VOLUNTEER RESEARCH EXPERIENCES PROVIDE SCIENTIFIC TRAINING AND PROFESSIONAL DEVELOPMENT FOR STUDENTS MAJORING IN THE ENVIRONMENTAL SCIENCES AND IN PRE-HEALTH FIELDS

Taylor W. Faulk[1], V. Ruth Pannill[2], Elizabeth L. Wesley[1], James B. Deemy[3]

AFFILIATIONS University of Georgia [1]Franklin College of Arts & Sciences, Department of Biological Sciences, [2]College of Agriculture & Environmental Studies, Department of Crop & Soil Sciences, [3]Warnell School of Forestry & Natural Resources

REFERENCE: *Proceedings of the 2007 Georgia Water Resources Conference*, held April 19th and 20th, 2017, at the University of Georgia.

Abstract. Over the course of three semesters, undergraduate volunteer researchers associated with the Warnell Aquatic Resources Group have collected physiochemical water quality data from two campus streams, Tanyard Creek and Lily Branch, as well as Lake Herrick. These volunteer research activities are intended to accomplish two major goals, 1) establish a baseline water quality dataset for campus water resources and 2) provide informal experiential learning opportunities to undergraduate students interested in water resources / limnology. These volunteer projects require students to learn the research process and the basic tenants of hydrologic science. These learning experiences provide opportunities to concretely observe effects of urbanized watersheds on streams, gain first hand observations of changing seasonal flow conditions and how these relate to cumulative local meteorological conditions. This volunteer research project also generated enhanced understanding and thoughtfulness for streams and bodies of water on campus. Finally, it promotes the informal teaching of other citizens about campus streams by the students involved in the experiment. The goal of our study is to highlight the lasting benefits to undergraduate students that participate in volunteer research.

INTRODUCTION

At a public research university, such as the University of Georgia, there are initiatives to promote experiential learning in and out of the classroom. Experiential learning initiatives focus on helping students learn through immersive programs (Kolb 1984; Kolb & Kolb 2005), which are generally in the form of field courses, study abroad programs, internships and undergraduate research.

Academic degree program schedules, finances, and highly competitive applicant pools for REU (research experience for undergraduate) programs can all be challenges to students that want to participate in research opportunities for the sake of learning science. One solution to these challenges is to participate in volunteer undergraduate research programs. Volunteer research in some disciplines can be used as a simple way for students to work around their restrictive course schedules and avoid using scholarship hours to gain research experiences (as is the case when doing formal independent study).

Undergraduate research is a critical component to university education because research is at the heart of most university mission statements. Volunteer research accomplishes two main goals, 1) it adds to the growing body of knowledge in the specific field of the student's choosing, and 2) it provides an experiential learning opportunity for the student.

Experiential learning is an important part of science students' undergraduate educations and is evident throughout science curriculum. Early career science majors are generally required to take introductory lab courses in biology, chemistry, and physics. Students then choose courses and a major that fit their more specific interests within the sciences that have additional opportunities to practice skills and gain knowledge through inquiry. Advanced courses within science curriculums often include a research opportunity that helps prepare students for independent study, senior projects or REU programs.

In this study, we highlight the lasting benefits of volunteer student research. The three UGA students highlighted in this study completed water quality monitoring research on UGA campus streams. Their research was designed to provide baseline water quality data on two campus streams. Our study examines the role of volunteer research as an experiential learning opportunity using these three focal students.

BACKGROUND

Students

Student A was enrolled in UGA's Franklin College of Arts and Sciences, majored in biological sciences, and will attend medical school in Fall 2017 (Medical College of Georgia). Student B is enrolled in UGA's College of Agriculture and Environmental Studies, majoring in environmental chemistry, and plans to attend graduate school. Student C was enrolled in Franklin College, majored in Biology, and will attend dental school in Fall 2017 (Dental College of Georgia). All three students met while participating in UGA's Coastal Summer Semester, field study

in oceanography (MARS 4500). During the summer semester, the three students were each required to design and conduct their own experiment. This course satisfied the Franklin College Biological Science Department's undergraduate research requirement. Upon returning to UGA's Athens campus in the fall semester, the students collaborated with a graduate student within the Warnell School of Forestry & Natural Resources. Together they designed the experiment being evaluated in this paper.

Student Project

Lily Branch and Tanyard Creek are headwater streams in the North Oconee River Watershed. Working with the Warnell Aquatic Resources Group, the students carried out their research over the course of the fall 2015 and spring 2016 school semesters. At each of the sites, the researchers used a quanta multi-probe device, a Lamotte colorimeter, and a Hatch turbidimeter to measure the temperature, pH, dissolved oxygen, salinity, and turbidity of the stream as well as nitrate, nitrite, ammonia, and phosphate in the water each week.

FINDINGS

The water quality study had many different components that each provided a different learning opportunity for the students. The students could point to a skill that they acquired or knowledge that they learned (Table 1).

The most important skill that the students gained from this experience were skills necessary for informally teaching other citizens about water quality. All three students began their study with no research experience in limnology and very limited knowledge about water resources. The experience produced much deeper knowledge of anthropogenic impacts on local aquatic ecosystems. The students believed that this knowledge could then be used in their post-academic lives to make informed decisions and lifestyle choices that would minimize their impact on aquatic ecosystems around them. The students also felt compelled to pass this knowledge on to other citizens.

The skills and knowledge gained by the students in this experiment added to those that they had already gained in their academic careers (Figure 1). Prior academic background in science and undergraduate research did not diminish the magnitude of learning from this experience. The students found that their volunteer research experience built upon what they had learned in their major coursework. Perhaps most importantly, the students believed that the research experience had provided skills and knowledge that they could apply to their future careers.

Table 1. A few of the activities completed by the three experimenters, as well as what they took away from the experience in terms of either a skill acquired or knowledge learned during the experiment.

What we did	What we learned	
	Skill	Knowledge
Extensive independent background research and experimental planning	Developing a research plan	Research methodology Deriving project context from literature
Researching and conducting the experiment	Techniques for water quality sampling	Water quality parameters and their ecological implications
Testing two different streams and observing several neighboring streams	Broader environmental consciousness	How neighboring watersheds affect one another
Multi-week experiment	Consistent sampling techniques	Experience with possible sources of error
Spending time in the field	Creating hypotheses from field observations	How observations of the natural world provoke questioning
Working as a team of three	Task delegation and allocation as well as problem solving	Harnessing each individual's strengths to produce the best possible result
The whole project	Informal teaching of other citizens based on scientific training	Enhanced environmental consciousness

Environmental chemistry is a major where water quality research would be expected to assist in the academic and professional development of a student, however, all three students benefitted from this experience regardless of their major or career goal. While the immediate benefits to a pre-medicine or pre-dental student may not be as obvious, they still benefitted greatly from their respective volunteer research experiences. Each student found different skills and knowledge important to their academic and professional development (Figure 2).

All three students learned a variety of skills relating to water quality testing which were most important to the environmental chemistry student because they may use these skills again in future research projects. All three students benefitted from field experience, literature review methods, and scientific writing but the level of importance of each skill differed between the three students. For the pre-health field students (Students A and C), these skills are not required, but did make them highly competitive students in their major related classes. The environmental chemistry student (Student B) found these skills to be vital to their success in their academic program.

After completing this experiment, the three students believed that the knowledge and skills they had acquired were applicable beyond their academic careers (Figure 3). Research based experiential learning that spans multiple semesters allows students to learn from repeated processes and reflect on mistakes. The focal students in this study performed their weekly monitoring routine for two semesters and had many opportunities to make mistakes and modify their protocol accordingly. Reflection on their experiences also allowed the students to learn about aquatic sciences. As with all scientific studies, research insights

derived from data led to more questions. What the students learned by performing their experiment, regardless of its results, increased what they understood about the context of the experiment. Time spent in the field carrying out the experiment led to passive observations that generated the context for different experiments.

CONCLUSION

Through their participation in this experiment, these three students gained a variety of skills that will be useful in their undergraduate, graduate, and professional careers. This experience deepened their knowledge of the scientific method, as well as increased their environmental consciousness as it relates to stream ecology. The water quality research that they conducted proved to be a valuable experiential learning opportunity for all three students.

Water quality research can have potential benefits for undergraduate students regardless of their majors or career goals. In this study, three students in different scientific fields were all able to gain a variety of new abilities that are useful in their major related courses and post-graduate careers. These benefits are applicable to students of any major or career goal (Cantor 1997). Based on the experiences of these three students, volunteer research in the field of water resources and limnology is recommended as an important professional development step for students of all fields.

As water becomes an increasingly important resource, it is important that students learn more about the bodies of water around them (Pahl-Wostl 2002). Students benefit greatly from the opportunity to learn first-hand how anthropogenic activities affect nearby water sources. All three students gained a deeper understanding of the relationships between humans, land, and water through this experiential learning opportunity. Additionally, they have contributed to establishing a baseline for water quality on their campus. Finally, this experience has given the students skills and knowledge that will benefit them in their future academic and professional careers.

REFERENCES

Cantor JA, 1997. "Experiential Learning in Higher Education: Linking Classroom and Community" *ERIC Clearinghouse on Higher Education*.

Kolb AY, DA Kolb, 2005. " Learning Styles and Learning Spaces: Enhancing Experiential Learning in Higher Education". *Academy of Management Learning and Education* 4 (2): 193-212

Kolb DA, 1984. "Experiential Learning: Experience as The Source of Learning and Development". New Jersey: Prentice-Hall.

Pahl-Wostl C, 2002. "Towards Sustainability in the Water Sector - The Importance of Human Actors and Processes of Social Learning" *Aquatic Sciences* 64:394-411.

ACKNOWLEDGEMENTS

We extend a special thank you to Prof. Todd Rasmussen for providing the equipment and opportunity to carry out our study. We thank Kelsey Morton and Wesley Sparks for photographs. Additionally, we thank the Warnell Aquatic Resources Group for draft edits

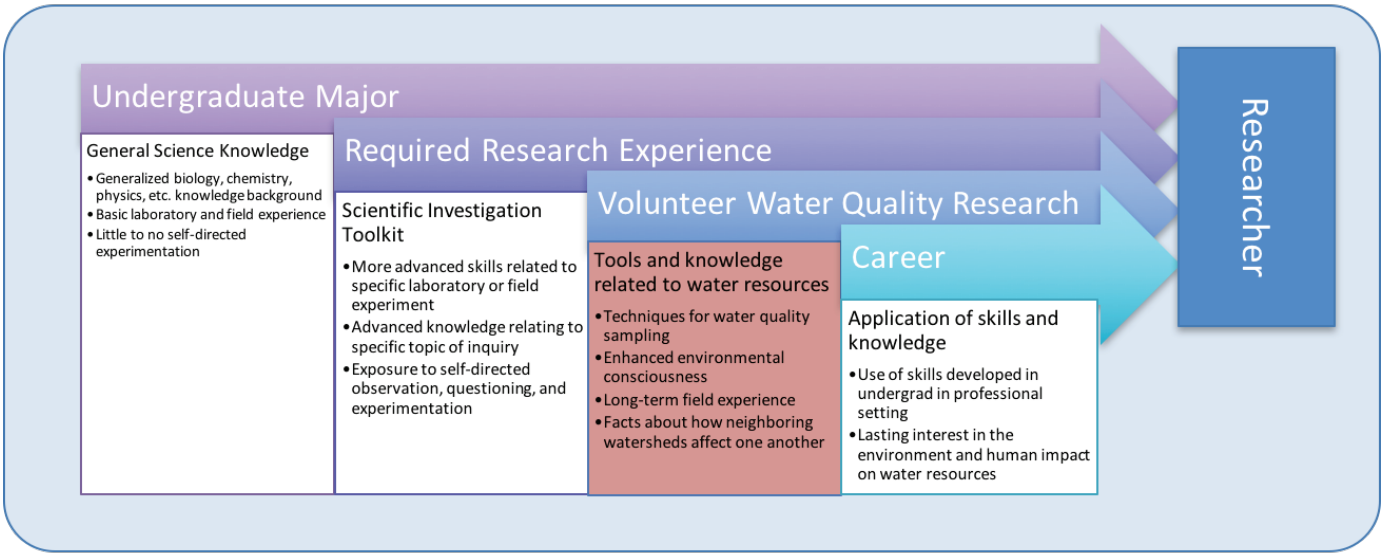

Figure 1. Pathway through a student's academic career and into their professional career. Abilities and knowledge that a student learns from these four areas are listed in the white boxes. The advantages of adding an undergraduate water-quality research experience are highlighted in red.

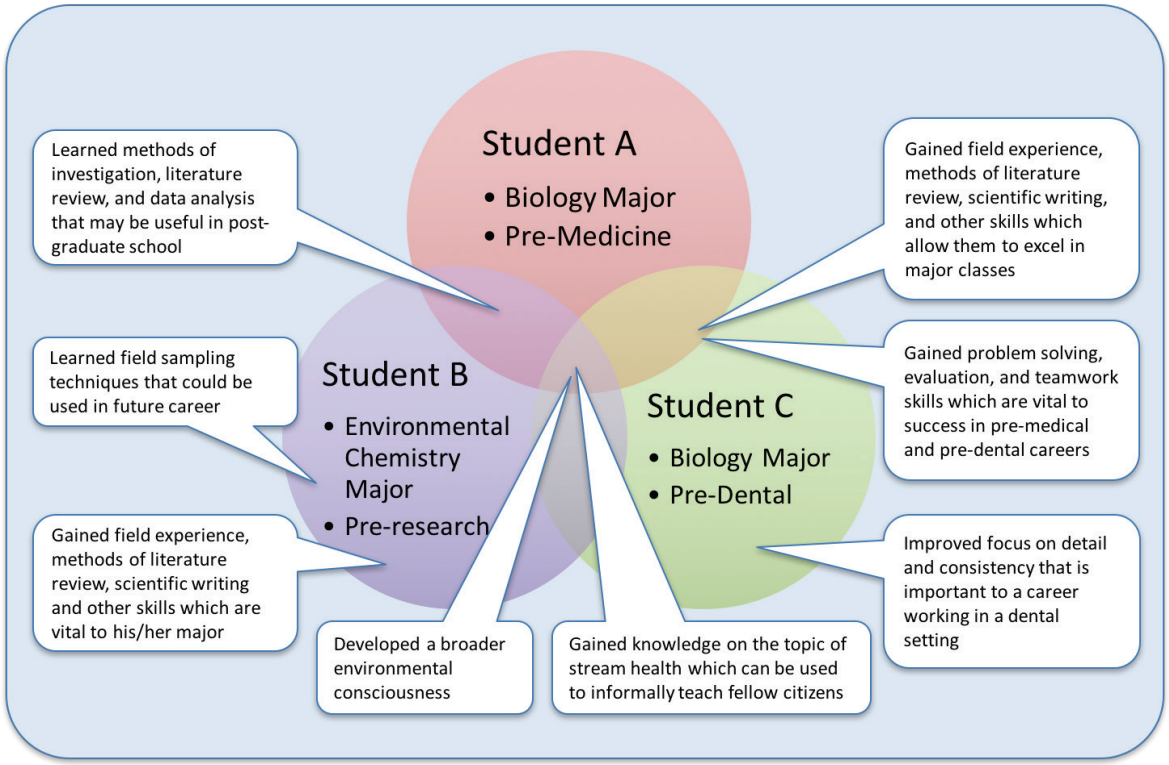

Figure 2. Venn-diagram comparing the different skills and knowledge that the three students considered most important at the end of this experiment.

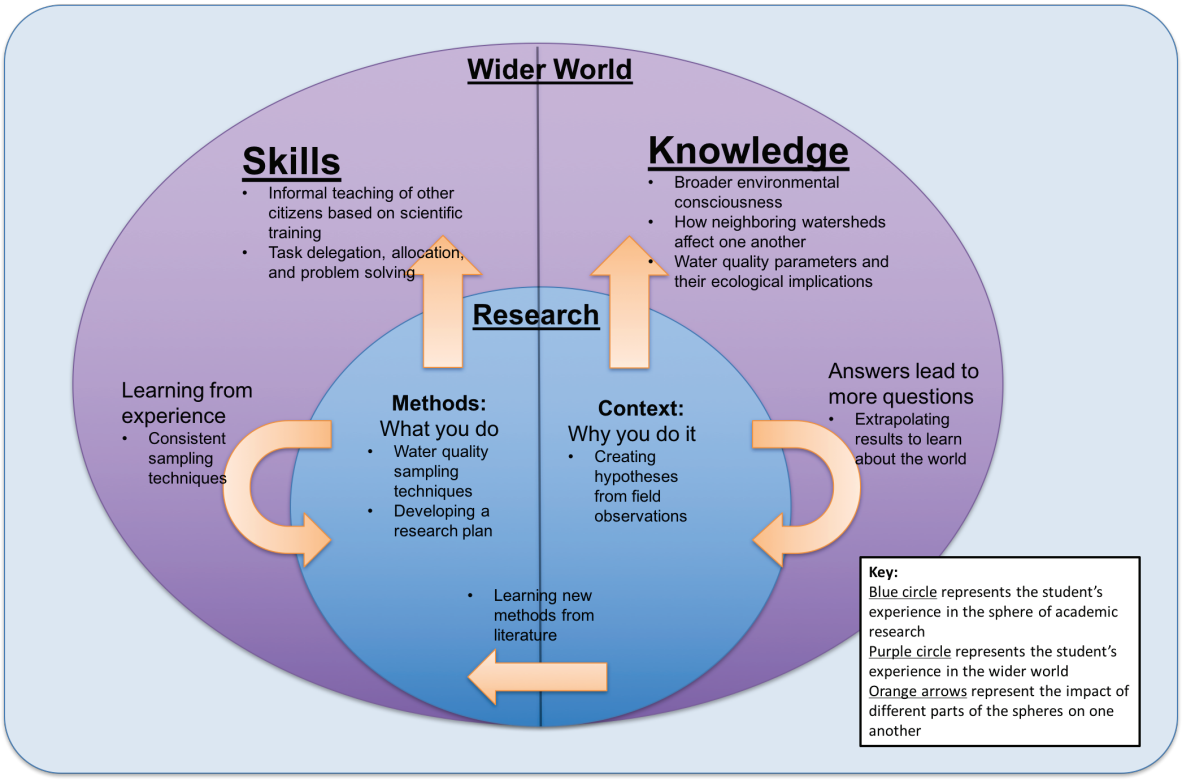

Figure 3. Flowchart of interactions between skills and knowledge gained through water quality research