

## **UW Academic Challenge and Engagement Study (UW ACES): School of Aquatic and Fishery Sciences**

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August 2013*

### **INTRODUCTION**

Research on learning in college shows that learning is profoundly shaped by the goals, practices, culture, and values of the academic disciplines<sup>1</sup>, particularly the disciplinary practices in students' majors. Therefore, if we are to understand the kinds of experiences that students find intellectually rigorous (and, thus, engaging), we need to examine challenge in the major. Understanding challenge in the major is important because at every stage of their college experience, students report that they want to be challenged, that they perform better in courses that are challenging, and that they value classes that stretch their thinking and ask them to demonstrate learning more than they value classes that ask little of them.<sup>2</sup> Although learning about where students experience challenge is important, asking students to describe challenging learning experiences in their majors requires some prior understanding of how those majors operate. The Office of Educational Assessment (OEA) designed the UW Academic Challenge and Engagement Study (UW ACES) to accommodate these needs.

### **METHOD**

Qualitative methods are recommended when researchers are seeking to understand the complex learning experiences of students, as well as the meaning of those experiences<sup>3</sup>; therefore, we designed the UW ACES to be primarily an interview study.<sup>4</sup> Using a "citizen science" model, OEA asked departmental advisers if they would be willing to volunteer to interview seniors in their departments who came in to advising to apply for graduation. Advisers are knowledgeable about their academic programs, understand disciplinary practice in their departments, and are trusted by students in the major, so they have the best chance of gathering good information from seniors about their experiences in the major.

Sixty-six advisers from 32 undergraduate programs volunteered to participate. During the 2012-13 academic year, the volunteer advisers asked students if they would participate in brief (5-10 minute) interviews about challenge in the major. If the students agreed, advisers asked students to respond to

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<sup>1</sup> Beecher & Trowler, 2001; Bransford et al., 2000; Beyer et al., 2007; Donald, 2002; Pace and Middendorf, 2004; Wineburg, 2001, 1991; Neumann et al., 2002; Shulman, 1988; Biglan, 1973.

<sup>2</sup> Beyer, et al., 2007.

<sup>3</sup> Merriam, 2001.

<sup>4</sup> One participating department asked students to respond to the open-ended questions in writing.

four open-ended questions, entering students' responses directly into a Catalyst survey form that OEA researchers had designed for that purpose. The questions were as follows:

1. What do you consider to be the most challenging work that you had to complete in this major? And by "challenging" I mean doing the work that stretched your thinking the most. This can be anything—a project, a paper, an exam question, homework, something else you did related to the major.
2. What made the project/class/activity challenging?
3. What did you do or learn that enabled you to meet those challenges?
4. What do you think you learned by completing this project/class/activity?

In addition, advisers asked students in what course the challenging work took place and how many quarters they had until they graduated.

Researchers in OEA conducted training workshops in interviewing skills with all participating advisers, provided individual departments with customization if required, and monitored all resulting interviews, reporting back to advisers about the interviews they had conducted. By the end of the academic year, departmental advisers had interviewed 1,237 students.

Students' responses were analyzed using a constant comparison method, an inductive process designed to let themes emerge, rather than imposing assumed categories of response on students' comments.

## **STUDY LIMITATIONS**

If we interviewed students post-graduation, they would be likely to identify their capstone courses or their advanced senior-level courses as the ones asking for their most challenging work. However, because we wanted to attach the interview to a time when students would normally see their academic advisers, we interviewed students when they came into the advising office to apply for graduation, which often meant that they were two or three quarters away from graduation. Although this approach meant that we might not gather information about late-senior year courses, we felt that it would be interesting to departments to learn the kinds of challenges that lead to and prepare students for those more advanced experiences.

## **SCHOOL OF AQUATIC AND FISHERY SCIENCES (SAFS) RESULTS**

The School of Aquatic and Fishery Sciences was one of the UW ACES' participating departments. Samantha Scherer, the academic adviser in SAFS, asked nine students if they were willing to be interviewed for the study and all of them agreed. This number represents about 28% of the seniors in SAFS who graduated during the 2011-2012 school year.<sup>5</sup>

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<sup>5</sup> The number of undergraduate degree completions is based on the IPEDS report published by the UW Office of Planning and Budgeting: [http://opb.washington.edu/sites/default/files/opb/Data/ExternalReports/Completions\\_Seattle\\_2011-12.pdf](http://opb.washington.edu/sites/default/files/opb/Data/ExternalReports/Completions_Seattle_2011-12.pdf). Since newer data for 2012-2013 is not currently available, this 2011-2012 figure is only a proxy to approximate what percentage of graduating seniors we were able to interview.

## ***Quarters to Graduation and Where Students Experienced Challenge***

The challenges students described experiencing occurred most often before or at the beginning of students' senior year. Six of the students interviewed had two quarters left before they graduated, and the other 3 students had three quarters left. Even so, two students were already underway in their capstone experiences, as their responses made clear.

When asked which courses in the major had presented them with the greatest challenges, seven of the students listed a total of 10 classes (some students mentioned multiple classes), as follows:

BIOL 479, Research Apprenticeship  
FISH 311 (2 students listed this course)  
FISH 312  
FISH 323  
FISH 340  
FISH 437  
FISH 450  
FISH 455  
FISH 494, Capstone (2)  
OCEAN 492

In addition, two of the students said "multiple courses" when asked where their most challenging learning experiences occurred.

### ***1. Students' Greatest Challenges***

Students were asked: "What do you consider to be the most challenging work that you had to complete in this major? And by "challenging" I mean doing the work that stretched your thinking the most. This can be anything—a project, a paper, an exam question, homework, something else you did related to the major."

Two strong themes emerged from students' responses.

**Writing scientific papers.** Four of the nine SAFS majors said that their greatest challenges were learning to write scientific papers. In the words of two of the students:

- *Writing papers, I suppose...ones you have to design experiments for and format in a scientific way. It's a different sort of [writing]. [You have to] be wary of what you say—language, references. Switching from regular writing to scientific writing (prose to technical) was challenging. Also reading and being able to extract scientific literature is a huge transition, especially specific to this kind of major. [It was like moving from] prose to technical report writing. [The] same [was true for moving from reading] a novel to reading journal articles. It was a skill that I had to work on.*
- *Writing scientific articles for a lot of different classes. One of them, genetics, was a paper on seahorses. The data analysis was challenging.*

**Designing and conducting experiments on one's own.** Four students also mentioned challenges inherent in designing and conducting their own scientific experiments. For example:

- *In 455 lab, part of designing the experiment, the logistics, [was challenging]. You got to see cruel truth that not everything is laid out and ready.*
- *In my internship at Friday Harbor Labs, working with sematic indices and sea urchins. [It required] a lot of learning about test animals, a lot of independent research. [It was challenging] to do it on your own. [I had to do] self-guided research—getting to know the test organism, the behavioral characteristics of species, where to find them, interpretation of mashed up facts, looking at papers that said one thing or another and what that might mean in the field. The professors were available and accessible, but I was pushed to do work on my own.*

Two of these four students specifically mentioned that it was their capstone project that required this challenging and independent research work. These students remarked:

- *[The] capstone was tough. I had to design my own experiment without much help. When things didn't go as planned, [it was] hard to bounce back within the structure i had to deal with.*
- *Most challenging is the capstone. I made contact with professors and I had to make my own project. [It was] basically not like a class. Class is directed, [but in] the capstone you have to make your own project. It creates a network [and you are] able to meet professors and get to know them better.*

**Other.** In addition to these two themes, two students each mentioned the following challenges:

- Coursework (in one case requiring a great deal of memorizing)
- An apprenticeship or internship
- The seahorse assignment

## **2. What Made Those Activities/Classes Challenging?**

All but two students noted multiple challenges in **designing, conducting, and reporting results of their own experiments and research** as aspects of those experiences that made them the most challenging. Students noted that it was a challenge to:

- Know how to interpret data
- Use computer programs to analyze data
- Be creative in coming up with their own questions and experimental methods
- Develop project budgets
- Run tests in the lab that no one had done before them
- Work with a team to collect and analyze data
- Deal with experimental failure
- Figure out how to use references correctly

Interestingly, students reported challenges associated with designing and conducting their own research in all the courses they listed, which we noted in a previous section. This suggests that the practice of asking students to conduct research on their own scientific questions is a widespread practice across the major. The following three quotations address the challenges students noted:

- *In lab, we weren't reproducing an experiment, they were new tests nobody had done before. No one knew the outcome, including the professor.*
- *The first project that forced independence. I had a broad idea for a project but having to choose on my own what to focus on and what questions to ask [was challenging]. I got really cool results that contradicted the only paper ever written on subject, [so I] was happy with that.*
- *I'm such an analytical person, being creative is sometimes hard especially not being trained in the methodologies of scientific experimentation. I had to come up with my own methods. Also writing a budget is a lot harder than it sounds. In ecology, data is messy. You want to have results come out a certain way, but when they don't, it's really frustrating—like when setting up experiment, when it doesn't run the way you want it to run. In my case, the fish just ran into the corner and hid.*

Relatedly, one student spoke about the importance of identifying one's own research interests in the capstone process:

- *You have to look into yourself, find what you're really interested in, then find an adviser. [If you] want your future to be like that project, you need to find out what you really want to do. If you don't know what you want to do after you graduate, this is an opportunity to think about that.*

In addition to these challenges associated with students' own research, one student noted that linking samples with their appropriate order was a course challenge because the samples were often in poor condition and another student said that in some courses poor instructors made it difficult to learn in the classroom.

### **3. What enabled students to meet those challenges?**

All students but one identified two or more things that helped them meet the challenges they described—which were mostly challenges in research and scientific writing.

**The scientific literature.** Six of the nine interviewees mentioned their field's scientific literature when responding to this question. Although students spoke of needing to learn to read the scientific literature in an area in order to learn more about that field, they also spoke of learning how to conduct experiments by using the examples provided to them by the literature in their field. Thus, articles in SAFS served two purposes. First, they increased students' understanding of knowledge in the field and second, they increased students' understanding of how knowledge is created in the field. In addition, two of these six students also noted that writing was their biggest challenge and that the scientific literature review was key to their improvement as writers.

Three students' comments serve as examples of this category of response:

- *Learned to look at past studies to see how they did things, incorporating their thinking with my own (citing references of course).*
- *Different researchers' organization and methods helped. Learning the basics and how others worked as a model to compare and contrast.*
- *Learning that it's okay to do/use research from past papers with similar experiences.*

**Repetition, practice.** Three students spoke about the importance of repetition and practice in enabling them to meet the challenges they described. This was especially true for students who spoke about scientific writing as their greatest challenges. As two students put it:

- *Practice makes perfect. Taking lots of classes forcing you to write papers, a lot of ecology classes.*
- *Repetitive writing helped you improve. Doing it in every class helped to get better.*

**Classes/instruction from faculty.** Three students also mentioned that their faculty, TAs, and courses had helped them meet the challenges they had described. For example, one student spoke about the value of both writing and statistics courses:

*Classes specific to writing (such as the FISH scientific writing course) were a big help, a huge help. Learning how to read and extract information. All the literature follows a common template—what is the purpose, results, major implications of the paper/study. Lot of tips from instructors—the real world kind... Q SCI and statistics helped me better understand scientific papers and the tests they used. Most science is quantitative so you need to be able to think that way when analyzing data and designing experiments (sample size, sampling method, statistical in nature).*

**Other.** In addition, two students spoke about the help they received from each of the following:

- Peer review.
- Learning to talk with professors/asking faculty and TAs for help. As one student remarked, *“Knowing the focus of professors, what they teach – you can see if you’re interested. [You have the] chance to talk to them and network and understand more about their field. [That] helps decide what you want to do and build up from there.”*
- Talking to experts in the field outside of the classroom.
- Beginning a project early. As one student said: *“Creativity doesn't come on the spot, so you need to give it time.”*
- Using resources through the UW Libraries (interlibrary loan, Web of Science searching).

#### **4. What did students learn by completing this project/class/activity?**

We asked students what they felt they had learned by meeting the challenge they had described. Students’ responses to this question were largely idiosyncratic; however, two themes emerged from their responses.

**What I wanted to do in the future/what future research would be like.** Five of the nine students spoke about the importance of the challenge they had met on their thoughts about the future—both future careers for themselves and research work they might do in the future. In the words of three of those students:

- *Working on the [capstone] project was a taste of real life after you graduate—[the] long hours. It prepares [you] for things ahead.*
- *[I learned from the research apprenticeship] what it really takes to be a researcher in the field. [I learned] what I want from the degree. Research is something i want to do*

*instead of teaching or other things. It's hands-on in the field and independent. It taught me I needed to go further in [earning] degrees than I originally thought but I'm willing to commit to that.*

- *Able to see what i wanted to do in future, whether research something I was interested in doing. I think it is. Frustrating but with the finished [apprenticeship] project and results, I thought "I could do this." Research has a lot of challenges but is well worth it.*

**What the research process is.** Four of the nine students said that they learned about various aspects of the research process. In the words of two of them:

- *[I learned] how to approach a research topic and all the things to think about and include to be a good scientist, instructor, teacher--not just the big picture but all the small things that make the big picture.*
- *[The] holistic world of designing experiments. [My] results weren't profound. It was more the process and how many questions we opened. There was no definitive answer, and more questions than when we started. Experiencing real world applications [that were] not tailored to labs, [as in most] undergraduate classes. [It's] not so cut and dried in the real world.*

**To read and understand scientific literature.** Two students noted that they had learned to read and understand scientific literature in experiencing the challenge they described. For example:

*Looking back, I can't believe how much I've learned. I learned communication skills, how to speak and write. I learned how to use other scientific literature to understand more about what I'm doing, more about what's out there, what other people are doing.*

## SUMMARY

A strong theme that crossed students' responses to all questions was the challenge in learning to become scientific researchers and writers. Students spoke of the challenges they had met in coming up with their own research questions and designs, with one student noting that this aspect of SAFS experiments differed from other undergraduate courses, where the labs were "tailored" for the students. Related to this point, students also spoke of the messiness of research—that you could work hard on a project and fail and that you needed to know how to ask for help. Students spoke of help coming from faculty, TAs, and peers, and two students spoke of getting help from experts outside the university. In the words of one of them:

*[I] consulted books and resources—the Strathman book. I talked to him (a famous guy, won naturalist of the year award). If I saw something odd, I called experts who were all around and willing to talk, not just in email, but in person meeting with them talking about their life work. [It was] really cool.*

Students also spoke of the importance of learning to read and understand the scientific literature in the field both as a way to increase their knowledge and to learn more about research design and scientific writing. Finally, students talked about learning to do research as a way of clarifying their own futures.

Students' responses to questions about challenge were consistent with SAFS faculty aims. In a recent capstone-based assessment workshop that SAFS faculty conducted about learning in the major, faculty noted:

*Although capstone structure may vary, the goals of the capstone experience do not. Broadly speaking, the main goal—in the words of one faculty member—is “to focus on my students’ ability to function as scientists.” With that in mind, faculty members spoke of helping students move through every step of the research process, from generating researchable questions to giving a public presentation of one’s research findings. In the words of one of the faculty members: “We are really trying to focus on them extracting a good question, on them thinking what are the objectives they can achieve given the data at hand, and then on bringing that data together in a cohesive fashion. We use the capstone to help them synthesize the tools they have collected through the year, to use the book learning to help them understand real relationships (pp.2-3, Report, “Capstone-based Assessment of Departmental Learning Goals”).*

As the UW ACES results show, students see their greatest challenges as focused on this main goal of the capstone (and indeed, of the SAFS program)—learning to think, research, and write scientifically. Furthermore, students identified writing and conducting their own scientific research as the main challenges presented by all the courses they listed. (Due to the timing of the interviews, only two students were primarily talking about their capstone projects throughout their interviews.) Students especially spoke of challenges in identifying their own research questions, which was a new experience for most of them.

Although the total number of student interviewees is small, their responses suggest a clear overlap between the goals of the SAFS program and the academic challenges it presents for students. As students' responses suggest, explicit assistance with identifying good research questions early in the major and with instruction in scientific writing helps students meet those challenges, and the use of scientific articles in class is a significant aid for both identifying researchable questions and for understanding scientific writing practices. These are two areas that SAFS faculty discussed in the capstone assessment workshop, and the program has already put resources into both.

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