

UW Academic Challenge and Engagement Study (UW ACES):

Astronomy

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INTRODUCTION

Research on learning in college shows that learning is profoundly shaped by the goals, practices, culture, and values of the academic disciplines¹, 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.² 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 experiences³; therefore, we designed the UW ACES to be primarily an interview study.⁴ 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 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 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.

² Beyer, et al., 2007.

³ Merriam, 2001.

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

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.

ASTRONOMY RESULTS

The Astronomy Department was one of the UW ACES' participating departments. Sarah Garner, Academic Counselor and Assistant to the Chair in Astronomy, asked five students if they were willing to be interviewed for the study and they all agreed. This number represents about 26% of the Astronomy seniors who graduated in 2012.⁵ This number is small because the study got underway after the majority of seniors in the Astronomy Department had already applied to graduate; it should not be considered representative of all seniors. However, although a small sample, the five students' responses to questions about challenge in the major may still be of interest to the department.

⁵ 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. 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

Two of the five students interviewed were completing their final quarter before graduating. The other three students had two more quarters before graduation.

When asked which courses in the major had presented them with the greatest challenges, students listed a total of seven courses (two students mentioned more than one course). Four of those courses were Physics classes, and three students noted that Astronomy 480 had presented significant challenges. The list of courses students identified is as follows:

ASTR 300
ASTR 480 (mentioned by 3 students)
ASTR 425
PHYS 226
PHYS 323
PHYS 324
PHYS 428

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."*

Students mostly mentioned areas of study that they felt were challenging. Individuals listed condensed matter, CCDs, particle physics, and quantum mechanics as challenging. Two students also reported that programming was an area of learning they found particularly challenging. As one of those students said:

Learning the programming aspect, I went into the University not knowing anything about programming and now know the basics about a couple of different languages. Definitely a bit of a learning curve.

In addition, one student said that research was especially challenging because:

Research is always a very different way of thinking. You always have a guilt factor because someone is always wanting you to finish stuff.

Another student noted that a project for ASTR 480 was challenging. In her words:

My Astronomy 480 project. We actually got to use a telescope to take data; it was the first time I had used an electronic telescope.

2. What Made Those Activities/Classes Challenging?

In describing what made the activities they had discussed challenging, three of the five students described the challenge in figuring out and integrating unfamiliar technology—computer programs, charge-coupled devices (CCDs), and telescopes—into the work they were doing. For example:

- *Wrapping your head around what the CCD is doing, subsequently working with the program to process what you're getting from the CCD was all just unfamiliar. It wasn't*

like just taking another physics class where you're just doing another type of math; I hadn't done this before.

- *A different type of thinking. It's easy doing math but you have to put it in the format to understand it--translating your ideas into a code the program can understand.*
- *I had to take some data, then I had to analyze it—measure the extinction of the galaxy. But going into it, I had no idea how to do that. So I had to figure out how to do it and write a program that would do it for me.*

In addition, one student spoke of the time involved in understanding difficult concepts well enough to do well on the tests, and another student said that the work she described was challenging because instruction was unclear, the concepts were quite difficult, and she had missed several classes.

3. What Enabled Students to Meet Those Challenges?

Two themes emerged from students' responses to the question of what enabled them to meet the challenges they described.,

Talked/worked with peers. Three of the five students mentioned the benefits of knowing and talking with other students about their work. In the words of two of these students"

- *The biggest thing in college for me was finding a group of people to meet with—people in physics and astronomy to talk it through. Finding people to work with and struggling together, and finding someone you can be upset with. A big part of college is finding a group. Just studying on campus you bump into people you click with. Spending more time on campus; a lot of people have an issue that if they don't spend time on campus they don't make those connections.*
- *Luckily I had two friends taking the class with me that are avid programmers that could help me stumble through it. I got good at Googling programming, which apparently is very common*

Practice and learning to recognize one's own mistakes. A second theme, mentioned by two of the five students concerned the value of practicing. As these students noted:

- *I got used to doing things over and over again--making a mistake, recognizing I made a mistake, and starting over without making it.*
- *Really, just practice. I mean, the professors can show you what methods do what, but really you just have to do it over and over again until it becomes habit and just starts to click.*

Other. Individuals also mentioned that getting help online and from the Physics Education Group enabled them to meet the challenges they had described.

4. What Did Students Learn by Completing This Project/Class/Activity?

Except for two students who said they learned specific content—one saying he learned quantum mechanics and the other saying she learned programming languages—students' responses to this question were each unique.

One student said that he had learned that the major needed to give students better and more programming instruction. In his words:

I think there's a deficiency in programming preparation in the major, before ASTR 300 even. It teaches you bits and pieces of different languages, [but it's] like learning vocabulary for a foreign language but not the grammar. I felt very lost. I voluntarily took CSE 142 because I felt so lost, which helped immensely, and I wish I had [taken] that before ASTR 300. I didn't know how to approach programming problems. ASTR 480 (and everything after ASTR 300), I had to find code from ASTR 300 and shape it to fit what I needed it to do, because I didn't have the skills to write my own code. Especially because Astronomy is such a heavily programming field, I feel like the jobs need strong programmers and the major doesn't get you there.

Another student spoke about learning the importance of persistence:

I learned to succeed you need persistence. You don't have to be the smartest person, just want it. Something that seemingly is impossible or difficult, if you treat it with a positive attitude, you realize you can do it. To not be daunted is a big life lesson I've learned. Coffee is fantastic.

One student spoke about the importance of taking a break when you are working on a difficult problem. As she put it:

I learned to take a break. Sometimes if you go too hard for too long, nothing makes sense. If you're just stuck on the same train of thought you don't get a new perspective. You need to get outside, take a breath, go eat food.

Finally, one student learned about science and careers:

I learned how to do science, like what kind of things I can look forward to in a career.

SUMMARY

The small number of senior Astronomy majors completing the interviews and the uniqueness of their responses make it difficult to generalize from their comments. However, one theme that seemed to cross students' responses was the challenge of learning new technology almost at the same time students were using it to solve problems and answer questions in the field. One student suggested that students be required to learn programming at an early stage in the major. Another theme, connected to the issue of learning technology, was the importance of having colleagues—friends and groups with whom to study and who may be able to offer help with tough programming questions or other issues.

SOURCES

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