Designing Effective Undergraduate Research Projects

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A quality research experience enriches an undergraduate's education and has the potential to further a faculty member's own research agenda. In this session we will explore strategies for designing and facilitating effective undergraduate research projects appropriate for independent study, senior, or honors projects. Some of the issues we will consider are: philosophical approaches to undergraduate research, the appropriate scope and scale of an undergraduate research project, managing and mentoring the student in research, devising practical time lines, evaluating student research proposals and contracts, making realistic assessments of how student research fits within your own research program, options for deliverables and presentation forums.

Before you begin an Undergraduate Research Project Consider the following:

Identify what are the most significant things a student could learn from the research experience and rank them in order of their priority. Are they - Problem solving? Time management? Skill with an analytical technique? Increased confidence? Creativity? Quantitative techniques? Presentation skills? Writing skills? Something else?

Who are you in relation to this student or group of students? Do you see yourself as an mentor or supervisor? Will the project complement your own research program? Are you willing to advise a student on a project outside your expertise? What other time commitments do you have? Is there an institutional expectation that you advise a certain number of students on research projects? Do you prefer to guide a team of students on one problem or several students on separate problems? Is funding needed to support your student's project?

Who is the student? What type of research questions interest her? What courses has she taken? What outside interests does she have? Does she work better independently or in a small group? Would she work better with more direction or more freedom? Has she done a summer or class project previously? What's her motivation for doing a research project? (Prepare for graduate study? Experience research? Get credit/money for something she's interested in? Fulfill a requirement?) [Do you know the student well enough to answer these questions?]

Managing and Mentoring

Tips from current and previous early career workshop leaders and workshop alumni:

- Have mutually agreed upon written expectations (see proposal and contracts sections), time tables, goals, and deliverables.
- Have weekly check-in sessions and set interim deadlines
- Everything takes longer than you think when working with undergraduates
- Integrate student projects – team-based projects that also support your research projects and build on the peer-learning potential are an effective way to maximize your effort; they will, however, require extra time to work with students in lab/field
- Require students to read background primary literature early and often, and have students discuss readings with each other and you during check-in sessions

- Mentoring and managing will not be the same for each student researcher – be flexible and responsive.
- Do quality control checks on their work.
- Bring research students to professional meetings early on, even before they present their own research. It will motivate them.

Research Contract

The research experience will work most smoothly if the advisor clearly communicates what is expected of the undergraduate researcher, and what the undergraduate can expect of the advisor. Some of the details to be communicated might include when each portion of the project needs to be completed, how many hours per week the student is expected to work on the project, the learning objectives for the project, when the advisor is available to meet with the student or help with the project, authorship of any publications, and how the student will be evaluated. One way to communicate these details is through a research contract that lends structure to the research experience. Examples of research contracts are listed in the references section. The research contract may include:

- Student's and advisor's name and contact information
- Project title and overall goal
- Start and end date of project
- Research and learning objectives
- Dates to accomplish specific objectives
- Dates for training, material acquisition, field work, instrument time
- Safety considerations
- Responsibilities of student and advisor
- Deliverables (see below)
- Evaluation plan

Research Proposal

The student gains ownership in the research project when he is involved in developing a research proposal. A proposal is a way for the student and advisor to work together to focus a project. Within a department or college, the research proposal may also be used to secure internal funding or to determine if a student should be allowed to do/continue with a project that will be considered for honors. The proposal should explain the broad significance of the project, put the project in context by providing background information, indicate materials and funds that will be needed, outline the methods, timetable and expected results for the project, and list relevant references. Suggestions for proposal writing and specific examples of undergraduate proposals are listed in the references section.

Deliverables may take several forms, for example:

- Undergraduate thesis
- Written research paper
- Map
- Data set
- Web page
- Poster or oral presentation to department or at college-wide symposium
- Abstract and presentation at regional or national meeting
- Paper in peer reviewed journal

Funding

- Are there college or departmental sources of funding that may be used for research expenses, summer student stipend, or travel to conferences?
- Some geology associations (e.g., GSA) offer funds for students to attend conferences.
- NSF-RUI and REU grants may support undergraduate research projects
- Geological surveys may have funds for regional projects (e.g., USGS-EDMAP)

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References

Research Learning Contracts

Mabrouk, P. A., 2002, "Research Learning Contracts - A Formula for Successful Undergraduate Research Experiences,"CUR 2002 Workshop Report. http://www.cur.org/conferences/cur2002summaries/R22.html

Mabrouk, P.A., 2003, "Research Learning Contracts: A Useful Tool for Facilitating Successful Undergraduate Research Experiences," CUR Quaterly XXIV(1), 26-30. (Summarized on-line at http://www.sc.edu/our/faculty_learning.shtml)

WebGuru-Guide to research for undergraduates http://www.webguru.neu.edu/devices/research_learning_contracts/

Research Proposals

Research proposal guidelines and support materials, Department of Geological and Environmental Sciences, James Madison University http://csmres.jmu.edu/geollab/Fichter/studresrch/studresrch.html

The Art of the Proposal, University of New Hampshire, Center for Undergraduate Research, includes example of a geology proposal. http://www.unh.edu/undergrad-research/apply_proposal.html#resources

General

Council on Undergraduate Research (CUR) http://www.cur.org

Information and booklets on undergraduate research, including "Reinvigorating the Undergraduate Experience", "How to Mentor Undergraduate Researchers" and "Developing and Sustaining a

Research-Supportive Curriculum:
A Compendium of Successful Practices"

Guide to research for undergraduates. Funded through NSF DUE-0341080, Mabrouk, P. http://www.webguru.neu.edu/

Kurdziel and Libarkin, 2002. Research Methodologies in Science Education: Undergraduate Research Mentoring, Teacher Workshops, and K-12 Outreach Activities. Journal of Geoscience Education, v. 50, n. 5, p. 602-609. http://serc.carleton.edu/files/nagt/jge/columns/ResMeth-v50n5p602.pdf

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine,1997. Adviser, Teacher, Role Model, Friend: On Being a Mentor to Students in Science and Engineering. Washington, DC: National Academy Press. http://www.nap.edu/readingroom/books/mentor/

Case studies for working with research students
http://serc.carleton.edu/NAGTWorkshops/earlycareer/research/students.html