
Undergraduate Research: Importance, Benefits, and Challenges

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ABSTRACT

Int J Exerc Sci 1(3) : 91-95, 2008. Developing and maintaining undergraduate research programs benefits students, faculty mentors, and the university. Incorporating a research component along with a sound academic foundation enables students to develop independent critical thinking skills along with oral and written communication skills. The research process impacts valuable learning objectives that have lasting influence as undergraduates prepare for professional service. Faculty members at teaching intensive institutions can enhance learning experiences for students while benefiting from a productive research agenda. The university in turn benefits from presentations and publications that serve to increase visibility in the scientific community. Whether projects are derived through student-generated or mentor-generated means, students benefit from completion of exposure to the hypothesis-driven scientific method.

KEY WORDS: Student involvement, science-based methodology, exercise science professional development

Does research have an appropriate place in the undergraduate curriculum of an exercise science-based department? Published findings, as well as personal experience, suggest that developing and maintaining undergraduate research benefits the students, the faculty mentors, the university or institution, and eventually society at large. Additionally, the scientific community places increasing importance on research performed at primarily undergraduate institutions. Since 1978, the Council on Undergraduate Research has promoted research opportunities for faculty and students at predominantly undergraduate institutions. This national organization of individual and institutional members currently represents over 900 colleges and universities with 3,000 members (1). The National Conferences for Undergraduate Research provides a venue for undergraduates to present findings at

an annual meeting which featured 2,800 presenters in 2008 (4).

Our belief is that an exercise science curriculum provides students the opportunity to become responsible professionals of competence and integrity in the area of health and human performance. The components necessary for professional competency in exercise-related fields include an understanding of the basic concepts and literature in the health-related specialty that is being studied and knowledge of the terminology or technical language used professionally. Incorporation of research methodology and the hypothesis-driven scientific process can build on this foundation through the development of independent critical thinking skills as well as oral and written communication skills. Independent thinking can instill in the undergraduate

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student the confidence to form one's own conclusion based on available evidence. Undergraduate students who took classes in the same department where the research projects occurred reported having increased independence of thought, a more intrinsic motivation to learn, and a more active role in learning (3). Thus, the research process has a very favorable impact on valuable learning objectives as undergraduates prepare for their respective professions.

Further benefits to the student have been reported and disseminated from the SURE study (Survey of Undergraduate Research Experiences) (3). Undergraduate students who completed a mentored research program identified multiple areas from which they benefited. Of interest to us as advisors of an undergraduate research curriculum were the following items, which were reported as being positively impacted by the research experience (for a complete list, see Figure 1 of Ref. 3):

- Understanding the research process
- Understanding how scientists work on problems
- Learning lab techniques
- Developing skills in the interpretation of results
- The ability to analyze data
- The ability to integrate theory and practice

However, participation in an undergraduate research experience also benefited students in areas that can reach beyond academia (3).

- Having tolerance for obstacles
- Learning to work independently

- Understanding how knowledge is constructed
- Self confidence
- Understanding that assertions require supporting evidence
- Clarification of a career path

These benefits persisted after a 9-month follow-up survey, suggesting some lasting changes in undergraduates' perceptions of the value of research. The fact that participation in undergraduate research helps students clarify a career path is valuable not only for the student, but for society at large. Students who complete an undergraduate research opportunity report increased interest in careers in the areas of science, technology, engineering, or mathematics (7). After an undergraduate research experience, 68% of students stated they had some increased interest in pursuing a STEM career (i.e. Science, Technology, Engineering, or Mathematics) (7). Additionally, 29% developed a new expectation of obtaining a PhD due to the experience of undergraduate research (7). This increased interest in careers in STEM benefits society at large as students develop interest in highly skilled professions that promote independence, collaboration, and innovation.

One of our own students, in response to a departmental exit survey stated, "research methodology is an important portion of the curriculum because graduate schools and supervisors are impressed when they see this on your resume, plus it's a great experience." We certainly believe undergraduate research to be an advantage when seeking post-graduate training; however, experience in research methodology is beneficial to all students

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not just those seeking further training after graduation. Ethical study and application of the scientific process develops critical thinking and independence necessary for achieving the highest standards of quality in scholarship, service and leadership. Developing skills in critical thinking and communication will allow students to emerge as leaders in multiple professions after graduation.

Faculty mentors also benefit from the undergraduate research process. The faculty mentor can initiate or continue a productive research agenda while at a teaching intensive institution. Interactions with students in the research process can enhance teaching (1) through the use of the scientific process as a class objective and by incorporating lab skills into the research process. This again facilitates the students moving from classroom theory to practical experience to solidify learning. Further, the university or institution will benefit from the publications, abstracts, and local, regional, national, or international presentations that increase visibility in the scientific community.

The scientific community also recognizes the importance of undergraduate research. Several national agencies have directly identified undergraduate research for funding initiatives. Funding for undergraduate research has been specifically identified by National Science Foundation which recently allocated \$33 million for the Research Experiences for Undergraduates Program (REU) (6). This competitive mechanism typically funds an undergraduate student for a 10 week mentored project with a \$3,000 - 4,000 stipend. The National Institute of Health

has also announced the R15 mechanism or AREA grant which can provide an institution with up to \$150,000 over 1 to 3 years for faculty mentored research at traditionally teaching institutions (5). An additional national funding opportunity for undergraduate students is the Howard Hughes Undergraduate Research Fellows Program providing a \$2,600 stipend and possible tuition waiver (2).

Fifteen years ago, the faculty in our department had the foresight to require each senior to complete an individual research project. The implementation of a research project was quite a progressive idea for 1993, particularly in an undergraduate department housed within a liberal arts university whose mission was almost exclusively teaching focused. At the time, students in our department designed their projects, collected data, and presented their results in a single 15 week semester. The process of completing the research project has endured numerous transformations throughout the years and has morphed into its current state, a year-long faculty mentored research endeavor. The students learn research methodology and develop their research projects in one semester, while data is collected, analyzed, and presented during the second semester. The capstone assignments for the research projects include a journal-style manuscript, a poster presentation, and an oral presentation given to the faculty and staff of the department. Additionally, all students are required to present their research at local or state conferences and many have gone on to present at regional, national, and even international conferences.

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Two schools of thought predominate when determining the research topics: a student-generated research topic versus a mentor-generated research topic. The former requires the student to perform a thorough literature review prior to the development of the project to ensure the project is novel. The student must then develop his or her own faculty-mentored methodology in order to appropriately answer the research question. This method provides a well-rounded research experience; however, the projects tend to be less sophisticated when compared to the mentor-generated projects. The more classic, mentor-generated projects often provide students with the opportunity for greater exposure to advanced laboratory techniques. However, as these projects are ongoing the student has less input into research design and methodology. Each method has its unique benefits and limitations, yet both result in excellent research experiences for the students. The decision to choose one method over the other often is dictated by the interests and future goals of the individual student. Those students who are interested in graduate or professional school tend to migrate towards mentor-generated projects in order to gain additional laboratory experience, though students can and often do chose a student-generated projects.

As we look to the future of our undergraduate research program, we continue to pursue opportunities to improve the quality of instruction and mentoring provided to our students with the hope that this will enrich the research experience for our students. We believe the greatest limitation to an established undergraduate research curriculum is

monetary support. Many universities have an Undergraduate Research Office that provides small stipends for the students to travel and present research. We have found that our students are willing to present at regional or national conferences, but many do not have the funds for travel, registration, and professional membership dues, and therefore, often choose not to present their research. Thus, if we desire our students to gain the valuable experience of presenting at larger conferences (other than state or local), the financial burden lies with the student and/or the department. However, the precedent has been set within our university and other universities to seek external donations from community members who are committed to the development of future scientists. Such donations could provide the stimulus for increased research activity by making available stipends for students as well as for faculty mentors. The additional financial support would not only increase the quality of the research projects, but could also provide the much-needed support for students to present their data at larger conferences.

As faculty, we believe the research experience is extremely valuable for our students. It provides multiple benefits to students and faculty, as described above. However, those that have mentored research projects know it can be a trying or frustrating experience at times. Therefore, it is particularly gratifying to hear our students speak positively about the research process. One student reported last year, "I am really glad that I had the opportunity to complete a research project. It is an excellent tool for learning how to

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perform research, but also it has taught me skills I can use to complete any task.” For our purposes, this may be the primary goal of undergraduate research: students learn how to perform research, but they also learn problem-solving skills that translate to arenas beyond the classroom or laboratory.

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