plan…and then plan some more. Research is open ended, but students need instruction on how it is done. Instructors need be ready to make choices about research and learning goals, particularly if these become conflicting.
3. Start small. Practicing with research students, a smaller section or students, or a smaller part of a course is an excellent way to hone the CURE model in your own hands.
4. Be cognizant of time and timing. We are often overly ambitious in our own research, and teaching students in that format will both slow any progress and potentially take more of your time.
5. Acclimate students. Research means failure, so students need to know that success in the course is not attached to success in their project.
6. Iterate. Like all changes to your teaching, adding a research component will be most successful after some trial and error.

4. What do you need?

Research costs money and time. A 400-seat general chemistry course cannot get synchrotron time for each student, but those students can have infinite Spec-20 time, for example. Most CUREs require instructional support, which may be the faculty member and/or teaching assistants, appropriate space, supplies, and access to necessary equipment. These needs may be met by converting a pre-existing course that has the requisite resources. At the same time, resources you have may determine the choice of project.

5. Do you have the time?

Converting all of the E&M laboratories for 1000+ students to a CURE is a tremendous operation. However, converting a single experiment is a more manageable step toward a larger goal for a course. Additionally, a shift from traditional experiments to inquiry, for example, may be another way to make larger changes more manageable.



6. Will the research element introduce greater hazards in a lab course?

More consideration may need to be given to additional hazards and increased risk when adding discovery elements into experiments. Complexity and novice workers, combined with agents, chemicals, equipment, and processes having greater hazards can all increase risk in any laboratory.