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Developing Research Opportunities for Undergraduates

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Introduction

Improving science literacy is considered to be a vital skill for the 21st century. The scientific and educational communities are unanimous about this. The way in which we achieve and fund this goal is varied, but it is clear that we must act quickly to implement meaningful changes if we are to see results relatively soon. Many educators have suggested that inquiry-based learning should be the framework for this learning with critical thinking skills and applications to real life situations being emphasized.

One of the best ways to engage students in inquiry-based learning is to provide them with opportunities to participate in research. Earlier exposure to scientific research may do much to both attract and retain students in undergraduate science programs. Many students drop out of science courses because education at the undergraduate level often treats science as only something to be memorized rather than being relevant to many aspects of their lives. Courses are often content-heavy in addition to requiring long hours for both lecture and laboratory experiences.

Most undergraduate programs afford their biology majors the opportunity to participate in research. This is usually done as a culmination of their degree program in the fourth or senior year. This may be part of a credit course (i.e. capstone course) or it may be an expectation for completion of a degree over and above the regular course work requirements. These courses are designed for independent study and may include sessions on ethics, scientific writing and safety, in addition to actively engaging students in independent research. They target select students who are focused on both career paths and requirements for possible post-graduate studies.

Many senior level courses also provide research projects as part of the laboratory curriculum. This is may be focused around a few general topics (instructor generated) or students may develop their own topics within the framework of the course. Often this is structured around group work with written papers and oral presentations being the culmination of the experience. Both of these experiences are still aimed at the more senior students and often target majors.

What are some of the other undergraduate research opportunities? Summer Research Programs occur at many institutions where they may be credit courses (field stations, research labs; oversees travel experiences) or a paid research experience (scholarship such as NSERC (Canada), NSF (REU), Howard Hughes, etc.) working as part of faculty-designed research project. Sometimes students may be working on independent and novel projects (i.e. NSERC/NSF summer assistantships). Occasionally these projects may extend into the regular academic terms. At predominately undergraduate teaching institutions, students are often paid as undergraduate research assistants.

Volunteering in a research lab occurs at many institutions. There may be formal routes for volunteering which is organized through lists/web sites in departments or a coordinator may assist students making contact with major professor. However, in many instances volunteering requires students to have initiative to go and speak directly to professors about possible research opportunities. Students who are still struggling to develop a career path or interest rarely have this initiative.

While most educators would argue quite strongly that opportunities for undergraduate research is a critical component of science education, putting this into practice is often met with resistance, especially at research-intensive universities. The argument is often that these researchers are too busy to mentor students, their research is far too complex for most undergraduates to understand and their research is also very expensive. They also do not see “rewards” for their efforts during discussions of salaries and promotions. Many of these institutions have not developed a culture or a climate that fosters undergraduate research opportunities, especially for the more junior students.

Ironically where there are fewer faculty with opportunities for including undergraduates in larger scaled research projects, smaller predominately undergraduate teaching institutions, there are often more avenues available for students to engage in original research. At many of these institutions undergraduates fill the roles of research assistants or MSc students in a research lab. It is the only way that some researchers can afford to continue with a research program at these institutions. Also there is more and more competition among these smaller institutions to attract high caliber students into their programs. Opportunities for research either for experience and/or student support is necessary and recognized as an essential component of an undergraduate science degree.

Developing Biology 299

The Department of Biological Sciences at the University of Alberta is a research-intensive department. With over 75 full-time academic staff and more than 300 graduate students, the research focus has not been aimed at the undergraduate student. While the various honors programs require a full year honors research project, there has been no requirement for research before the capstone or senior year experience. There has been little done to include undergraduates in research at an earlier point in their career, except through summer research experiences for a select few that obtain summer- supported scholarships (E.g. NSERC).

Biology 299, Research Opportunity for Undergraduate Students, is a credit/no-credit course for supervised participation in a faculty research project in the Department of Biological Sciences. This course is normally taken after completion of a minimum of 30 (first year) but not more than 60 units (second year) of course weight in a program in the Faculty of Science. There is a prerequisite of a GPA of 2.5 or higher, and a 100 or 200 level course in the field of research and consent of department. Credit for Biology 299 may be obtained twice.

Biology 299 has been designed to give students an introduction to biological research. It is not meant to be an all encompassing experience but rather “a taste” of the process of doing research. Students can expect to learn research methods (i.e. state of the art techniques, lab or field work), engage in discussions of scientific research (i.e. attend lab meetings, read and discuss primary literature) and experience the research environment in the department (i.e. attending research seminars). It is also hoped that students will develop a long-term relationship with faculty who may act as mentors during the remainder of the student’s undergraduate program.

The credit/no-credit designation was developed so that students would take a chance on the Biology 299 experience despite heavy requirements for their programs. The ability to take two Biology 299s enables students, who have had a positive experience with their research, to have the course count as a full 3- credit course for their program. Equally important, the credit/no-credit designation enables students who have not had a good research experience to withdraw from the course without having a major impact on their GPA and/or program.

The prerequisite for Biology 299 is meant to be an introductory course in the area of study proposed for a specific project. A GPA of a minimum of 2.5 offers the research opportunity to a cohort of students who might not normally qualify for honor's projects or undergraduate research scholarships. Thus the pre-requisites are designed to attract students who have not established a dedicated career path, those who might be lost in the system without a focus for advanced study.

Course Requirements

1. Each student must complete the Safety Training (Fire/Safety/WHMIS) course given by the Department of Biological Sciences. This course is given at the beginning of each term.
2. Student should be willing to commit 3-4 hours a week to this program.
3. Student must keep a journal that documents the specific requirements of the project, meetings, progress reports, and any other aspects of the research project (i.e. what was learned about the project in particular and the nature of the research in general).
4. Student will attend any demonstrations, seminars, or other meetings that the faculty member might require (listed on project form). Student may also be asked to read pertinent background material for lab discussions and/or seminars. The specific requirements agreed upon by the student and supervisor will form the "contract" for the student. This contract must be signed by both the supervisor and student.
5. Student must meet weekly with their supervising faculty member and record the dates and times in their journal.
6. Student will submit to the faculty member a two-page interim report detailing the research experience by **November 1st** (Fall term) or **March 1st** (Winter term). The faculty member will provide the student with an interim assessment in which he or she must discuss the student's progress to date before the deadline for dropping courses without academic penalty (~**November 10th** in the Fall term, and **March 18th** in the Winter term).
7. Student will be required to submit their completed journal and a two-page written report to the faculty member on the **last day of classes**. This report should include a description of the activities that the student undertook as part of this research experience, including a short critique.
8. The faculty member will provide both the student and the Biology 299 Program Advisor with a complete written assessment of the student's performance in the course by the **last day of exams (December 22nd /April 29th)**.
9. The faculty member will make a recommendation of credit or no-credit when the complete written assessment is submitted.
10. If the performance is positive for both the student and the faculty member, the faculty member may make the recommendation for the student to enroll in a second Biology 299 in a subsequent term.

The student and supervisor will be required to attend three sessions hosted by the Associate Chair, Undergraduate Programs. The first session will be on how to carry out independent research, the second will be informal assessment of how the program is progressing to date and the third will be a presentation of student results. Students will be given the option of either presenting a short talk or poster presentation to their fellow Biology 299 cohort and their supervisors. Workshops on poster presentations and PowerPoint presentations will be available in late November (Fall Term) or March (Winter Term).

About the Author

Maggie Haag received her BA (biology) from Russell Sage College (1971) and MS (Environmental Physiology) from the University of Alberta (1975). She is a faculty member in the Department of Biological Sciences where she coordinates the undergraduate laboratory curriculum and supervises the graduate teaching program for the Department of Biological Sciences. She is the Program Coordinator for the University Teaching Program and the Research Opportunity Program in the Department of Biological Sciences.