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How do resources at UC Davis prepare CS students for careers in CS?

Introduction:

Despite holding prestigious computer science (CS) degrees from their universities, computer science undergraduates still experience elevated levels of unemployment soon after graduation. According to a study done in 2014 by M. Teitelbaum, there was 7.8% unemployment among recent CS graduates and 11.7% unemployment among recent information systems graduates. The elevated unemployment rate is similar to other recent college graduates in 2012 (Roksa 9). Additionally, the elevated unemployment rate among CS graduates is anywhere from 1-4 percentage points higher than the national unemployment rate in 2014 (*Bureau*). Even if CS graduates' unemployment rate is only a few percentage points higher than the national average at the time, a few percentage points of the population of recent CS graduates encompasses several thousand recent graduates each year and the elevated unemployment level still represents an anomaly. More and more employers in the technology industry see CS graduates as woefully unprepared for the workplace. In a survey conducted in 2015 by the Chronicle for Higher Education and Marketplace, nearly one third of employers said that recent graduates lacked basic workplace skills. A separate Washington Post article explained what the missing skills were, which included coding, data analysis, problem solving, and communication skills (Lawrence-Fowler). In light of this nationwide trend of CS students being unprepared for the industry, I

wanted to find out how the University of California (UC) Davis CS campus resources (curriculum, etc) affect CS students' career confidence/success.

In general, college students appear to know little about what they need to do to prepare themselves for life after college. According to a study conducted by Wang Qianli in China, many Chinese students either are unmotivated to learn about career preparation or are unaware how to prepare for their careers. CS students may learn all about the principles and theories underlying CS itself, perhaps they may not sufficiently be taught how to do things like what to say in an interview or how to organize a project schedule. These are transferable skills that, while not specific in CS, are essential for preparing them for the industry. Even for CS-specific industry-related topics, CS students appear to not be interested. According to a 2009 study of CS undergraduate students in Finland, most were uninterested in many positions such as database specialists and application designers. Only two positions interested the majority of the students: project manager and systems designer. The same Finnish paper also notes a lack of motivation among CS undergraduate students to complete their degrees because of the perceived uselessness of CS classes and the lack of awareness of career opportunities in CS (Vesisenaho).

Rybarczyk and Acheson modified an existing CS course at Purdue University in an attempt to get students to better understand certain hard skills needed to succeed in the workplace. Normally, the CS2 course at Purdue teaches two programming languages: C++ and Java, with one being taught fully before the next. For the modified CS2 course, Rybarczyk and Acheson taught both languages side-by-side. The purpose of teaching both languages at once is so CS students have a better understanding of the semantics of each language and when to use each language (Rybarczyk). In this regard, the authors believe mainly that students lack hard skills not because the University did not teach them those hard skills, but because they were not

taught in a way to better understand how to apply those hard skills. Purdue's CS2 course, according to the authors, incentivized students to focus too much on learning the syntax of each programming language rather than understanding how to apply the similar tools found in each language to solve problems. Of course, a baseline for CS students to succeed in their jobs is to understand how to use the tools necessary to design and develop projects. My research may help CS teachers assess whether Davis curriculum needs to change so that students understand what are the important things to take away from the course rather than focus on things that are less important, such as syntax.

Other professors, such as Rosanne English and others in "Improving Computer Science Student Graduate Skills Through Assessment[.]" argue that, rather, the reason CS students struggle after graduation is because they lack transferable skills. Their one-pager compiled self-reported graduation goals by several universities in the UK and the authors identified three skills that were mentioned the most: global citizenship, the ability to adapt, and critical thinking (English). The logic behind universities identifying these traits as most important for their CS graduates to have is likely because each workplace environment demands something different out of their employees. Amazon most likely uses different programming languages, different databases, different SDKs, etc, compared to other companies like Apple, Google, etc. In my opinion, learning what hard skills are necessary for the companies you apply to is still important, but I agree that learning basic workplace skills such as learning to work with all kinds of people and adapting to unexpected situations is not only important to securing a job, but also important to applying the hard skills learned in college to an entirely new environment. English argues that colleges are not doing enough to teach their students what the workplace environment is like and

what companies demand vs what is taught in the lecture hall. Ways to make up for this deficiency include introducing more experiential learning, such as labs and internships.

I plan to see if UC Davis also faces similar challenges preparing students attending Davis for careers, if such unpreparedness is so widespread. Not only will I ask students if they possess certain skills necessary for the workplace, but I will also ask them if they feel that certain campus resources are helpful for career preparation. This way I can see what needs to be changed on campus.

Methodology:

To conduct my primary research, I surveyed UC Davis senior undergraduates, graduate students, and alumni. I distributed this survey by posting the link on the senior, grad student, and alumni text channels in the Davis ECS Discord. My survey contains a mix of demographic, Likert, and open-ended questions. The demographic questions contain typical demographic inquiries such as “[what] gender are you” and “[are] you a CS or Computer Science and Engineering (CSE) major” to see if identity affects which resources students choose to use. After getting a sense of their background, I ask several Likert questions that contain statements about how prepared they are to do X thing. For example, I ask them to rate how much they agree with a certain statement on a scale of 1 to 5 (1 for strongly disagree, 5 for strongly agree). One such statement includes “I know what to say in a job interview.” Additionally, I also ask them Likert-scale questions about how much they utilize major advising, career advising, clubs, seminars, etc. Open-ended questions are included as a separate section at the end of my survey, completely optional from the rest of the survey. While I collected many data points from my Likert-scale questions, the open-ended questions are an opportunity for me to gain insight into why the

respondents responded in the way they did to the survey. One of the questions I asked, for example, asked what kind of advice they may have received from alumni, upperclassmen, and/or faculty. A Likert-scale question in my survey already asks how often they receive such advice, but I do not know what advice the respondent received, and I want to know how helpful that advice ended up being to prepare them for their job. Long-answer questions are a great opportunity for me to fill in the gaps not captured by a 5-tier Likert-scale questionnaire.

My secondary research will mainly focus on what skills are needed to pursue successful careers in CS in addition to collecting data from other studies that discuss newly grads' preparedness for the CS industry in the United States as a whole. I identified two databases that host several papers that already concern the career preparedness of CS graduates from American universities: the Institute of Electrical and Electronics Engineers (IEEE), and the Association for Computing Machinery (ACM). Additionally, I utilized UC Davis's Computer Science Research Guide to find more databases and journals that discuss the career skills that CS students need to succeed. When the Research Guide was insufficient for my secondary research, I used UC Davis's Discovery System to search papers using keywords such as "computer science students career skills." The Discovery System also has links to other academic paper searching sites such as Worldcat and Google Scholar that I can use if I find a comprehensive paper the UC system does not own.

Results:

I managed to get 3 responses by the time I am writing this section.

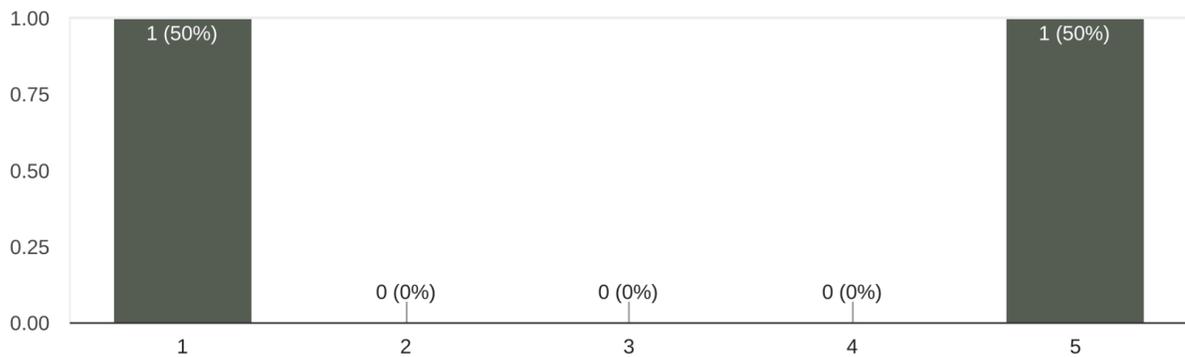
For demographics, I got responses from two 22-year-olds and one 24-year-old, all male. 2 of the respondents were Asian, the last respondent was White. Interestingly, I had 2 international students on student visas answer my survey. Everyone was comfortable with communicating in

English. One of the respondents was already employed as a cyber research intern. One respondent was a CSE major, the rest were CS majors. There was one CS major who switched majors to CS in their first year. One respondent was a University Honors Program (UHP) member.

Two of the respondents had prior experience in CS prior to entering university, albeit with varying levels of experience (1 for little experience, 5 for very experienced).

Rate your experience in CS prior to entering UC Davis.

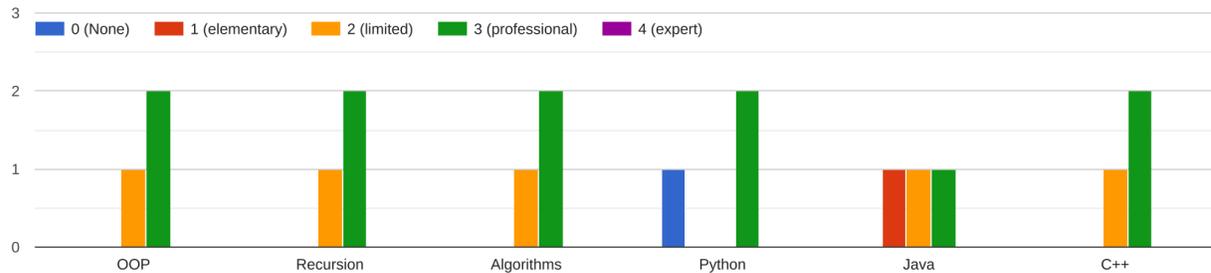
2 responses



For the questions related to what hard and soft skills my respondents already possessed, I grouped the survey questions into several categories: coding hard skills, non-coding hard skills, and workplace soft skills.

In general, the respondents were comfortable with their coding hard skills, with most respondents having a professional understanding of most of the programming-related skills below.

Rate your proficiency in these skills:

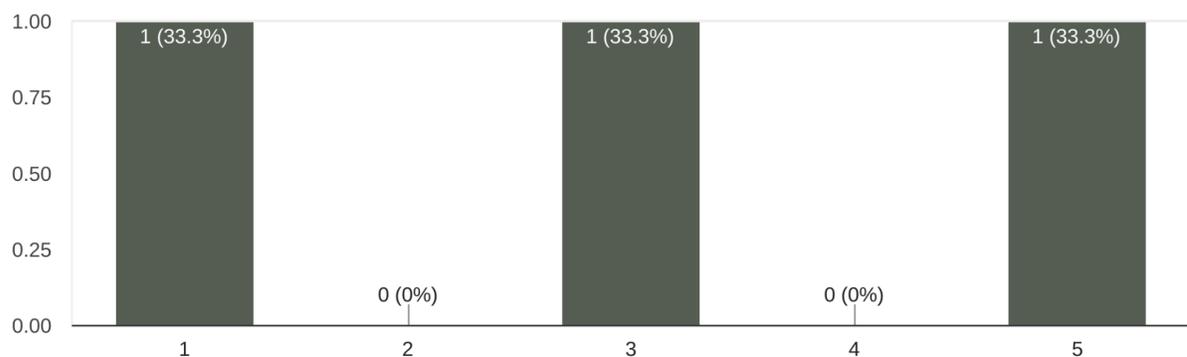


As for non-coding hard skills, there were mixed responses as to how confident they were in applying hard skills that were not necessarily related to programming itself. For example, there were mixed responses about how comfortable the respondents were when solving LeetCode problems, knowing when to use each language, and knowing what development tools specific places of employment use.

As a reminder, the respondents answered these questions using a Likert scale from 1 to 5. They answered how much they agreed to the following statements (1 for strongly disagree, 5 for strongly agree).

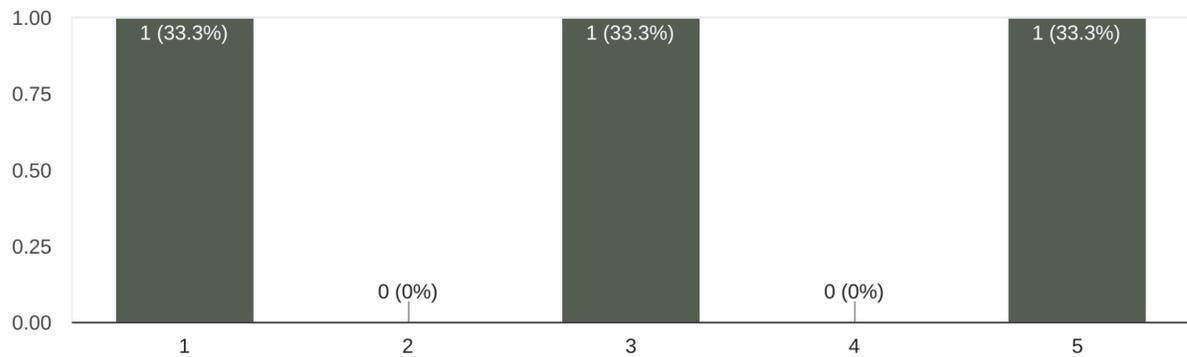
I am comfortable solving LeetCode problems.

3 responses



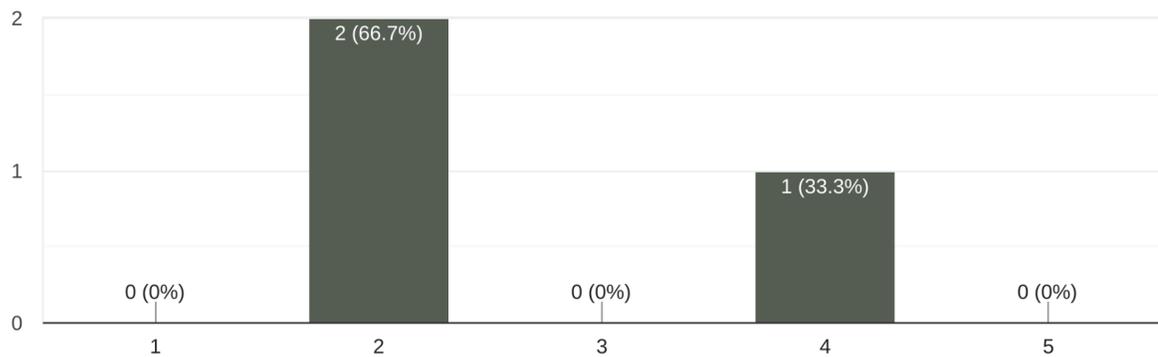
I know what programming language is best to use in a certain situation.

3 responses



I know what development tools specific places of employment use.

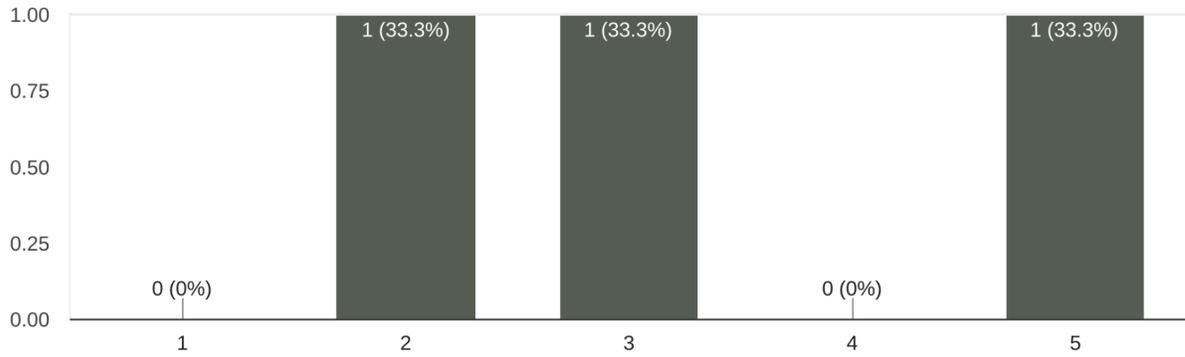
3 responses



However, the respondents were generally confident in their workplace soft skills, such as their communication skills, their ability to work with all kinds of people, and their ability to adapt to a situation where their job is threatened by innovations in the technology industry.

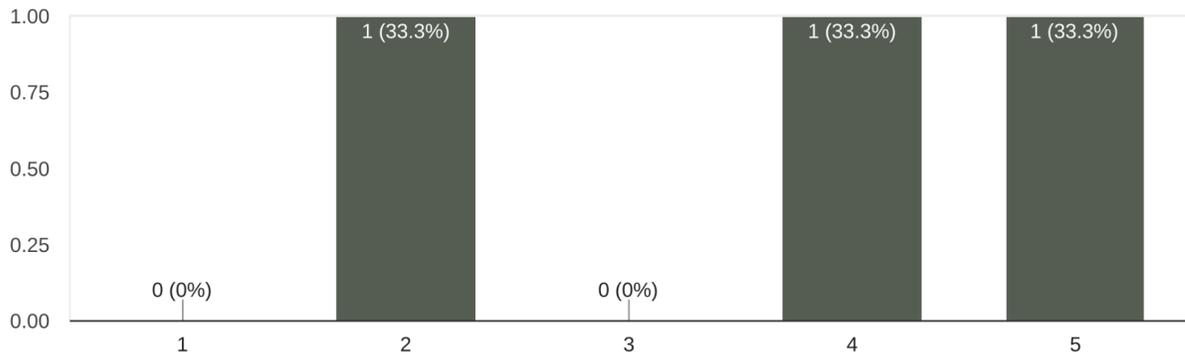
I have strong communication skills.

3 responses



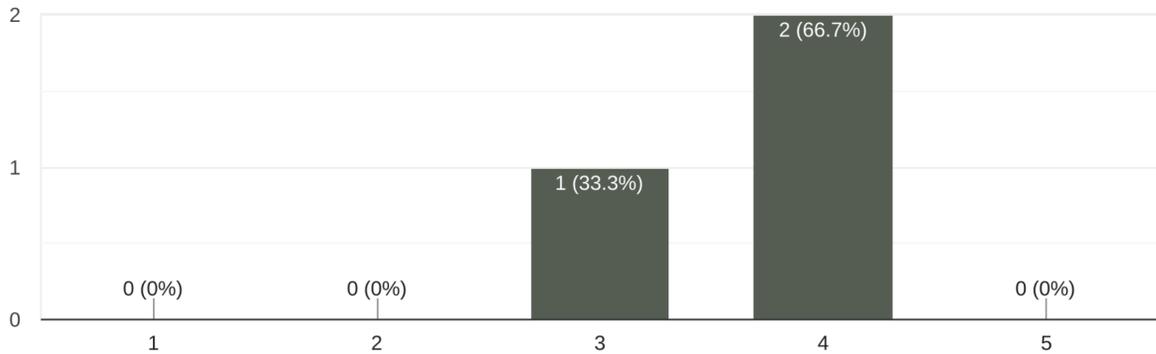
I can work with all kinds of people.

3 responses



If new technology is threatening my job, I can adapt to and learn how to use the new technology.

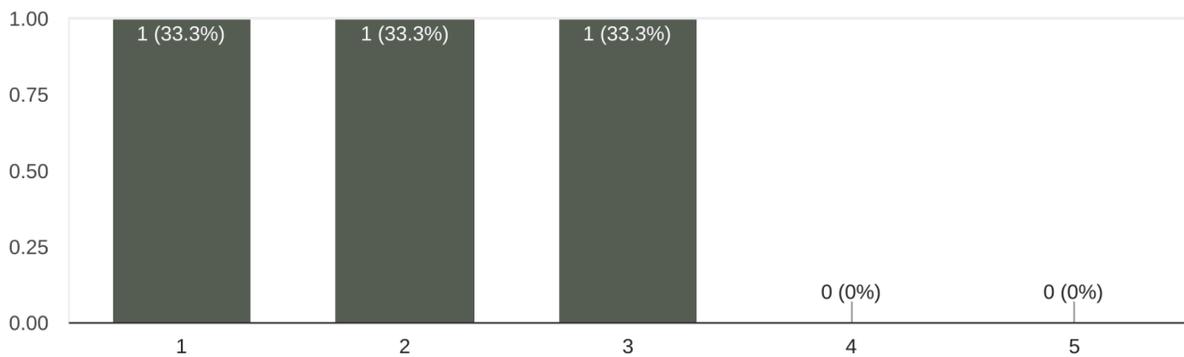
3 responses



There were notable exceptions to this trend, however. Namely, the respondents were not confident in their networking skills, their knowledge in what to say during a job interview, and their job-hunting skills.

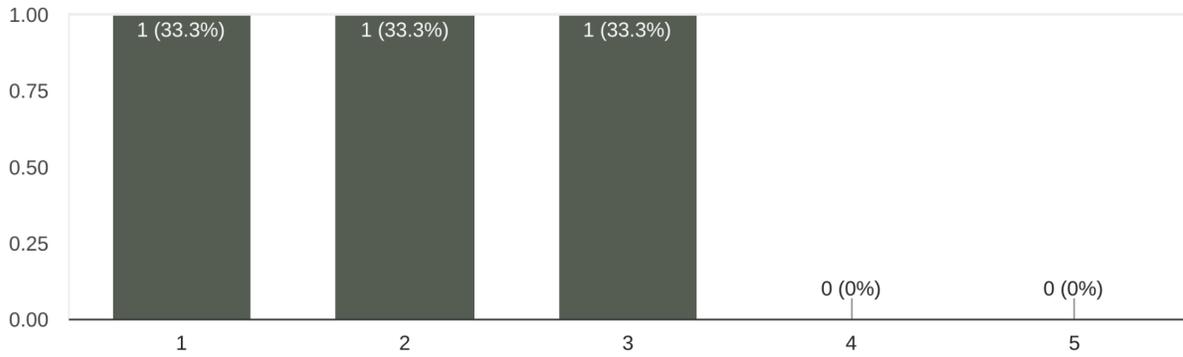
I know how to build my network in the workplace.

3 responses



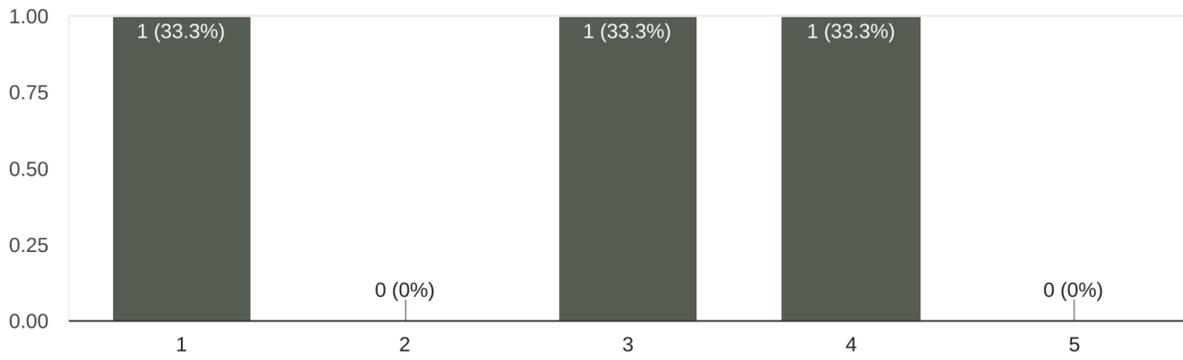
I know what to say in a job interview.

3 responses



I have strong job-hunting skills.

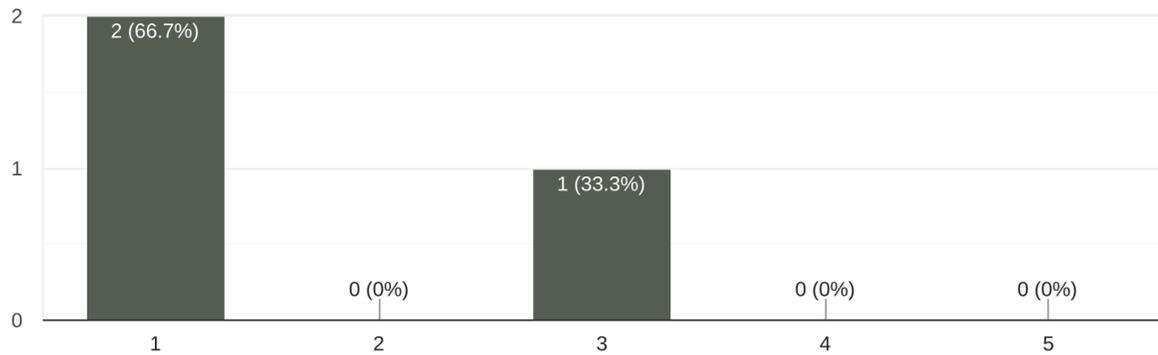
3 responses



As an aside, one of the questions asked during this Likert-scale section of the survey was how optimistic the respondents were in getting a job after graduation. The responses were mostly pessimistic.

I am confident that I can send my resume to employers after graduation and get a job in a reasonable timeframe.

3 responses

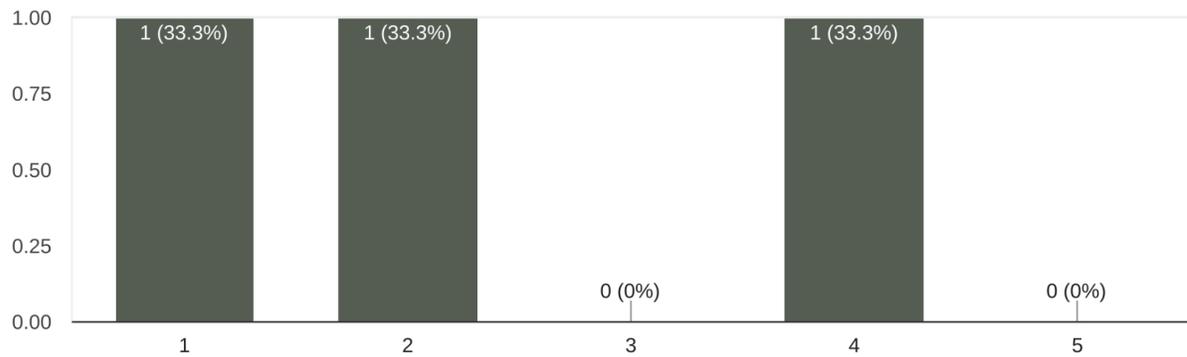


As for the section of the survey that asked which resources did the respondents use/find most helpful, the general pattern was that the respondents rarely used the campus resources I listed for their career preparation and found a few of those resources to not be that helpful. For example, the respondents did not use the Internship and Career Center (ICC) nor career advising that often, and their senior design projects did not appear to help them that much in their career preparation.

For how often a certain resource was used, an answer of “1” represents “rarely used” and “5” represents “often used.”

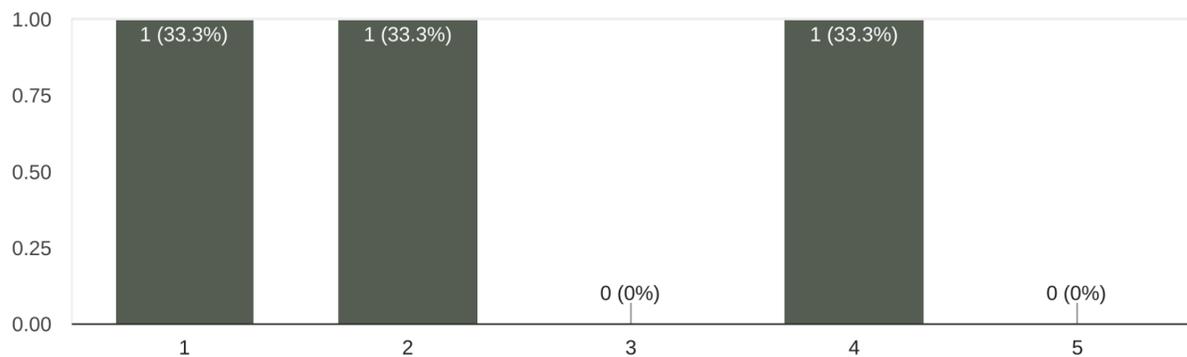
How often did you use the resources at the Internship and Career center?

3 responses



How often did you use career advising?

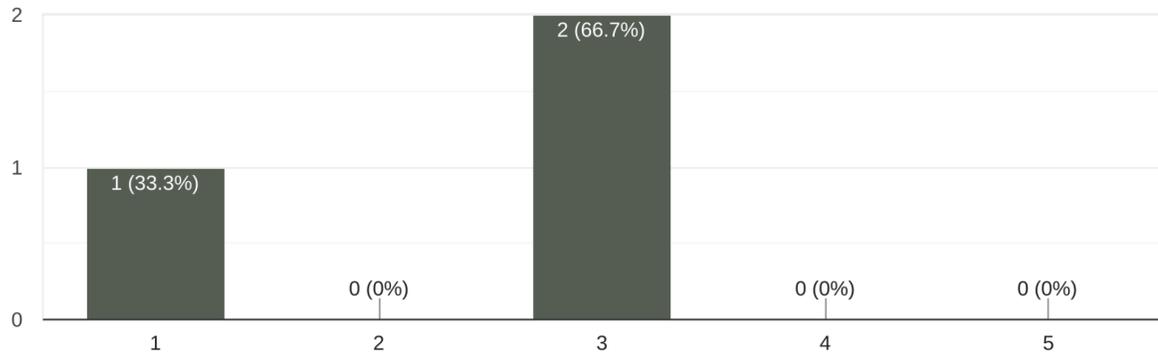
3 responses



For the questions that asked how helpful a certain resource was, an answer of “1” represents “not helpful” and “5” represents “very helpful.”

How helpful was your senior thesis/capstone project/design project in preparing you for a CS job?

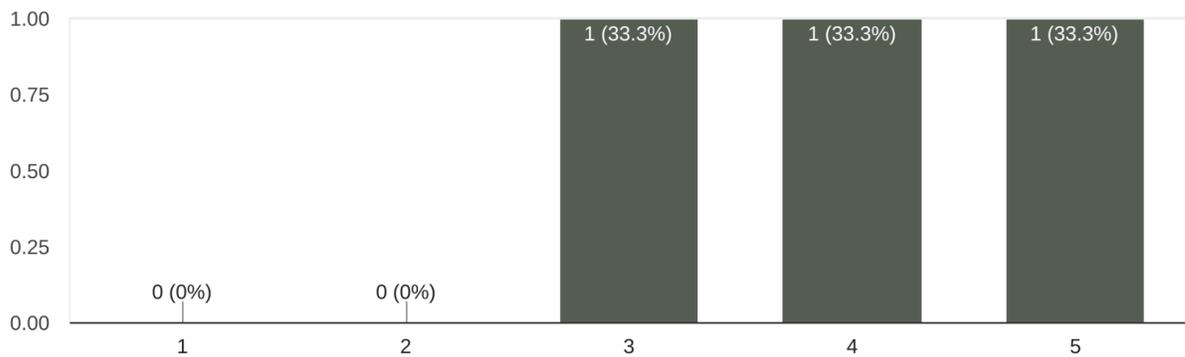
3 responses



Two notable exceptions to this trend in resource usage was the usage of clubs and online servers. These resources were more widely used than the rest I asked about.

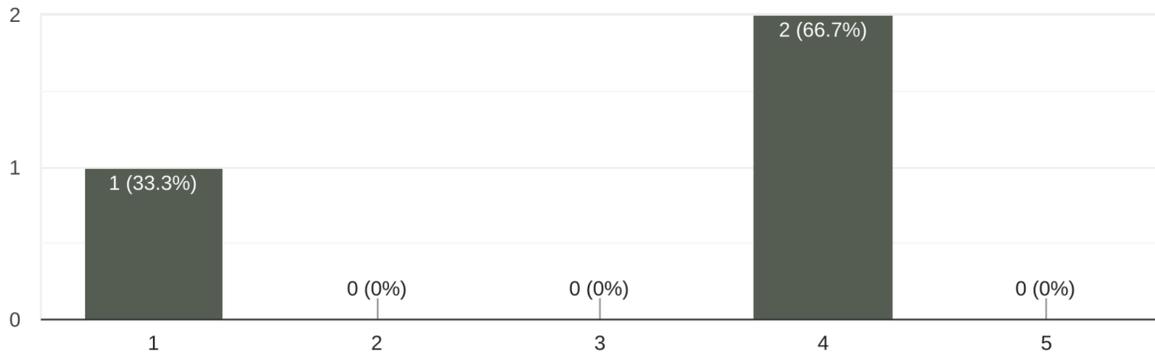
How often did you participate in clubs?

3 responses



How often do you utilize CS-related online servers?

3 responses



As for responses to the open-ended questions, I got one response from a respondent describing their problem solving process. To paraphrase, that respondent breaks down problems into pieces and recursively breaks those pieces down into simpler pieces until the problems are simple to solve.

As for clubs participated, one respondent described two clubs they attended while they were a UC Davis student. One club was the Dungeons and Dragons (DND) DND club, and the other was the Game Design and Arts Club (GDAC). According to the respondent, the DND club made them more personable, while the GDAC improved their programming skills for game design.

Interestingly, one respondent, in their open-ended responses, said the Internship and Career Center did not help them prepare for a CS job. According to the respondent, while the ICC gave them advice for resumes and interviews, the respondent later realized that advice was “bad and worthless.”

All three respondents responded to the open-ended question that asked what changes they would make to the CS/CSE curriculum. One respondent didn’t want to change all that much

except for introducing more classes. Another respondent wanted to add “[more] practical classes like ECS [162.]” The last respondent wanted to make internships and resources more accessible and advertised because “that’s all that matters when job [hunting.]”

I only got one response to the question that asked what advice the respondent would give to a 1st year student who wants to enter the industry. To paraphrase, the respondent emphasized the need to find an internship/part time job ASAP and to fight for the permission to get class credit from that job.

Discussion Of Findings

The results discussed here are subject to several issues. One issue is that I only got three responses, a far cry from the thousands of Davis CS seniors, graduate students, and alumni, so I cannot say that this is a representative sample of how everyone who held bachelor’s in CS from Davis feels about how well the University prepared them for a job.

I first want to cover the patterns I noticed between each section of the survey across all the respondents before moving on to how the answers in the Resources section of the survey may have influenced the answers in the Skills section of the survey. After that, I will analyze what the open-ended answers say about the respondents and how well UC Davis prepares them for a career. Then, I will go over how the demographics of the respondents may have influenced what resources they reached out. Finally, I will go over future opportunities for further research.

For the answers in the Skills section of the survey, it appears that the respondents were confident in their workplace skills. Perhaps they had opportunities during their time at UC Davis to experience what a workplace environment is like, or maybe the classroom environment is enough for them to practice their soft skills. This is interesting because the Lawrence-Fowler article says that American C.S students typically lack these kinds of soft skills. I wonder what

UC Davis does differently so that these students are better practiced in their soft skills compared to students from other universities. Maybe there is a difference between one's self-reported confidence in a soft skill and one's actual proficiency in a soft skill. As mentioned in the Results section, these respondents said they were confident in skills such as communication, working with all kinds of people, and explaining their work to others. However, because I only was able to get three respondents, maybe I happened to get responses from three CS students who happened to actually have a good handle of soft skills and maybe I missed the majority of CS students who do not have a good handle of soft skills.

However, their proficiency in some soft skills may not be enough to make up for the deficiency in other crucial soft skills. Concerningly, the respondents appeared to be less confident in their interview skills, for example. Job interview skills are unique to the life after college, compared to other skills which could already be practiced in a classroom environment, like communication and making a schedule. Maybe these respondents practiced certain skills that could be transferred to a job but did not receive specific career training that could prepare them for the unique hurdles that they would face when finding a job. 2 out of the 3 respondents I interviewed were currently unemployed. Is this because they lack certain skills more essential to a career, or is it because they are newly graduated? This relates to my respondents' answer to how soon they can find a job. Are they pessimistic about their prospects because they feel like they don't possess the skills necessary for a job? Maybe their resumes are not very strong because they were busy with college work and didn't have time to add experiences? Or maybe they have other commitments after college and cannot find a job. The answers to the questions related to finding a job and their employment status may be due to other factors.

Based on these answers, the respondents seem to have a good grasp on soft skills needed in the workplace, however they do not appear to be completely prepared for a job.

Now onto the hard skills. The programming hard skills I asked about included OOP, algorithms, and several popular programming languages. In general, the respondents had a good grasp on these coding skills. This probably means that classes are teaching these topics effectively and there appears to be no issue with getting students to understand the basics of CS.

However, the non-coding hard skills appeared to be lacking in my respondents. Even if the respondents knew how to code in Java, Python, and C++ for example, the general feeling was that my respondents didn't know which language to use in certain situations. What's the point of learning a programming language if you don't know how to use it? Maybe, like what Rybarczyk identified in the Purdue study, students are too focused on learning the syntax of the language in CS classrooms rather than understanding why people use the language in the first place. That way, when students build their toolbelt for their careers by learning new languages, they know how to use the tools in their toolbelt.

Additionally, another deficiency that concerned me was that these respondents did not appear to be entirely confident in solving LeetCode problems. LeetCode is an application used during job interviews to determine if the applicant possessed the necessary hard skills to be employed. Basically, you solve programming problems on their platform. These respondents may struggle to even pass interviews if they aren't confident in solving LeetCode problems. However, maybe it is because that LeetCode problems can vary in difficulty is the reason why my respondents aren't confident in solving LeetCode problems. Regardless, this lack of confidence is indicative of the fact that my respondents have not been practicing on LeetCode as

much as they should. Perhaps Davis does not offer resources that help students better solve programming problems such as those found on LeetCode.

Another point that also concerns me is that students do not appear to know what developmental tools places of employment use. However, maybe it's because these tools are only taught at that place of employment because of licensing issues that may prevent UC Davis from training students in these tools. Alternatively, this unawareness of what developmental tools places of employment use could mean that my respondents were not researching where they would apply for a job. Maybe this is a deficiency the university's career resources can fix.

Next, onto the resources utilized for the respondents' career preparation. The respondents used most of the campus resources listed rarely, with the exception of clubs and online servers. Do these respondents not use these resources because they were unaware that these resources were available? Perhaps they thought these resources were not helpful for them? Maybe they did not have time to use these resources often? Despite everything UC Davis has to offer for CS students, it appears that CS students do not take advantage of these resources. Perhaps the reason that they lack certain hard skills is because they do not take advantage of the resources available to them.

Onto analyzing my respondents' long answer questions, only one of the respondents told me what their problem solving process was. Maybe this was because the long answer questions were not required, or this could mean that the other respondents do not have a system in place to solve problems. The CS industry demands good problem solving skills from its employees because the CS industry is constantly building and maintaining new products and innovations. To only see one respondent have a problem solving process is concerning. I wonder if the other respondents would struggle with their first jobs after graduation.

As for the questions about the clubs, one respondent said that the two clubs they joined (the DND club and GDAC) strengthened both their soft and hard skills. One of the resources all the respondents appeared to use more often was clubs. Based on this answer, clubs appear to be integral to building hard and soft skills necessary for the workplace, and UC Davis should support CS clubs because many students rely on clubs for their career preparation.

Concerningly, one respondent said the resources at the ICC were not helpful for their career preparation. UC Davis should perhaps look into how helpful the ICC actually is to prepare students because this respondent said the advice they received there was actually useless.

As for changes that the respondents would like to make to the CS curriculum, 2 respondents wanted to make changes to the classes offered. One respondent wanted more classes, and another wanted more practical classes. I interpreted both responses as wanting classes that were more related to what employers expect out of applicants, and perhaps more classes that explore more about CS. Perhaps the University should give more funding to the CS department to offer more courses so that students are better prepared for life after college.

One respondent wanted the University to make internships and part-time jobs more available and advertised more widely, for reasons I will explain below.

Only one respondent gave what kind of advice they would give to a 1st-year who wanted to enter the industry. The advice basically boiled down to finding employment ASAP. Employment, as explained by the Lawrence-Fowler article, is a great means of experiential learning that can impart essential career skills onto those who are employed during their time in college. I suppose that respondent knew how valuable those experiences would be when finding a job. Additionally, those experiences are things you can put on a resume. However, I wonder if CS student have the time to intern/work during their time at Davis. Like what this respondent

said on changes they would make to the curriculum, Davis should probably make internships and employment more widely available, perhaps through advertising and working with employers.

As for how demographics affected how the respondents responded, I didn't get enough data points to make too many conclusions.

Future opportunities for this research is surveying more respondents than I was able to and perhaps asking whether students possess certain CS-related hard skills I am unaware of as a 1st-year CS student. Maybe we can also see how effective the ICC specifically is in preparing CS students for a job. Another area of research is seeing which clubs at UC Davis are most helpful for CS career preparation.

Limitations of this research obviously included that I only have 10 weeks to learn how to conduct such a project, get data, and make this paper. Someone with more time may be able to create a more sophisticated study. Additionally, the way I got this survey out was through the ECS Discord, a server whose activity I greatly overestimated, so I did not get many responses. Perhaps someone with more access to all the UC Davis CS students could get more representative responses and data points.

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