OFFICE OF EDUCATIONAL ASSESSMENT
Improving Learning Through Assessment

OEA Report 16-02

UW Academic Challenge and Engagement Study (UW ACES): Informatics

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March 2015

INTRODUCTION

Research on learning in college shows that learning is profoundly shaped by the goals, practices, cultures, and values of the academic disciplines[1], 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 experiences[3]; 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 33 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 them 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:

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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 survey 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[5], 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.

INFORMATICS PROGRAM RESULTS

The Informatics Program was one of the UW ACES' participating departments. The adviser for Informatics, Dowell Eugenio, invited 22 students who were applying for graduation to participate in the interview study and all of them agreed. This number represents about 21% of the 105 seniors in the Informatics program who graduated during the 2012-2013 school year.[6]

Quarters to Graduation and Where Students Experienced Challenge

Most of the students interviewed (13, 59%) were completing their last quarter before graduating, and nine (41%) had two quarters to go before graduation.

When asked which courses in the major had presented them with the greatest challenges, students listed a total of 19 courses in the Informatics major, with several students noting more than one course.

[5] Merriam, 2001.

[6] The number of undergraduate degree completions is based on the 2012-13 UW Profiles reports published by the UW Office of Planning and Budgeting (https://bitools.uw.edu/views/13-SummaryandTrendsDegreeAttributes_0/13-Dashboard#1.

Students identified four 300-level courses and eight 400-level courses as the sources of their most challenging academic experiences. The list of courses in the major as well as the number of students who identified them (only one if not otherwise noted) were as follows:

INFO 330: Introduction to Information Architecture (2)
INFO 341: Computer Networks and Distributed Applications
INFO 360: Design Thinking (3)
INFO 380: Information Systems Analysis and Design

INFO 431: Metadata Design
INFO 445: Advanced Database Design, Management, and Maintenance (2)
INFO 461: Cooperative Software Design (2)
INFO 463: Input and Interaction (2)
INFO 490: Project Capstone I
INFO 491: Project Capstone II
INFO 498: Special Topics in Informatics (Exploration Seminar in Ghana)
INFO 499: Independent Study (2)

In addition, seven students mentioned CSE 373 (Data Structures and Algorithms) as the course that presented them with significant challenges.

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."

In discussing their most challenging work, two major themes, one minor theme and several idiosyncratic responses emerged.

An Informatics course. One-half of interviewees (11 of 22) noted a specific course or courses that had presented them with their most challenging work in the major. In the words of a few of those students:

- *Well, I don't know if it's too early to talk about this quarter, but INFO 445 this quarter will be most challenging since it is both mathematical and technical.*
- *It was actually in the cooperative software course, INFO 461. It was the first time I had to collaborate over code with Bitbucket. It was a real world experience where everyone could work on the same code at the same time, which caused delays I didn't expect. I didn't know some of the techniques that some of the other students had, so I wished that I had taken some classes in INFO before then. All in all though it was a great experience.*
- *I think the hardest was when I took INFO 463.... It was an elective and I wasn't expecting to work so hard. We had to design something to teach a blind person to use a touch device, like a smartphone. I had to stretch my thinking to learn the technology but also how to work with my group. This wasn't something I had to do before in my life. It really raises employers' eyebrows when I tell them I had to design a touch screen for a blind person. We ended up making a game like that game "Bop It" to help solidify teaching of those gestures.*

- *INFO 461 was probably the most interesting class that I took at the UW.... It gave me the most real world experience, within a class, that the UW could.*

A computer science course (CSE 373). Eight of the 22 interviewees (36%) cited Data Structures and Algorithms (CSE 373) as their greatest challenge. As several students noted:

- *CSE 373. I think that's the one that stretched my thinking the most. The abstract thinking in that class was outside my area of comfort. I think it was just the abstract aspect of coding that was most difficult, but then I realized the potential of the course when interviewing for more technical courses. The algorithm questions were exactly what we were taught in the course. I literally say this to everyone that's complaining about it now--you'll need this later.*
- *I think it was the CSE 373 because that's a part of the CSE department, not in the Informatics department. There is a lot more math. The Informatics courses tend to feel more like liberal arts courses. There is more discussion and analytical work. They're more interpretative. In CSE there's very much a right answer and very much not a right answer.*
- *CSE 373 was the most challenging, technically because of the challenge that was presented to me to "crack" the code and being forced to do the research independently.*
- *CSE 373 from previous quarters was the most challenging because everything can be seen as a data structure or algorithm you're trying to conceptualize and visualize.*

A project. Three (14%) of the interviewees described a project in the major as their most challenging experience. For example:

- *I would have to say it was the project for INFO 463 because we had to come up with our own idea and make it work– well, not a fully working one but we had to show it to industry people. [The instructor] brought in people from Microsoft Research and other industry people from a bunch of different fields.*
- *My advance database class had an excellent project and the class in general was excellent. It was very open ended. We had a clear goal but we were left on our own to accomplish it.*

Other. In addition to the themes already discussed, individual students mentioned the following challenges:

- **Exploration Seminar in Ghana**
- **Running for student body leader**
- **Work experience**. *In terms of stretching my thinking, my work with Life - Work Bridges with David Hendry. Since this summer I was the HCI assistant. It gave me a lot of research, design, and development experience in a meaningful project: building info systems that help homeless young people connect to employment opportunities.*
- **My independent study (INFO 499).***What I did was I made some videos and some text and code that demonstrated how to use Microsoft SQL and write secure code around it. We used a lot of this in Farricker's class (Cloud Security).*

2. What Made Those Activities/Classes Challenging?

Next, students were asked to note what it was about the activity or the class they had described that made it especially challenging. About 41% of the interviewees identified more than one reason the course or project they had described was challenging. Several themes emerged from their responses.

Learning new concepts. Thirty-two percent of the interviewees (seven of 22) said that the most challenging aspect of the work they had described in the Informatics major was learning new concepts, particularly those required to be able to code effectively. Of those seven, three participants were specifically referring to CSE 373. The following examples illustrate this category of response.

- *It was just something I had never done before. It was really outside-the-box thinking. A whole other way of using the internet in ways you don't even see. We were learning about lining data across websites and name spaces. It was about how to programmatically get information from the internet not using an interface.*
- *CSE 373 was challenging because it was about difficult algorithms and data structures that might not be used in the day-to-day but still might pop up in your work.*
- *The class was challenging because I've never seen the problems before. Some of the others saw it because they had taken programming before. You had to think about what kinds of programming you had to use for certain problems. It stretched your thinking.*
- *What's challenging about the class is learning new technology. So, we are building the website within a framework–a new framework--and the syntax and code within that framework. The framework requires the command prompt, which I've never coded in.*

Applied nature of the work. Twenty-seven percent of interviewees (six of 22) noted that conducting applied research was what made the work in the Informatics major challenging. More specifically, students commented on the challenge in putting themselves in the shoes of the user and producing a quality product that is useful in everyday life. Some examples of this category of response:

- *I guess the goal itself, to end homelessness, [made it challenging]. That itself is a huge and complicated issue, of course. In particular, doing the research to develop an information system, a mobile application, for this population's needs [was challenging].*
- *Working with new technologies or concepts and taking things to a level that could be applicable in the industry.*
- *Just the ways to solve the problem [were challenging] We came up with a bunch of ideas but none of them were good. First, you had to figure out what it means to teach a person, and then how do you teach someone who is blind since so much of teaching is pointing and other visual cues. The coding wasn't that difficult, just the abstract thinking.*
- *I didn't think I'd have the opportunity to learn about natural medicine in a technology course but it was really fun to develop a solution for an actual company. It was like an internship without having to work for it. It gave me a lot of experience that I have been mentioning in all my interviews.*

Working on a group project. Five of the 22 Informatics majors (23%) said that working together with classmates on a shared goal was a particularly challenging aspect of the course or project they had previously described. In their words:

- *I think 461 was difficult because it was so different from regular programming. Working in a group is so different, but it helped me get my internship to say that I had experience working and programming in groups.*
- *Making sure that everyone knew their roles in the project and could complete the project within the time given to them [was the challenge]. It was also important to understand their work techniques and their strengths and weaknesses.*
- *[It was challenging] because there was a lot of exposure to different group dynamics, but it wasn't so far from the deviation that I couldn't handle my teammates. In regards to that, there was a lot of help from our TAs, and Andy as well. It kind of felt like the speed at which we developed our solutions and project was at a good pace.*
- *Motivating teammates is a challenge as well as expecting the same level of input from the teammates as I put in.*

Working independently. In contrast to the challenges in working in groups, three interviewees (14%) explained that working independently made the course or project particularly challenging. As two of those students noted:

- *Mostly the assignments. They were 10 hour assignments and we had to do it on our own, no checking with friends, validating the code. Going over and over a hash table on your own without validation made it really difficult.*
- *[It was challenging] because I proposed it and completed it all on my own without anyone else. I had to create the study; it wasn't created for me. It was more real for me.*

Open-ended projects. Three students (14%) noted the challenge in working through and completing projects that were open-ended. Two students explained:

- *Because the projects are really open-ended, you can do a lot of different things. It's really a challenge because you don't know what the project will be like in the end.*
- *Just the open-endedness of it, in terms of coming up with our processes and milestones. The instructor just let us go and do it. He gave us resources and information, but it was really up to us to decide what direction the project went and up to us to check up on our progress throughout the rest of the quarter.*
- **Other:** Two students each spoke about the following as significant challenges:
- **The challenge to explain your process.** *The process book was brilliant. It forced you to explain how you came upon your design decisions and helped set you up for your professional portfolio.*
- **Fast pace of course.** *There's a lot of information to know, and it went really fast. There was a lot of terms and concepts that built on each other. You couldn't just "learn" it, forget it, and move on to the next topic.*

Finally, three students gave the following individual responses as to why the course/project was challenging:

- **Minimal TA support**
- **Significant time commitment necessary**
- **Different process/goal in CSE course**. *I guess it was because it was very different than how I approached courses for that year. The INFO computer courses were very much trial and error. In CSE it was pretty much "did you get the right answer?" "No!" "Bummer." In INFO it was finding a problem and bugs, fixing it, and getting it right in the end.*

3. What enabled or helped students to meet those challenges?

The majority of students (15, 68%) identified two or more things that enabled them to meet the challenges they described. Three strong themes emerged from students' answers to this question, along with several minor themes and distinctive responses.

Putting the work in. The most frequently given response (36% or 8 students) to the question of what enabled or helped students meet the challenges they had described was their own willingness to put the necessary time into the class/project, including attending lecture, taking part in classroom discussion, and completing homework and readings. Some examples of this category of response include:

- *Probably willingness to put the time in to work it out. I guess just become really familiar with the language. Lack of understanding (Java) was holding me back.*
- *I also did a lot of reading in the literature about homelessness and homeless youth.*
- *It's a combination of the assigned readings, class lectures, and the clarifying questions with the professor or the TA.*
- *What I did was I forced myself to really put forth the effort. It was sheer determination that got me through the work. It was really about forcing myself to understand them.*

The opportunity to work with classmates. Seven students (32%) said that working closely with other classmates helped them to meet the challenges posed by the Informatics major. In their words:

- *Since it is a group project, I did a lot of discussion with teammates. We brainstormed about what we should do.*
- *Collaboration is your friend. Talking problems out and seeing how different people attacked the problem really helped.*
- *We set up weekly scrum meetings where we just briefly went over our progress and what our goals were for the week and how we planned to meet them. We also tried to send out many emails to inform each other of our progress throughout the week. By the end of the quarter we learned each other's strengths and weaknesses.*

Assuming the perspective of the user. Five students (23%) explained that they met the challenges they had described by learning to take on the perspective of the user and, in some instances, working directly with potential users and/or talking with people in industry. Two students stated:

- *Me and my partner talked about strategies to kind of reduce bias and make it more comfortable for our subjects to answer more truthfully, not give us answers they thought we wanted. Every couple of days we would have seminars with the other research groups and got some tips on how to better approach our different populations.*

- *We engage with our target users through co-design activities. We do a lot of iteration wireframing and prototyping.*

Faculty members, TA's, and/or industry guests: Four students (18%) commented that they met the challenges described with help from faculty members, TA's, and/or industry guests. In the words of two students:

- *I met with TAs and talked to [the instructor].*
- *Once our project was underway, we had constant feedback about where it was going and things like that. It was a useful resource to have [the instructor], TA and all the industry people that came to the class.*

Other: Two students each spoke about the following as helping them meet the challenges described:

- **Talked with friends/family with Informatics backgrounds.** *(I had friends that took the class before that shared some of their strategies to get through the course. A lot of those strategies were knowing where to look in the books or resources or helping me articulate the problems I was likely facing.)*
- **Used online resources.** *(If you Google your problem you will find your answer.)*

Finally, three students gave the following individual responses regarding help in meeting the challenges posed by activities in the Informatics major:

- **Becoming familiar with the programming language (Java).**
- **Visualizing techniques**. *Using the powerful tools they taught us to their fullest extent and relying upon visualizing problems as much as possible. On tests drawing things out, using Eclipse for visualizing in CSE 373, looking at debugging as a technique for learning the material rather than a process that hinders or frustrates you.*
- **Philosophical shift.** *I realized that there's "college world" and "real world." UW is a sky-island to the rest of the world. A degree is just a piece of paper, no offense. It's everything around it that makes a difference in the real world. I realized I needed to do things my way to make the most of my education.*

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

Finally, we asked students what they believed they had learned by completing the challenges they had described. Several themes emerged from their responses along with several idiosyncratic responses. Ten students (46%) noted more than one lesson learned as a result of their challenging project, class, or activity.

Technical skills. Forty-five percent of the students interviewed (10 of 22) said that they learned technical skills— including general coding skills (e.g., Python) and techniques in information architecture— as a result of completing the project/class/activity they had identified as their most challenging. The following five examples illustrate this category of response:

- *[I learned] how to code in a professional environment and how to go from simple text and graphical manipulation when programming.*

- *It definitely expanded my technical expertise in object-oriented programming and problem solving. Doing a piece-by-piece decomposition of a large problem translated into my other classes as well.*
- *[I learned] the foundations of computer networking, which allows me to further expand what I do with security from the networking and protocol perspectives.*
- *For 373, it kind of showed how complex programming can be. It further showed how much you can get coding to do for you if you really know what's going on underneath.*
- *[I learned] the skills and techniques in information architecture.*

How to work with others. Five (23%) interviewees noted that they learned how to work well with others to achieve a shared goal as well as gaining a greater appreciation for the benefits of the group process. In the words of two of these students:

- *It helped me a lot to talk about user interaction with my peers and it helped me understand that different dynamics in teammates is not a bad thing. I mean, that probably seems obvious, but well, it made for a better team.*
- *Working with a team in this kind of environment helped me learn better collaboration skills, not just with my team members but with the 14 other students and my professors. Learning how to collaborate in that context—it's different.*

Better understanding of the users' perspective. Eighteen percent (4 of 22) of students interviewed commented that they developed a better sense of design and learned how to look at things from the perspective of the user. In the words of two students:

- *I learned a lot about how to put myself in someone else's shoes, to focus on the user's needs, to get outside of my own needs so they can better use it. I learned a lot about user research.*
- *Recently, I learned how to make a mobile website, I learned how to co-design an activity, how to get a user to draw out their thinking.*

Professional skills. Four students (18%) explained that they gained professional skills including presentation skills, how to code in a professional environment, as well as how to work effectively with clients. As two of them said:

- *I am refining my soft skills by working with my teammates and our clients. I learned many technical skills that are applicable to jobs.*
- *I learned how to network and communicate well with senior leaders in the field, mostly through our weekly meetings presenting our findings. [I learned] how to properly communicate within the technical and business field.*

Two students each mentioned they had learned the following as a result of challenging projects, classes, or other activities:

- **How to narrow down ideas.** *Ideation is a huge one. Narrowing scope down to define an actual idea. In other classes you talk about scope but in this class you actually start with a really big idea and then narrow it down to something extremely specific and concrete.*

- **Perseverance.** *I definitely learned to overcome technical difficulties through sheer force of will--to not get stuck but force myself through. Other courses it just came to me, but with CSE you just had to force your way through it. Take a minute or a day off but come back to face that problem.*
- **What a career in the field is like.** *I learned a lot of things such as what it means to go for this profession in the future. I got a taste for what it is like.*
- **Working independently.** *I am used to working with others. It was satisfying to figure it out on my own, like the logic problems and breaking it apart. Mostly just working independently.*

Finally, one student said:

> *There's only 24 hours a day and you only need 4 hours a day. I come in at 9 in the morning and leave here by 3 a.m.*

SUMMARY

When asked about their greatest challenges in the major, students' commonly mentioned courses that they had taken with approximately one-half citing Informatics courses and one-third mentioning a single computer science course, CSE 373. Informatics courses mentioned by students varied widely and included the following challenges: working on collaborative code, programming and "technical issues," as well as the challenge of working on real-world problems.

Students explained that CSE 373 was challenging because it was significantly more "math-based" than Informatics courses and "there's very much a right answer and very much not a right answer," unlike Informatics courses, which tend to be more open-ended.

Across classes, participants noted that learning new concepts, particularly those required to understand and implement code, made these classes challenging. Students also discussed being required to think "outside the box" and learn new technology as challenging aspects of courses.

Another strong theme underlying students' responses were the challenges involved in conducting applied research including both taking the perspective of the user as well as working directly with the user to gain a greater understanding of her/his perspective. As one participant said:

> *Just the ways to solve the problem. We came up with a bunch of ideas but none of them were good. First you had to figure out what it means to teach a person and then how do you teach someone who is blind since so much of teaching is pointing and other visual cues. The coding wasn't that difficult, just the abstract thinking.*

Moreover, one-quarter of participants explained that working together with classmates on a group project was a challenge because of varying group dynamics and the need to make sure all group members knew their roles and were motivated to completed their tasks.

When asked what they did or learned that enabled them to meet the challenges discussed above, students most often noted the willingness to put the necessary time into the class including attending lecture, taking part in classroom discussion, and completing the requisite homework and readings. Working closely with classmates was also mentioned by students as helping them to succeed by giving them the opportunity to bounce ideas off one another and see multiple ways of solving problems. In the words of one student:

Collaboration is your friend. Talking problems out and seeing how different people attacked the problem really helped.

In addition, one-quarter of students said that the ability to assume the perspective of the user was particularly vital to success in the major.

When asked what they had learned from meeting the challenges they had described, students most commonly cited technical skills (e.g., coding, principles of information architecture), followed by the ability to work effectively with others, perspective-taking skills, and professional skills (e.g., presentation, networking skills).

The number of students interviewed for the UW ACES study was fairly small; however, their responses largely reflect the goals of the Informatics major, which aim to creative innovation at the intersection of technology and human values. The challenge to learn new technologies and better understand the perspective of the user were two major themes that ran throughout the student interviews. By and large, students' responses to the interview questions suggest that Informatics students found the challenges engaging and felt a sense of accomplishment upon meeting those challenges. These findings are consistent with research on student learning that shows challenging coursework engages students and leads to more learning than easy coursework.

One Student's Responses to All Four Questions

Course where greatest challenges occurred: INFO 461: "Cooperative Software"

Q1. What was the most challenging work you did? *It was actually in the cooperative software course, INFO 461. It was first time I had to collaborate over code with Bitbucket. It was a real world experience where everyone could work on the same code at the same time, which caused delays I didn't expect. I didn't know some of the techniques that some of the other students had so I wished that I had taken some classes in INFO before then. All in all though it was great experience.*

Q2. Why was it challenging? *Making sure that everyone knew their roles in the project and could complete the project within the time given to them. It was also important to understand their work techniques and know their strengths and weaknesses.*

Q3. What helped you meet that challenge? *We set up weekly scrum meetings where we just briefly went over our progress and what our goals were for the week and how we planned to meet them. We also tried to send out as many emails out to inform each other of our progress throughout the week. By the end of the quarter we learned each other's strengths and weaknesses.*

Q4. What did you learn by meeting that challenge? *We learned how to handle sending out assignments were best suited for certain individuals. Collaboration on one giant file is a LOT harder than it seems. It requires a lot of work and a lot of stress but when all the various pieces come together you have a product you can be proud of.*

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