Discovering Factors Affecting Student Retention in Computer Science at Cal Poly

A Senior Project

presented to

the Faculty of the Liberal Arts and Engineering Studies Department

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of the Requirements for the Degree

Bachelor of Arts

by

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Introduction

Cal Poly's Computer Science program is known to be a rigorous, challenging, and rewarding program, attracting some of the brightest students who become very sought after by industry. According to most recent Graduate Status Report, all of those who had responded to the report's survey and had been seeking full-time employment did receive and accept offers. Several of those graduates earned six-figure salaries right after graduation. In addition to the impressive employment rate of Cal Poly's graduates, students also chose to pursue a M.S. or Ph.D. in Computer Science. However, even though the program is held in high regard and its graduates are successful, the program does not necessarily provide the best student experience it could be providing.

A student retention issue is very apparent in the Computer Science program at Cal Poly. The following data was acquired through a current professor at Cal Poly (Anonymous, personal communication, May 20, 2015). From the 2008 cohort, less than half of the students completed or continued their degree after 6 years. More than half of the students were either disqualified or chose to discontinue their education at Cal Poly. The original cohort consisted of 90 students, but after 15 left the major and 19 joined the major, the adjusted cohort consisted of 94. Out of these 94 students, 40% graduated after 6 years, 3.6% were still enrolled, 24.5% discontinued, and 31.9% were disqualified. This drastic statistic causes questions to be raised. Why have 3.6% still not graduated within 6 years, when according to the university's curriculum flowchart, the Computer Science BS is supposed to be a four year program? Why have 24.5% of the students decided to discontinue their major? I personally know students who were employed as full-time developers at large tech companies without finishing their Cal Poly degree, but it would be foolish to assume that all 24.5% of these students are in the same situation. Why did 15 students

leave the major? Why did 19 students join the major? There is much research to be done, but the focus of my senior project is to look at the factors that cause student experiences to be suboptimal, and cause students to leave the major to another major within the College of Engineering, leave to a major outside of the College of Engineering, or leave Cal Poly entirely.

The Computer Science Department at Cal Poly has made great efforts in improving retention and the overall student experience. In my project interviews, students note positive, personal relationships with professors who have encouraged them throughout their college career. With 40 faculty members listed on the Computer Science website, Cal Poly's students are privileged with an impressive faculty to student ratio. In addition to the supportive faculty members, programs have also been created to benefit the student experience. For example, WISH was founded in 2007 by Cal Poly students and faculty within the Computer Science department with the goals of providing a sense of community and support for females, and closing the gender gap in Computer Science. Faculty members are involved in advising the club, as well as attending club events. One of the most well-known club involvements is the now annual trip to the Grace Hopper Celebration of Women in Computing, at which Cal Poly SLO was noted in the top ten number of attendees in 2014. The gender gap has decreased over the past several years, yet a discrepancy still exists between the number of male and female students as indicated by the most recent Graduate Status Report, in which of the 32 respondents only 2 were female. It would have been interesting to include in my senior project data on students who graduated from the Computer Science program five years ago, shortly after the founding of WISH, or ten years ago, before WISH was in existence. Due to the timeline and scope of my project, I did not pursue this research, and instead focused on current issues students are facing,

but it may be useful to track what issues are being resolved by responses to them, and what new issues have arisen.

Although I am graduating as a Liberal Arts and Engineering Studies major, I began my college career in Computer Science. I chose Computer Science after taking AP Computer Science, as well as receiving the NCWIT Award for Aspirations in Computing, my senior year of high school. I was fortunate to grow up in the Bay Area, California, where I was taught fundamental programming concepts as early as first grade with PC Logo, and in middle school, Pascal. I loved playing with web development in my spare time, eventually exploring app development the summer before my college experience began. I excelled my first year at Cal Poly, receiving A's and B's in my Computer Science courses. However, I began to struggle my second year, and ultimately found myself on Academic Probation rather consistently my junior year, although I was just .003 below the threshold GPA. I was involved in Women in Software and Hardware, worked hard, excelled at software development internships, and spent countless hours in the library and in the Computer Science Lab. Something wasn't going right, despite my interests in software development and computer science. After changing my major to Liberal Arts and Engineering Studies with concentrations in Software Engineering and Psychology at the end of my junior year in college, I began excelling in school again and found myself on Dean's List every quarter. With the psychology courses I was taking, I began to ask questions about my college experience. I became interested in research methods, which inspired me to critically analyze my own experiences and ultimately led me to choose a descriptive research project as my senior project.

The research question I asked was, "What factors contribute to the retention rate of Computer Science students at Cal Poly?" From my personal experience as a former Computer

Science student, as well as my findings from literature, I hypothesized that spotlighting issues, self-efficacy issues, and perhaps even false interest issues were at the root of the retention flaws in Computer Science at Cal Poly. Spotlighting is the phenomenon which occurs when certain groups receive unwanted pressure and attention as an unintended consequence of efforts presented to encourage members of that group. With the prevalence of WISH, and Cal Poly's ability to send many female students to Grace Hopper, I believed that some female students experienced unwanted pressure and backlash from these offered opportunities. Self-efficacy was another issue I hypothesized to be affecting all students. There is little professor-student interaction and encouragement, which potentially affects the level at which students feel like they can be successful in the Computer Science program. Lastly, I also thought of the possibility that perhaps many students come into Computer Science and experience the field differently from how they were expecting, and decide that computer science is not of interest to them. This would then mean the issue is in recruiting the wrong students, rather than a failure to recruit the right students.

Deliverables

The most immediate deliverable of my senior project is the discovery of issues students face in the Computer Science program at Cal Poly. From the assessment through surveys, interviews, and other observations, the majority of student hardships can be summarized under the categories of orientation needs, spotlighting, imposter syndrome, maintaining big-picture interest, tutoring center needs, office hour attendance, non-collaboration policy issues, and the need for a sense of community. There are also student issues which are not under the control of the Computer Science Department, such as registration issues and the requirement for students to choose their major upon applying to Cal Poly. Additionally, the questions I developed for my

surveys and interviews are also deliverables which may be reused in the future to conduct further assessment of the condition of Computer Science students, or to track improvement of the student experience.

The deliverables of my project are summarized in my main deliverable, the presentation to the Computer Science Department on May 27th, 2015. It was a 20 minute presentation during which I presented my research findings on what issues students are experiencing within the Computer Science program, along with ways to improve them, as shown in the slide below. I only discussed the retention issues that I felt were the most urgent and feasible. This included orientation needs, spotlighting, imposter syndrome, maintaining big-picture interest, tutoring center needs, office hour attendance, non-collaboration policy issues, and the need for a sense of community. I also included my findings on what professors are doing right, like small words of encouragement and being willing to answer questions.

Successes	There's a lot going right! Keep encouraging students!
Orientation Needs	Let students know it's okay to not know.
Spotlighting & Imposter Syndrome	Build student confidence. Don't encourage negativity.
Maintaining Big-Picture Interest	Reminders or anecdotes that relate material to industry.
Tutoring Center/Office Hours	Be the first to reach out and establish a relationship.
Non-Collaboration Policy	Reconsider, or be sure to clearly outline the policy.
Sense of Community	Encourage social activities including all students.

Literature Review & Background Research

In my literature review, I came across a variety of issues which Computer Science students face, both generally and at the undergraduate level. There are also resources available online, especially from the National Center for Women and Information Technology (NCWIT), which offer suggestions, tips, and course materials which may help improve student experiences

in the classroom. NCWIT suggests that inclusive pedagogy helps with student retention, in the sense that collaborative work and small-group discussions open the opportunity for students to be valued and learn from one another (Barker). NCWIT also stresses the importance of encouraging all students, minimizing stereotype threat, and connecting students to social support networks, which is listed in NCWIT's "Top 10 Ways to Engage Underrepresented Students."

In my literature review, there also seemed to be a general emphasis on first-year programs at universities. Cal Poly's example of this may be the introductory CPE 123 course. Research suggests many first-year programs such as "well-designed and implemented orientation, placement testing, first-year seminars, learning communities, intrusive advising, early warning systems, redundant safety nets, supplemental instruction, peer tutoring and mentoring, theme-based campus housing, adequate financial aid including on-campus work, internships, service learning, and demonstrably effective teaching practices" (Kuh). However, Kuh also notes that programs must be customized for the students they are serving. My project serves as a form of customization of these recommendations for what is relevant, feasible, and urgent at Cal Poly.

WISH held an Imposter Syndrome panel during this spring quarter, and from attending, I was able to gather additional insights for this project. From a quick scan of the room, about a third of the students who came were male. The panel, which consisted of two Cal Poly professors, a student, and an industry professional, explained their definitions of imposter syndrome, and recalled personal experiences with it. According to their definitions, imposter syndrome means attributing success to external sources, but failures to internal sources. The Cal Poly student at the panel spoke about a time she won an award, and kept thinking that it was a mistake. She thought about ways may have accidentally been nominated and won. She was

unable to feel joy over her accomplishment at first, let alone believe it was real. The professors also discussed ways of addressing imposter syndrome, with the example scenario of an eager student asking an overly complex question hardly to class material, making some students feel inadequate and uncomfortable. The conclusion from this panel was to suggest the student come to office hours, and answer the question there rather than in class. The professors also admitted it was difficult to combat imposter syndrome in the classroom, as it may feel rewarding to gravitate towards students who are advanced in the material and consider it to be a personal teaching success. This experience may be more appealing than helping a struggling student, which may feel like a personal failure in teaching the material. A popular Medium article described imposter syndrome as the feeling of self-doubt and criticizing one's own experiences. The author wrote, "My first computer science class wasn't easy, but apparently it should have been," and goes on to recount the bragging of peers who made her feel as though she was far behind from where she should have been (Zhuo). In reality, many students probably felt the same way that she did, and she was not an inadequate student.

Another finding from my literature review which became one of my hypothesis is the concept of spotlighting. Spotlighting is a phenomenon in which excessive pressure and attention may be put on a minority group, causing discomfort when the intentions were to help this minority group. I suspected this phenomenon may be occurring at Cal Poly with Women Involved in Software and Hardware, as well as the Grace Hopper opportunity. A recent article by software engineer Amy Nguyen showcased spotlighting in her statement, "I resent that we keep perpetuating this idea that women in tech are good at everything because we shouldn't have to be any better than anyone else to belong in this field. We belong in this field because we're people who deserve a shot, not because we are geniuses" (Nguyen). Lisa McLoughin of Rensselear

Polytechnic Institute conducted research on the topic. To alleviate this issue, she recommended

policy changes including a pre-college program which would require all students to attend

orientation and seminars which would provide information on good habits for college success.

McLoughlin suggests that "opening pre-college programs to all students would have the added

benefit of eliminating the spotlighting by offering these programs to only certain demographic

groups" (McLoughlin).

In my research on feminist pedagogy and inclusive pedagogy, it is important to point out

that being inclusive of underrepresented students means being inclusive of and benefitting all

students. In a study by Sue Rosser, the changes she made in a class with the intention of

benefitting female students also benefitted male students as well. "The difference in grades

between the genders was significant before and during the project. The males had the steeper

increase in grade average, almost half a grade, but the female student grade increase was

significant as well" (Rosser). Perhaps the work done to alleviate gendered issues such as

spotlighting, and the recommendation for pre-college programs, will not only help female

students but improve the experiences of male students as well.

Technology Overview

Google Drive was where I stored my senior project materials. This allowed me to access

documents from any computer, and I wasn't worried about accidentally deleting or losing any of

my data. I also had easy access to edit history. Because of this, I decided to use Google Forms to

both develop and distribute my survey. Google Forms automatically creates a Google

Spreadsheet with data from the survey responses, and generates a summary of data with pie

charts and other appropriate graphs. Google Drive was also useful when I chose to upload my

presentation for the Computer Science Department, and shared the link with those who attended.

Unique Attributes Drawing from Relevant Research

My senior project is unique as it is partially conducted within Computer Science, yet also from a Psychology perspective. Additionally, my senior project is unique as it is a diagnosis of the issues specifically Cal Poly students are facing. Instead of Cal Poly's Computer Science Department needing to rely on the plethora of published recommendations and suggestions, the department can now use a consolidated list of the most prevalent issues their own students are actually experiencing, and begin by addressing those issues. Lastly, as a former Computer Science student myself, I was able to reach out to peers and draw upon personal experiences.

I was also able to draw upon other class work to help with my analysis and hypotheses in this project. Apart from my psychology classes where I learned about self-efficacy, achievement motivation, fear of success, and flow, I was also able to incorporate findings from an introductory anthropology course where students conducted participant observation and made notes about the built environment in a major. In my studies on the computer science major, I conducted participant observation in the Computer Science Lab (CSL), which is an open space for students to work on projects and assignments. I observed this room for an hour, and noticed very little interaction among students, yet some male students often broke silence with conversation. These conversations were mainly questions about programs or helping each other with code, which I assume is not allowed in their classes. The three female students sat at completely opposing corners of the room. Most students had headphones in, which prevented interaction. I noted that the environment was not conducive of collaboration, but also did not promote creativity as the walls were white, and there was absolutely no variety in the color or configuration of the workstations. As part of this anthropology class, I also made notes on the computer science lab classrooms, specifically rooms 301, 302, and 303 in the Computer Science

building. The layout of these classrooms promote the individuality that is emphasized in the major. Students sitting at work stations cannot easily see each other, and the work stations do not even face the whiteboard, or the same direction. I saw this to mean that even in the classrooms, students do not share experiences or connections to one afnother, which may diminish the sense of community outside of the classroom.

Design & Implementation

My senior project took place over the span of three academic quarters, from Fall 2014 in LAES 461, to Spring 2015 with LAES 462. During the fall quarter, I developed my research question, the scope of my project, and began the literature review. I did not take any senior project course during Winter 2015, but used the time in this quarter to continue the design and development of my senior project. I continued my literature review, and began the development of my survey and interview questions. During this time I was also enrolled in Personality, a psychology course (PSY 305) which helped me immensely in determining the aspects I wanted to measure in my survey, including fear of success, self-efficacy, achievement motivation, and qualities of flow. In the spring quarter, I launched my survey online. I posted links to the anonymous Google Form onto the Software Engineering, Computer Science, and Computer Engineering Facebook pages, computer science-related club pages, and my own personal Facebook page. I also advertised openings for interviews through these channels, and conducted most of my interviews on two days in the library. After I completed my student interviews earlier than I had expected, I decided to also interview two professors to see what their insights may be on the retention issue. The details of my Spring 2015 timeline are outlined in the image below.
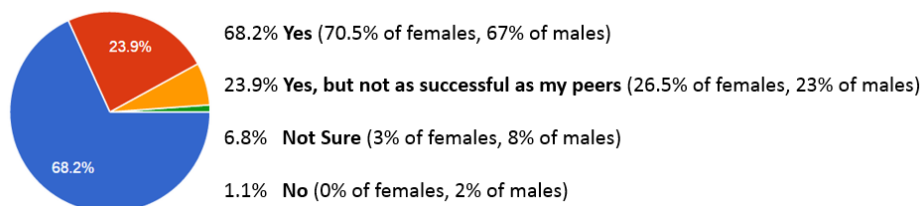
Spring 2015	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9
Survey	Run	Run	Analyze	Analyze					
Interview	Schedule	Schedule	Schedule	Conduct	Conduct	Conduct	Conduct		
Presentation						Develop	Develop	Develop	Present

In order to answer my research question, "What factors contribute to the retention rate of Computer Science students at Cal Poly?" I aimed to ask questions in both my survey and interview that would address a range of possibilities. My hypotheses was that the main factors affecting retetion would be spotlighting, self-efficacy, and false interest. Spotlighting refers to the phenomenon in which an uncomfortable amount of attention and pressure is placed on a minority group as an unintended consequence of efforts meant to help and encourage that group. Self-efficacy issues refer to students doubting their ability to attain success in a computer science career. False interest refers to the idea that perhaps students choose to major in computer science, then find out it is not what they expected, and decide to pursue other interests instead, which is not actually a negative factor. To test my hypotheses, I asked questions relating to spotlighting, self-efficacy, and false interest. I also included a free response section to allow open feedback from students. After analyzing my survey responses, I went on to interview students based on the survey findings.

Certain survey results stood out to me as they were not what I was expecting. It was interesting to me to see that many of the generalized gender issues are not as present here at Cal Poly. For example, in one of my questions attempting to gauge self-efficacy, I asked "Do you feel like you can be successful in a CSC/CPE/SE career?" It was encouraging to see that the majority of students answered "Yes" to this question, both female students and male students.
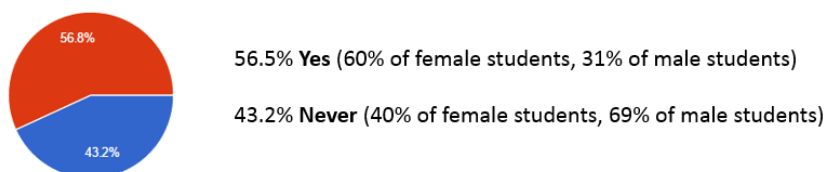
However, I expected many more females than males to answer "Yes, but not as successful as my peers," and found that almost the same percentage of male respondents chose this answer as female respondents. The specific percentages are shown in the image below.

Do you feel like you can be successful in a CSC/CPE/SE career?

68.2% **Yes** (70.5% of females, 67% of males)

23.9% **Yes, but not as successful as my peers** (26.5% of females, 23% of males)

6.8% **Not Sure** (3% of females, 8% of males)

1.1% **No** (0% of females, 2% of males)

Another set of survey questions I expected to see a significant gendered difference was when I asked if students ever felt disadvantaged or advantaged in their major due to gender. I was not expecting nearly one in three male students to feel disadvantaged in the major due to their gender.

Have you ever felt disadvantaged in your major because of your gender?

56.5% **Yes** (60% of female students, 31% of male students)

43.2% **Never** (40% of female students, 69% of male students)

Have you ever felt advantaged in your major because of your gender?

50% **Yes** (71% of female students, 35% of male students)

50% **Never** (29% of female students, 65% of male students)
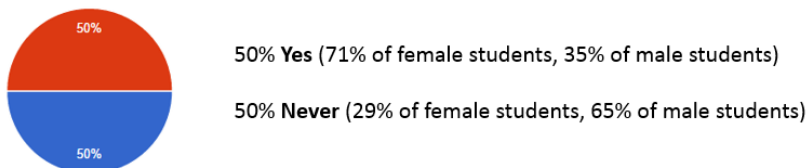
Finally, I used a question developed by a psychologist named Matina Horner to gauge a concept she called fear of success. If a person lies to a significant other about a grade they have received, saying the grade was lower than it was, then it may be an indication of negative social consequences for that person to be successful in their social context. I expected a majority of females to answer "Yes" on the survey, but I actually received more males than females in this

category. During the Computer Science Department presentation, a professor suggested asking

the opposite of this question too. If I were to re-do the survey, I would definitely also ask if

students have lied, saying a grade was higher than they have received.

Have you ever lied to a peer, friend, or significant other, or anyone about a grade you have
received, saying the grade was lower than it actually was?

76.1% **Never** (80% of females, 76.9% of males)

23.9% **Yes** (20% of females, 23.1 % of males)
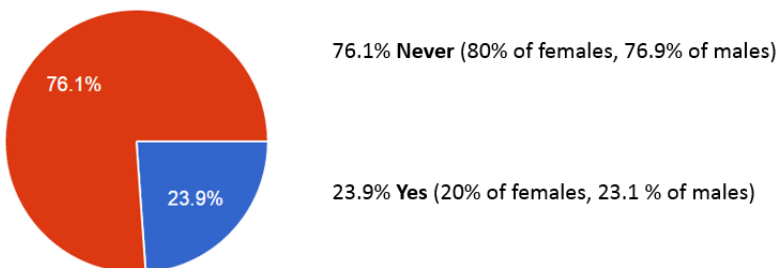
I also attempted to test my hypothesis of false interest by asking students to reflect on

their feelings while performing major-related activities, like programming. I used Mihaly

Csikszentmihalyi's qualities of a flow activity, which is considered an optimal, rewarding

experience that would be beneficial to have in one's career (Csikszentmihalyi). Students mostly

answered positively to these areas, except for feeling self-conscious.

Which of the following qualities describe how you feel performing activities related to your major?

I find it challenging and interesting	77	86.5%
I find myself absorbed in the tasks	67	75.3%
There are clear goals	56	62.9%
There is immediate feedback	48	53.9%
I give it a high level of concentration	63	70.8%
I feel in control	37	41.6%
I lose a sense of time	50	56.2%
I don't feel self-conscious	25	28.1%
It is enjoyable	57	64%
It is fulfilling	68	76.4%

Before I had conducted the survey, I expected to ask very specific questions in my interview relating to experiences with gender, self-efficacy, spotlighting, and false interest. However, due to my survey results, I asked more open-ended questions in my interview, listed below:

- What factors do you think affect retention in CSC/CPE/SE at Cal Poly?
- What has helped you be successful in your time here? Is there anything preventing you from being successful?
- Reflect on a time you've been discouraged from continuing in your major.
- What do you hope to accomplish with your career?
- What are your thoughts on the non-collaboration policy used in some CS classes?
- What are your thoughts on WISH, Grace Hopper, and any other gender-specific opportunities?
- If you could change anything about your major's program, what would you change? What would the ideal be for you?

This allowed me to continue to find results I did not expect to find. If the student had already left Computer Science, or if they left Cal Poly, I adjusted the questions accordingly. I interviewed 20 students, of which 17 were female and 3 were male. Two had left the Computer Science major and switched to a different major at Cal Poly. One had left Cal Poly due to academic disqualification. Many of the students I interviewed were successful and heavily involved in the program and related clubs, and also have had internship experience. The themes which emerged from my interviews are displayed in this slide from my senior project presentation:

Interviews

60% Are involved in WISH and find it to be very helpful or extremely vital

85% Needed more of an introduction and orientation to CS

85% Uncomfortable with opportunities and successes related to gender

70% Experience Imposter Syndrome

75% Feel that most material doesn't apply to their career

70% Stopped going to or strongly dislike the tutoring center

70% Stopped going to or strongly dislike office hours

75% Think students shouldn't follow non-collaboration policies

60% Want more opportunities to socialize with and meet professors and other students

From the interviews, I also learned of issues which were not apparent through my literature review or survey results. The list of factors I presented to the Computer Science Department which could feasibly be addressed included orientation needs, spotlighting, imposter syndrome, maintaining big-picture interest, tutoring center needs, office hour attendance, non-collaboration policy issues, and the need for a sense of community. I also mentioned the current qualities of the CSC program that are successfully encouraging students to remain in the major. These factors are outlined below, and correspond to a statistic from the slide above:

- Successes – Some students do feel very connected to the Computer Science community through clubs such as WISH, SWE, and White Hat. Some students also report feeling very encouraged by professors who acknowledge their accomplishments, and have been able to establish relationships with these professors.
    - o 60% of interviewees were involved in WISH and find it to be very helpful or extremely vital
- Orientation Needs – Many students feel threatened by the knowledge professors assume they have before coming into the introductory courses, like how to use tools such as Vim.

- o 85% of interviewees felt that they needed more of an introduction and orientation to Computer Science at Cal Poly

- Spotlighting & Imposter Syndrome – These two factors are related, as spotlighting refers to the excessive pressure and attention placed on female students to succeed due to programs like WISH and Grace Hopper. Students report experiencing backlash from peers including negative comments or social isolation for these opportunities. As a result, students begin to question if their accomplishments are really their own or of their own merit, but rather as a result of these opportunities which may feel undeserved.

  - o 85% of students reported feeling uncomfortable with opportunities and successes related to gender

  - o 70% of students experienced imposter syndrome

- Maintaining Big-Picture Interest – Students reported that it was important for their motivation to know how concepts taught in class related to real-world problems in industry. They noted that even a quick reminder or mention of how a concept is used in solving problems in industry would be useful in class.

  - o 75% of students felt that most material doesn't apply to their career

- Tutoring Center and Office Hour Attendance – Both of these sources of guidance and help are related as most students report that they have stopped going to office hours due to negative experiences.

  - o 70% Stopped going to or strongly dislike the tutoring center

- Non-Collaboration Policy – The push for individual work may have a negative impact on students. Most students do not follow these policies, yet feel guilty asking for help. They

choose to ask their friends for guidance in their programs as they felt more comfortable with their friends rather than professors or peers they may be trying to impress.

- o 75% of students indicated that all students should not follow the non-collaboration policy in order to be successful in the Computer Science program
- o One student suggested the removal of this policy, since those inclined to copy code and not benefit from collaboration are already copying code or having someone else program their projects for them anyway.

- Sense of Community – This refers to the need for students to feel connected to the greater Computer Science community at Cal Poly. A connection to other peers as well as professors in the department may alleviate discomfort felt in class, the tutoring center, and office hours.

- o 60% of students wanted more opportunities to socialize with and meet professors and other students

In addition to the findings I presented at the CSC Department faculty meeting, there were also issues which may not be in the control of the CSC Department, or at least more complicated to address. They may also be individual student experience or that of a small subset of students. However, I would still like to mention these issues as I feel that they are undoubtedly having a negative impact on the student experience and culture of the major. The first issue is the need to pick a major when applying to Cal Poly. Not only is there uncertainty in those who picked the major, perhaps more interested students may have been recruited into the program if they were able to take an introductory course first. Additionally, many students felt uncomfortable being placed in CPE 123 or CPE 101 with those who had far more programming experience. If those who did not have as much experience coming into college were able to take one extra quarter to

ramp up, there is the potential that these students would feel more leveled with their peers when they are placed in the same classes later on.

Second, many of my female interviewees mentioned issues surrounding the opportunity to attend the Grace Hopper Celebration of Women in Computing. Although each of these interviewees were grateful for the opportunity, there is a divide amongst the girls who do attend. Some are extremely competitive, closing themselves off from other peers and keeping their interviews and whereabouts very secret from the rest of the group. On the polar opposite end, there are girls who do not even attend the career fair, or the talks, but instead explore the city and treat the experience as vacation. The latter group tends to boast about this through social media, causing other attendees much anguish over the tainted portrayal of their conference attendance. Perhaps if attending certain tech talks, or a number of tech talks, were mandatory, then at least all attendees would be gaining valuable experience. The competitive group would have a break from the career fair, and the entire group is able to bond as a result.

One student, who was a Computer Science major, was very involved in WISH and felt that she benefitted from attending Grace Hopper through Cal Poly. She did not have difficulty attending office hours and asking questions, although she mentioned that professors must have found her annoying for going to office hours all the time. She didn't mind the potential social consequence, and continued to ask questions and gain clarity on concepts taught in class. However, when she was taking one of the last introductory computer science classes, a professor actually told her to consider switching her major and that computer science may not be for her, so she did. She had missed a project deadline due to personal circumstances, and explained this to the professor after the deadline had passed, and was okay with receiving no credit for the project. In response, the professor told her that she could have asked for an extension and hinted

that she was incompetent to major in the computer science field due to this mistake. It is important to note that this student was not discouraged from pursuing a Computer Science career. She is actually currently successful in attaining internships and enjoys programming despite her exit from the major. She stated that her reasoning for leaving the program was that she did not deserve to be treated in such a manner, rather than an academic reason or issues of self-efficacy.

The interviews were a great way for me to get to know these current and former Computer Science students. I cannot imagine the positive impact it may have for each student to have an opportunity to openly express themselves to the Computer Science Department, and to have their voices, concerns, and experiences heard. For this purpose, I am including quotes from the interview below which may serve as food for though. I think each of these quotes relate directly to one of the factors presented, so I have categorized them as such.

Successes:

"I've built relationships with professors who are really supportive and I think my experience would've been so different without that."

"A professor told me they thought I could pass the class, and just saying that gave me enough motivation to get through the work and help to pass it."

"I don't know where I'd be without my WISH mentor."

"WISH, White Hat, and SWE have been a great support network for me."

"I love solving problems. It's challenging and I like it."

Orientation Needs:

"I had no idea how to use the terminal or anything and I was too embarrassed to ask. Professors expect you to know it."

"I don't want to ask questions when I'm told to just Google something…but sometimes Google is still hard to understand."

"Everyone else seems to already to know how to set up a dev environment or how to use nano. It was so embarrassing."

"I had no idea how to start reaching out and applying for internships."

"One of my friends in CPE 103 asked me what was wrong with her program. It turns out she couldn't run it because she didn't know what a main method was."

Spotlighting & Imposter Syndrome:

"They say, 'You know you're only getting these interviews because you're a girl'"

"I felt so uncomfortable with all of the interviews I was getting in fall quarter because of Grace Hopper. I didn't know how to balance it with school work and I felt so guilty when I had to leave class or lab because [my peers] weren't having the same problems."

"I start to think that I only got these internship offers because I am a girl. They're probably right."

"Women are now getting an unfair favorability over men when it comes to recruiting."

"People have too much confidence in me. I was told to try a double minor in [two challenging subjects not related to my interests]. I don't think they're seeing me for me."

"I hate the guys that are asking really complicated questions and working on their own personal complex projects during class. But maybe they love it more than I do. Maybe CS isn't for me. Maybe I do just get internships because I'm a girl."

Maintaining Big-Picture Interest:

"Nothing seems to apply to what jobs or internships are looking for."

"I don't feel like anything in school has prepared me for my internships."

"If you were interested in doing different things with computer science other than the typical topics, you feel discouraged."

"I'm about to graduate and I feel that most of the things I learned that are relevant to industry I learned on my own or at an internship."

"I need to know how what I'm learning ties back to something relevant and useful."

Tutoring Center and Office Hour Attendance:

"Why would I go all the way to campus to maybe get one question answered or talked down to when I could just ask a friend?"

"I'd rather ask friends for help because I don't want someone in control of my grade to think I'm stupid. And my friends know my skills better."

"You only get one question answered. Then if you get stuck later you either cheat or fail."

"My professor told me to switch my major. So why would I even go?"

"I never wanted to burden professors by going to office hours."

"It felt too awkward reaching out to my faculty advisor."

"I don't want my professors or my peers to think I'm stupid."

"I didn't like it very much until I overheard someone I thought was really smart ask the same question I had. It made me feel so much better."

Non-Collaboration Policy Issues:

"Oh yeah I definitely violated the non-collaboration policy."

"[Laughter] Who doesn't violate the non-collaboration policy?"

"It only benefits the people who don't follow it. I never broke it."

"If it wasn't there, I would still only ask for help or direction, not answers."

"It would be so helpful to talk it out with someone. Free riding wouldn't be a problem because those students are already having other people write their code anyway."

"I never broke it and I felt like I should have."

"It's helpful to talk it out and expand my own perspective. I wish I didn't feel so guilty doing that though, because it helps so much."

"Yeah [alumni] always help me with my classes. I don't know how else I'd do it."

Sense of Community:

"Guys should be part of the [WISH] mentorship program."

"I wish there was a way of getting to know other people in the major early."

"I want to be involved in clubs but they are limited. WISH is like a mini-sorority, which I haven't the slightest interest in…"

"We need to promote male and female interaction…"

"I wish that some of the clubs promoted more collaboration between male and female peers."

"It would be nice if there were more clubs that worked on out-of-class projects."

"My peers are socially oblivious and annoying."

"I love WISH and White Hat….Having the community to support you is big."

After completing the student interviews ahead of my timeline schedule, I decided to begin interviewing faculty members as well. The two professors I interviewed had very different views on the retention issue in computer science, as well as student attitudes. This disparity in perspectives leads me to think that a department discussion on student experiences could be useful in surfacing both successful tactics and frustrating issues in the classroom. One faculty member felt that student success in Computer Science is primarily determined by ability, and the other faculty member felt that student success is primarily determined by effort. If I were to re-conduct my survey, I would also ask students if they felt as though their success in Computer Science would be determined by ability or effort. If students also think that success is purely determined by ability, then setbacks may be attributed to personal inadequacy and cause students to leave the major or decide it is not for them. If students think that success is determined by

effort, then setbacks may be attributed to personal actions rather than personal qualities, and attempt ways to improve and grow in the field.

Analysis & Verification

To assess my work, I asked the attendees of my CSC Department presentation to complete a feedback survey. Out of the 21 who attended my presentation, 10 were willing to fill out the feedback survey. The questions on this survey were based on a rubric developed by the American Society for Engineering Education for research papers. I included questions regarding content and focus, but excluded the writing category since I was presenting my work in presentation format rather than a paper. This rubric is included in the Appendix, and is displayed alongside the results below. Instead of having a description under each category, I decided to use the Likert scale and allow answers to be circled to save time. My goal was to have an average response of Agree or Strongly Agree on each area. I also wanted to inspire at least one professor to address each of the issues I presented. In both of these areas, I was able to verify the success of my project. I received an average of "Agree" in each rubric area, and had at least one professor indicate interest in each of the issue areas. The results of my rubric are displayed below.

Using the Likert scale, the averages are displayed next to each rubric area.

(Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4, Strongly Agree = 5)

The presentation contains original treatment of, or new perspective on the topic: 4.0
The research approach is adequate and appropriate: 4.2
Data collection results are clear and logical: 3.7
This project makes a significant contribution to Computer Science education at Cal Poly: 4.1
The goals are developed and explicitly stated: 4.3
The order in which ideas are presented are clear, logical, and effective: 4.0
The conclusions are well formulated and supported by the data: 4.0

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4 out of 10 indicated interest in addressing Orientation Needs
2 out of 10 indicated interest in addressing Spotlighting
4 out of 10 indicated interest in addressing Imposter Syndrome
2 out of 10 indicated interest in Maintaining Big-Picture Interest
2 out of 10 indicated interest in addressing Tutoring Center Needs
5 out of 10 indicated interest in Encouraging Office Hour Attendance
5 out of 10 indicated interest in addressing Non-Collaboration Policy Issues
5 out of 10 indicated interest in Fostering a Sense of Community/Social Events

Comments:
"I rarely teach majors – part timer"
"Draw more conclusions from results and link to the original goal."
"Use more rigorous statistic techniques. Transition from retention to male-female issue was unclear. The data collected is super useful! Thanks! Good Job!"
"Small samples. Not confident that the sample is truly random, but even so, results are useful and interesting."
"Many great questions – I wish you could spend another year digging deeper."
"The students that left are those that really need to be asked more but that is nearly impossible."
"I am not a CSC faculty member."

Societal Impacts

From my rubric results, 8 out of 10 respondents indicated that my project makes a significant contribution to Computer Science education at Cal Poly. I hope that the impact of my project exceeds that impact on faculty members in that room, but sparks conversation which spreads to other faculty members, student clubs, and individual students as well. Aside from Cal Poly, it is possible that other universities and even industry can begin to look at the issues that Cal Poly students are facing and explore ways to alleviate these issues. The societal impact on individual students is not only a call to action for culture change, but also an explanation of the struggles and frustration they may be facing. Understanding the student experience is the first step in improving both the current experience, and that of students in generations to come.

Future Work & Next Steps

If I were able to re-do my project, there are many aspects I would have approached differently. I would have created a more robust methodology of conducting an analyzing my survey, and coding the interview results. In addition to surveying and interviewing a majority of students currently in the major, it would have been beneficial to branch out and somehow find students who did leave the major and learn why that decision was made. I would also recruit survey responses and interviewees through classes and professors along with my personal posts on Facebook pages. This would have allowed me to gain a larger data set, and also allow me to consider my sample to be random and less biased. I also would have used strong statistical methods to prove the significance of my results. However, I have learned a great deal from my project and it was a first attempt at approaching the retention issues in Computer Science.

With additional time and resources, I would also have liked to perform a test run of the suggestions I made to the Computer Science Department faculty. One of the most lacking areas in Computer Science is a sense of community, and with more time in my senior project I would have attempted to host a department-wide social event. I have envisioned a lunch meeting perhaps in a classroom or on Dexter lawn, potentially with food provided, where both students and faculty are encouraged to discuss the issues they may be facing or observing in Computer Science. The free response data in my survey and the open ended questions in my interviews led me to explore areas that I would not have thought of, but proved to be extremely relevant, like the non-collaboration policy issues. By allowing students to openly speak about their struggles, other students may be able to relate and feel a connection with their peers, and faculty members will become aware of issues that were perhaps unknown or otherwise not obvious.

Conclusion

In conclusion, students face a variety of issues during their time in the Computer Science Department program at Cal Poly, yet small and feasible steps can immediately be taken to alleviate some of the adversities. At Cal Poly, students of all backgrounds and genders experiences times where they are heavily discouraged from continuing in the major. This calls for action, and improvements to the program will not only improve the experience for a subset of students, but rather the majority of students in the major. The importance of student feedback is highlighted in this research effort, as my literature review would not have been able to guide me to focus on the relevant issues for Cal Poly. The uniqueness of each student's experience exposes the many possible benefits and consequences that may result from spotlighting, imposter syndrome, orientation needs, maintaining big-picture interest, tutoring center availability, office hour attendance, non-collaboration policy issues, and a sense of community. Each of these areas vary in the resulting impact on each student. However, there is one overarching theme in all of the students I was able to interview. Cal Poly's students like to be challenged, like to learn, and are truly interested in computer science. With the right students, I believe it is up to the Computer Science Department and the University to truly listen to student needs and begin conversations that help these students have the experience they deserve.

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Appendix

A. Survey Results from Google Forms Summary of Data

B. Computer Science Department Presentation

C. Computer Science Department Presentation Handout

D. Computer Science Department Presentation Feedback Survey

E. Informed Consent Form (Interview)

F. Informed Consent Form (Rubric)

G. Informed Consent Form (Survey)

A. Survey Results from Google Forms Summary of Data

87 Responses

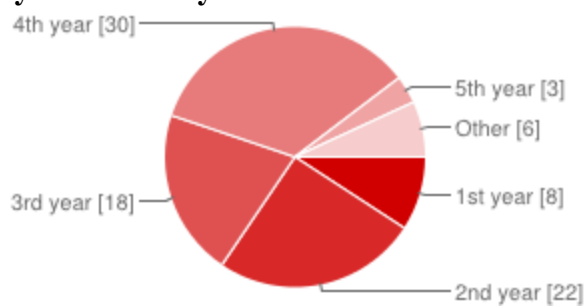**Demographic Information**
Please indicate your ethnicity:

White	**53**	59.6%
Hispanic/Latino	**8**	9%
Asian American	**31**	34.8%
African American	**3**	3.4%
Native American	**1**	1.1%
Hawaiian/Pacific Islander	**4**	4.5%
Unknown	**0**	0%
Other	**2**	2.2%

What is your gender?
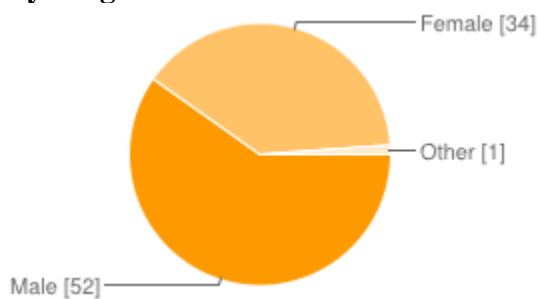
Male	**52**	58.4%
Female	**34**	38.2%
Other	**1**	1.1%

What is your current year in school?

1st year	**8**	9%
2nd year	**22**	24.7%

3rd year	**18**	20.2%
4th year	**30**	33.7%
5th year	**3**	3.4%
Other	**6**	6.7%

Did you transfer to Cal Poly from another college/university?
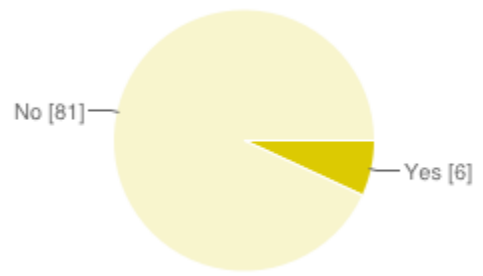
| Yes | **6** | 6.7% |
| No | **81** | 91% |

Survey
What is your major?

CSC	**48**	53.9%
CPE	**18**	20.2%
SE	**16**	18%
Other	**3**	3.4%

Did you have prior programming experience before coming to Cal Poly?
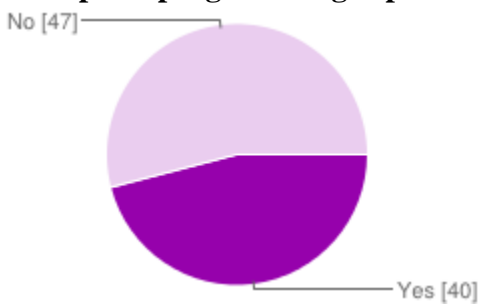
| Yes | **40** | 44.9% |
| No | **47** | 52.8% |

On a scale from 1 to 10, how much do you like your major?

| 1 | **0** | 0% |
| 2 | **3** | 3.4% |

3	**2**	2.2%
4	**2**	2.2%
5	**5**	5.6%
6	**1**	1.1%
7	**7**	7.9%
8	**21**	23.6%
9	**23**	25.8%
10	**23**	25.8%

**Which of the following qualities describe how you feel performing activities related to your major?**

I find it challenging and interesting	**77**	86.5%
I find myself absorbed in the tasks	**67**	75.3%
There are clear goals	**56**	62.9%
There is immediate feedback	**48**	53.9%
I give it a high level of concentration	**63**	70.8%
I feel in control	**37**	41.6%
I lose a sense of time	**50**	56.2%
I don't feel self-conscious	**25**	28.1%
It is enjoyable	**57**	64%
It is fulfilling	**68**	76.4%

Have you ever felt discouraged from continuing in your major?
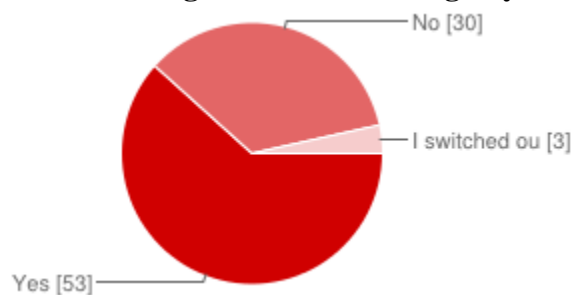
Yes	**53**	59.6%
No	**30**	33.7%
I switched out of my CSC/CPE/SE major.	**3**	3.4%

Do you feel like you can be successful in a CPE/CSC/SE career?
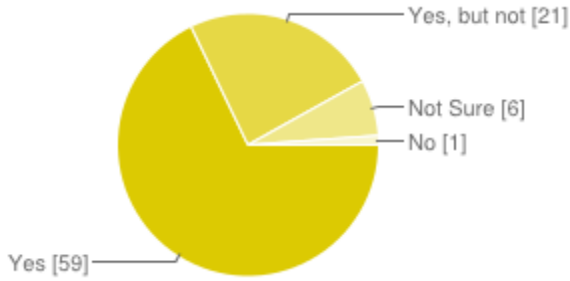
Yes	**59**	66.3%
Yes, but not as successful as most of my peers.	**21**	23.6%
Not Sure	**6**	6.7%
No	**1**	1.1%

Do you hang out with people from your major?
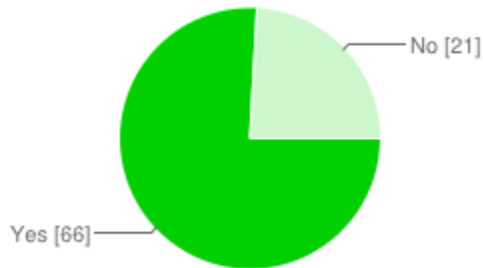
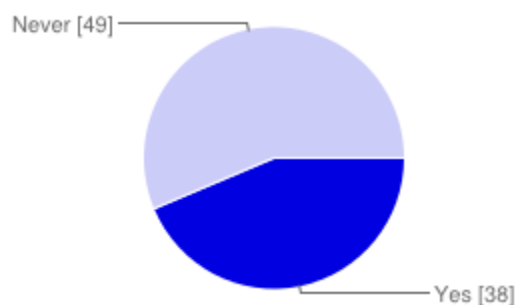|		
Yes	**66**	74.2%
No	**21**	23.6%

Have you ever felt like you've been treated differently, positively or negatively, because of your gender by:
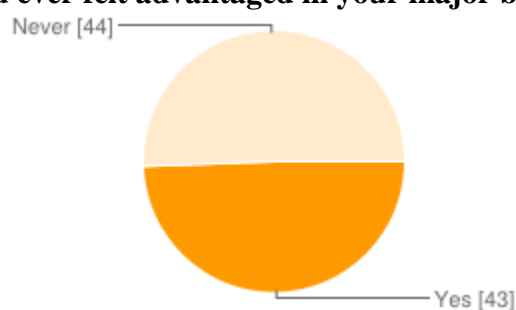
Professors from your major	**25**	28.1%
Peers from your major	**41**	46.1%
Recruiters	**24**	27%
Industry Professionals	**13**	14.6%
Other	**2**	2.2%

Have you ever felt disadvantaged in your major because of your gender?

| Yes | **38** | 42.7% |
| Never | **49** | 55.1% |

Have you ever felt advantaged in your major because of your gender?

| Yes | **43** | 48.3% |
| Never | **44** | 49.4% |

If you could change things about your experience as a CPE/CSC/SE student, what would you change?

- Work harder at the begining and get more involved.
- Leniency from professors towards females
- Class availability
- More female professors
- CPE 357's workload >.>
- I would try to build stronger relationships with my professors. They're a great source for mentorship and support, and I wish I would have done that earlier.
- Projects are more open ended, allowing for more design of software.
- Capstone is useless if you've had an internship I didn't enjoy any of the EE classes required for my major More classes like 357, since they teach the most
- ability to get tech electives
- Fire some of the few poor professors Offer a wider variety of tech electives Less clique-y clubs Include more classes that require you to work alongside non-CSC majors
- If my class load only consisted of CSC/CPE classes and no math or physics or GE classes then I feel like I would have performed better
- Promotion of group activity. I believe these classes are helpful towards learning, but at the same time the discouragement of talking to each other kinda encourages anti social behavior

- The clubs are limited. There's pretty much just WISH, which is just like a mini sorority, which I haven't the slightest interest in. The only other real software club is White Hat, which is for "hackers", which is obnoxious. If there are more, they aren't large enough to be known.
- I would have been interested in a game design conecentration.
- None
- More tutoring hours
- I wish the new GRC/CSC minor was available when I started. The last question is a weird question by the way... there's no context... it feels like a really broad question. On a Scale from 1-10 how happy are you with school?
- No GEs
- I'd say I would change what professors I took, but for most classes there is only on option. Sadly, I would say about half of my CS professors here have been pretty terrible.
- I wish that some of the clubs promoted more collaboration between male and female peers. I feel that some of the clubs for CSC/CPE/SE students make a distinction between males and females in industry - and while I agree that women should get the same opportunities within industry and the field in general. I also think that we need to promote male and female interaction in the industry in school - what better way to bring it to industry than to start it in our education?
- Get involved in more clubs as a freshman, rather than waiting until late sophomore year. Be less afraid to ask for help and go to tutoring more often.
- I wish professors had more skill in teaching the subject. I also wish men were more respectful towards women in the major.
- I would have preferred a different CPE 103 professor. Other than that, I probably wouldn't change anything.
- I have felt that if you were interested in doing different things with computer science than the typical topics, you feel discouraged that you don't like your major or that you won't like your job. There are only really discussions or opportunities for more 'typical' career paths.
- Get rid if 357. Get rid of handwritten exams and closed book exams.
- Better lower division classes. Some professors don't help lay a good foundation for their students.
- more collaboration during courses, more diverse courses taught, less stress about getting into classes because of how impacted it is
- The EE track in CPE needs to continue to useful classes, not dead-end halfway through Agbo-land.
- Get rid of the 8 units of support elective (psy 252, engl 310, rels 370, etc) and provide a couple of classes that are more relevant with modern techniques, technologies, frameworks. The major does a good job with the foundation, but I'm about to graduate and I feel that most of the things I learned that are relevant to industry I learned on my own or at an internship. Also, cpe 307/308/309 definitely need to be updated. The technologies in those classes are from the late 80s / early 90s. I understand that the landscape is constantly changing and we'll always have to make an effort throughout our careers to keep up with the latest and greatest, but why is it our professors aren't held to the same standard?
- No 357; study harder

- o Have more qualified teachers teach intro classes. Hatalsky and Mammen are good. Assal, kerns, and pretty much anyone that teaches 141 is terrible.
- o I wish some of the Professors were friendlier, and understood student difficulties better. Also there are some classes that are clearly meant more for CPE students, but CSC students are required to take them like CPE 315. All the CSC students in the class are totally lost while all the CPE students have no problems
- o It would be nice if there were more clubs that worked on out-of-class projects. I've found that it's really hard to get involved and learn more.
- o -more variety of tech-elective like classes at an introductory level
- o more academic involvement in other majors
- o Not much. Some of my peers are a little socially oblivious and annoying at times, but I'm sure that applies to any major.
- o I wish there were more opportunities for our major to interact with other majors, specifically in our choice of classes. There are so many ways that CS has applications to other majors and students should be encouraged to take on minors/projects in other departments more often.
- o More technical elective offerings would be nice
- o Curriculum feels kinda old school sometimes
- o Make it easier for students first learning, how to set up an IDE.
- o I would take less class each quarter so that I could actually learn instead of get 5 hours of sleep each night and barely scrape by.
- o It's been all great so far. Not looking forward to 357, but it's just a small bump in the golden brick road :)
- o The CS department is trash, honestly. Almost every professor I have had has given me an really bad experience whether that be bad teaching, unfair grading, poor attitudes, everything. It always seemed to me that the liberal arts teachers were much more involved with the students and definitely knew how to teach a college class. The majority of CS staff do not understand how to teach a class full of college kids who are trying to learn. Piling assignments on top of on another in the same week while not being able to effectively teach the student how to do the material does not equate success. Change the department staff and their attitude.
- o Need one common language for 101,102 and 103. Intro level shouldn't switch languages. It's very tough without any prior experience.
- o The intro courses need to be easier for people with no programming experience. There needs to be courses on how to use a terminal, properly set up development environments and even just an easier intro to CS course. However, when I was having this experience it was about 8-9 years ago and I believe they have implemented a simpler intro to CS course since then. Also I would like to add, that I switched out and and eventually got back into the major and came back. The second time around I was much more successful for several reasons: I knew what I was getting into, I had a decent amount of exposure to programming at that point, and my ideas about how much work was required for the major was actually based in reality. You cant party and be very social while being in one of these majors. Unless you are a talented and fast programmer, the time commitment is just too great for most people.
- o First and foremost, I would have the administration do more to set up students with internships early on. Advertise in classes and at the beginning of the school year and all

throughout the year where students can learn more about getting internships and experience outside of class. I am a 4th year and looking for full time work after graduation, but I have no intern experience so no companies want me. I would set up students early so they can have experience and make connections and have those for years before they want to move to full-time work somewhere. I was told that Cal Poly would be basically handing me a job with my degree and I have yet to see anything remotely close to that. I would have some of the leniency of collaboration that some of the 400 level classes have early on. I realize that being able to code on your own is important, but at some point you might just not get it and if someone can help you out that's great. I believe a lot of the notorious professors overdo the amount of work that is really necessary for a particular class. This makes stress levels incredibly high which is hard for young adults to deal with. Tone down the difficulty too; there is absolutely nothing to tip your hat to when the average of a test is 50% and you curve the class so that's a C. I would try to do something really early in the year each school year to promote students joining CSC related clubs and getting to know other people in the major early. There are so many people I really cannot stand being around, and a lot of people that I know now as a senior I really didn't like at all in classes freshman year because we worked in teams but after I got to know them better they weren't as bad. Push to have more fun activities to help students learn more. So many job applications was experience in lots of things besides C and Java. Actually the majority want something other than C, and Java is getting less and less, but those are the only two languages we were introduced to at Cal Poly. I would promote events to help learn JavaScript or Scala and such that are fun and actually get students to want to learn these things. Because for students like me I didn't do any real outside learning on my own until about the end of my 3rd year because I thought I was there to learn at school, but tons of other people seem to have done lots outside of school and now I feel like I'm at the bottom rung of the ladder compared to everyone else when it comes to skill. This also makes me feel like the dumbest person in many classes as well when underclassmen that absolutely love to go home at night and program instead of hang out with friends know so much more than I do. Lastly, there's a huge push to promote getting women into Computer Science and other Engineering fields and I totally understand it, but it seems like women are now getting an unfair favorability over men when it comes to recruiting. I don't know how to solve the problem of promotion without favoring, but somehow they need to have just as many opportunities as men, but not extra special things.

o I feel that the community in computing majors is friendly and supportive. WISH, SWE, and WhiteHat provide me with a lot of opportunity to meet people in my major and activities. I wouldn't change a thing.

o Peers The ones who get it immediately and finish assignments weeks ahead of time because it comes easy to them and bragging to other people about their progress. The ones who don't get it at all and want to copy your code or are constantly asking for your assistance without returning any help you ask for.

o More helpful professors that are interested in teaching, not lost in their own world. More classes.

o I would change the attitude that I have experienced in my EE classes from the guys in my classes. They usually treat me like I am not equal because of my gender. Although they

> may not realize they are doing it, it really could be discouraging. (Which may be a reason I switched out of the major).
> o A lot of the classes are insanely difficult. I wish teachers had more reasonable expectations. 4 unit CSC classes are like 10 unit engineering classes. The workload is immense, and the course credit is almost nothing. CSC classes are like toddlers: they constantly demand 100% of your attention, and put everything else on the backburner. TAs and teachers generally don't even show you the basics of doing necessary class tasks. The whole mentality is "Figure it out yourself!", even on class-specific information. The experience is not really anything like school. It's more like certification. Teachers are too busy to even show up in one of my classes. I will be ecstatic when I graduate with a head full of knowledge, and an end to the brutality.

Where do you seek support when you are having a rough time?

Friends	**67**	75.3%
Family	**43**	48.3%
Classmates	**35**	39.3%
Professors	**19**	21.3%
Therapist	**4**	4.5%
I deal with it myself.	**55**	61.8%
Other	**3**	3.4%

Have you ever lied to a peer, friend, significant other, or anyone about a grade you have received, saying the grade was lower than you actually received?
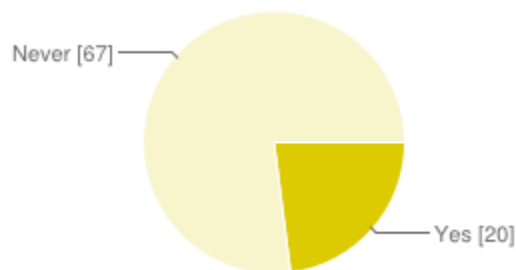
Yes	**20**	22.5%
Never	**67**	75.3%

On a Scale from 1-10 how happy are you with school?

1	**4**	4.5%
2	**2**	2.2%
3	**5**	5.6%

4	**4**	4.5%
5	**2**	2.2%
6	**6**	6.7%
7	**16**	18%
8	**19**	21.3%
9	**17**	19.1%
10	**12**	13.5%

B. Computer Science Department Presentation

Factors Affecting Retention in Computer Science at Cal Poly

DIANE EYKHOLT
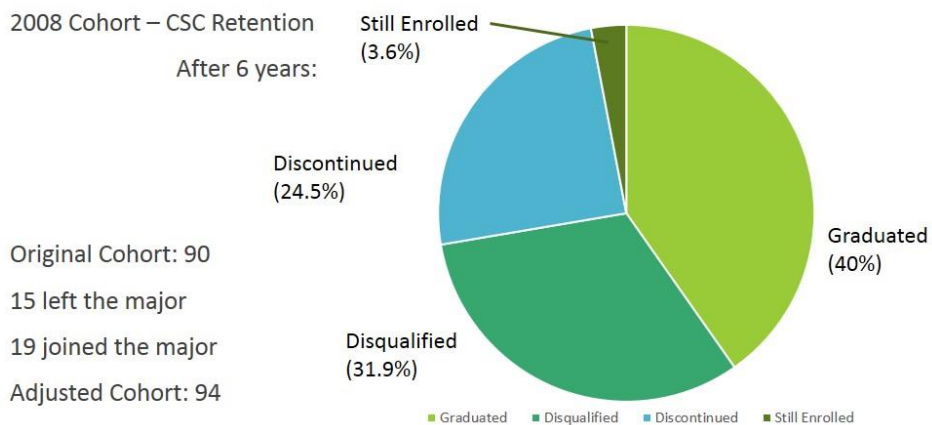LIBERAL ARTS AND ENGINEERING STUDIES
SENIOR PROJECT, SPRING 2015

Agenda

- Purpose
- Background
- Methods
- Findings
- Next Steps
- Feedback Cards

Purpose

- Hundreds of recommendations for improving Computer Science programs at the university level
- What is relevant to Cal Poly?
- What is urgent?
- What is feasible?

Broad Intro Course	Peer Tutoring	Collaborative Learning
Feminist Pedagogy	Mentoring	Minimize Stereotype Threat
Orientation	Theme-Based Campus Housing	Avoid Spotlighting
Placement Testing	Adequate Financial Aid	Avoid Gender Bias
First-Year Seminars	Internships	Role Models
Learning Communities	Research Opportunities	Student Support Networks
Intrusive Advising	Friendly Work Environments	Positive Feedback
Early Warning Systems	Inclusive Teaching Style	Imposter Syndrome
Redundant Safety Nets	Verbal Encouragements	
Supplemental Instruction		

Background – Cal Poly SLO

2008 Cohort – CSC Retention

After 6 years:

Original Cohort: 90

15 left the major

19 joined the major

Adjusted Cohort: 94

Still Enrolled (3.6%)
Discontinued (24.5%)
Graduated (40%)
Disqualified (31.9%)

Graduated   Disqualified   Discontinued   Still Enrolled

Research Question

What factors contribute to the retention rate of Computer Science students at Cal Poly?

Hypotheses:
- Spotlighting
- Self-Efficacy
- False Interest

Methods

Research Question

Literature Review

Hypotheses

Survey (87 Responses)

Interviews (20 Student Interviews)

Conclusion

Findings

Successes

Orientation Needs

Spotlighting & Imposter Syndrome

Maintaining Big-Picture Interest
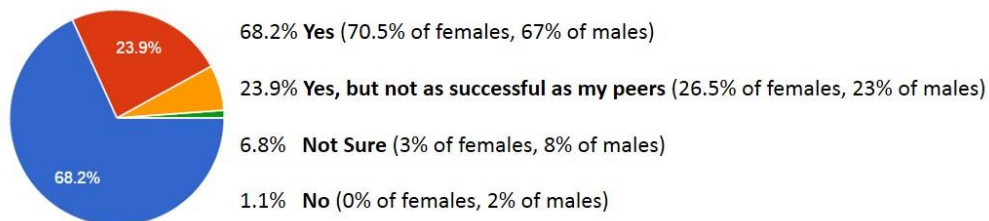
Tutoring Center/Office Hours

Non-Collaboration Policy

Sense of Community

Survey Results

Do you feel like you can be successful in a CSC/CPE/SE career?

68.2% **Yes** (70.5% of females, 67% of males)

23.9% **Yes, but not as successful as my peers** (26.5% of females, 23% of males)

6.8% **Not Sure** (3% of females, 8% of males)

1.1% **No** (0% of females, 2% of males)

eie

Survey Results

Have you ever felt disadvantaged in your major because of your gender?
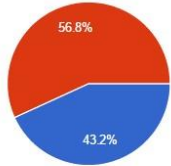
56.5% **Yes** (60% of female students, 31% of male students)

43.2% **Never** (40% of female students, 69% of male students)

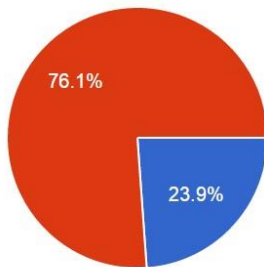Have you ever felt advantaged in your major because of your gender?
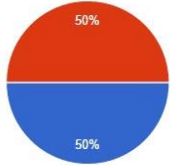
50% **Yes** (71% of female students, 35% of male students)

50% **Never** (29% of female students, 65% of male students)

Survey Results

Have you ever lied to a peer, friend, or significant other, or anyone about a grade you have received, saying the grade was lower than it actually was?

76.1% **Never** (80% of females, 76.9% of males)

23.9% **Yes** (20% of females, 23.1 % of males)

Interviews

60% Are involved in WISH and find it to be very helpful or extremely vital

85% Needed more of an introduction and orientation to CS

85% Uncomfortable with opportunities and successes related to gender

70% Experience Imposter Syndrome

75% Feel that most material doesn't apply to their career

70% Stopped going to or strongly dislike the tutoring center

70% Stopped going to or strongly dislike office hours

75% Think students shouldn't follow non-collaboration policies

60% Want more opportunities to socialize with and meet professors and other students

Successes

"I've built relationships with professors who are really supportive and I think my experience would've been so different without that."

"A professor told me they thought I could pass the class, and just saying that gave me enough motivation to get through the work and help to pass it."

"I don't know where I'd be without my WISH mentor."

"WISH, White Hat, and SWE have been a great support network for me."

"I love solving problems. It's challenging and I like it."

Orientation Needs

"I had no idea how to use the terminal or anything and I was too embarrassed to ask. Professors expect you to know it."

"I don't want to ask questions when I'm told to just Google something…but sometimes Google is still hard to understand."

"Everyone else seems to already to know how to set up a dev environment or how to use nano. It was so embarrassing."

"I had no idea how to start reaching out and applying for internships."

"One of my friends in CPE 103 asked me what was wrong with her program. It turns out she couldn't run it because she didn't know what a main method was."

Spotlighting & Imposter Syndrome

"They say, 'You know you're only getting these interviews because you're a girl'"

"I felt so uncomfortable with all of the interviews I was getting in fall quarter because of Grace Hopper. I didn't know how to balance it with school work and I felt so guilty when I had to leave class or lab because [my peers] weren't having the same problems."

"I start to think that I only got these internship offers because I am a girl. They're probably right."

"Women are now getting an unfair favorability over men when it comes to recruiting."

"People have too much confidence in me. I was told to try a double minor in [two challenging subjects not related to my interests]. I don't think they're seeing me for me."

"I hate the guys that are asking really complicated questions and working on their own personal complex projects during class. But maybe they love it more than I do. Maybe CS isn't for me. Maybe I do just get internships because I'm a girl."

Maintaining Big-Picture Interest

"Nothing seems to apply to what jobs or internships are looking for."

"I don't feel like anything in school has prepared me for my internships."

"If you were interested in doing different things with computer science other than the typical topics, you feel discouraged."

"I'm about to graduate and I feel that most of the things I learned that are relevant to industry I learned on my own or at an internship."

"I need to know how what I'm learning ties back to something relevant and useful."

Tutoring Center/Office Hours

"Why would I go all the way to campus to maybe get one question answered or talked down to when I could just ask a friend?"

"I'd rather ask friends for help because I don't want someone in control of my grade to think I'm stupid. And my friends know my skills better."

"You only get one question answered. Then if you get stuck later you either cheat or fail."

"My professor told me to switch my major. So why would I even go?"

"I never wanted to burden professors by going to office hours."

"It felt too awkward reaching out to my faculty advisor."

"I don't want my professors or my peers to think I'm stupid."

"I didn't like it very much until I overheard someone I thought was really smart ask the same question I had. It made me feel so much better."

Non-Collaboration Policy

"Oh yeah I definitely violated the non-collaboration policy."

"[Laughter] Who doesn't violate the non-collaboration policy?"

"It only benefits the people who don't follow it. I never broke it."

"If it wasn't there, I would still only ask for help or direction, not answers."

"It would be so helpful to talk it out with someone. Free riding wouldn't be a problem because those students are already having other people write their code anyway."

"I never broke it and I felt like I should have."

"It's helpful to talk it out and expand my own perspective. I wish I didn't feel so guilty doing that though, because it helps so much."

"Yeah [alumni] always help me with my classes. I don't know how else I'd do it."

Sense of Community

"Guys should be part of the [WISH] mentorship program."

"I wish there was a way of getting to know other people in the major early."

"I want to be involved in clubs but they are limited. WISH is like a mini-sorority, which I haven't the slightest interest in…"

"We need to promote male and female interaction…"

"I wish that some of the clubs promoted more collaboration between male and female peers."

"It would be nice if there were more clubs that worked on out-of-class projects."

"My peers are socially oblivious and annoying."

"I love WISH and White Hat….Having the community to support you is big."

Next Steps

Successes	There's a lot going right! Keep encouraging students!
Orientation Needs	Let students know it's okay to not know.
Spotlighting & Imposter Syndrome	Build student confidence. Don't encourage negativity.
Maintaining Big-Picture Interest	Reminders or anecdotes that relate material to industry.
Tutoring Center/Office Hours	Be the first to reach out and establish a relationship.
Non-Collaboration Policy	Reconsider, or be sure to clearly outline the policy.
Sense of Community	Encourage social activities including all students.

C. Computer Science Department Presentation Handout

Front:

Factors Affecting Retention in Computer Science at Cal Poly

Diane Eykholt   *Liberal Arts and Engineering Studies*   *d.eykholt@gmail.com*

Research Question

What factors contribute to the retention rate of Computer Science students at Cal Poly?

Survey Results

(87 Student Survey Responses)

62.8% of students think they can be successful in a CSC/CPE/SE career
(70.5% of females, 67% of males)

23.9% of students think they can be successful in a CSC/CPE,SE career, but not as successful as their peers (26.5% of females, 23% of males)

60% of females and 31% of males have felt disadvantaged in their major due to their gender

23.9% of students exhibit a fear of success at Cal Poly (20% of females, 23.1% of males)

Interview Results

(20 Student Interviews)

60% Are involved in WISH and find it to be very helpful or extremely vital

85% Needed more of an introduction and orientation to CS

85% Are uncomfortable with opportunities and successes related to gender

70% Experience Imposter Syndrome

75% Feel that most material doesn't apply to their career

70% Stopped going to or strongly dislike the tutoring center

70% Stopped going to or strongly dislike office hours

75% Think students shouldn't follow non-collaboration policies

60% Want more opportunities to socialize with and meet professors and other students

Back:

Project Findings & Next Steps

Successes	*There's a lot going right! Keep encouraging students!*
Orientation Needs	*Let students know it's okay to not know.*
Spotlighting & Imposter Syndrome	*Build student confidence. Don't encourage negativity.*
Maintaining Big-Picture Interest	*Reminders or anecdotes that relate material to industry.*
Tutoring Center/Office Hours	*Be the first to reach out and establish a relationship.*
Non-Collaboration Policy	*Reconsider, or be sure to clearly outline the policy.*
Sense of Community	*Encourage social activities including all students.*

Recommended Resources

American Psychological Association, Information on Imposter Syndrome
http://www.apa.org/gradpsych/2013/11/fraud.aspx

National Center for Women & Information Technology, How Can Encouragement Increase
Persistence in Computing?
https://www.ncwit.org/academicencouragement

NCWIT, Resources for Higher Education
https://www.ncwit.org/resources?field_audiences_tid%5B%5D=5

NCWIT, Ways to Engage Underrepresented Students
https://www.ncwit.org/resources/top-10-ways-engage-underrepresented-students-computing/top-
10-ways-engage-underrepresented

Revisit this presentation on Google Drive:

http://tinyurl.com/pvlbbyq

https://drive.google.com/file/d/0B6Y-aTlb8h0DQTFSTi03OU5CRXc/view

D. Computer Science Department Presentation Feedback Survey

CSC Department Presentation Feedback

Please circle your response to each question below:

The presentation contains original treatment of, or new perspective on the topic:

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree

The research approach is adequate and appropriate:

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree

Data collection results are clear and logical:

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree

This project makes a significant contribution to Computer Science education at Cal Poly:

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree

The goals are developed and explicitly stated:

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree

The order in which ideas are presented are clear, logical, and effective:

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree

The conclusions are well formulated and supported by the data:

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree

Which of the following issues are you interested in addressing? Please circle all that may apply:

- Orientation Needs
- Spotlighting
- Imposter Syndrome
- Maintaining Big-Picture Interest
- Tutoring Center Needs
- Making Office Hours More Inviting
- Non-Collaboration Policy Issues
- Fostering a Sense of Community/Social Events

Comments:

E. Informed Consent Form (Interview)

Informed Consent Form

INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT, "Discovering Factors Affecting Student Retention in Computer Science at Cal Poly"

Senior project research on student retention in computer science at Cal Poly is being conducted by Diane Eykholt, a student in the Department of Liberal Arts and Engineering Studies at Cal Poly, San Luis Obispo, under the supervision of Dr. Jane Lehr. The purpose of the study is to discover factors affecting student retention in Computer Science at Cal Poly, and identify methods to improve the quality of student experiences.

You are being asked to take part in this study by participating in an interview. Your responses will be audio recorded for the purposes of transcription and the audio file will be deleted immediately upon transcription. Your name and other personally identifiable information will be excluded from recorded data. Your participation will take 20 minutes. Please be aware that you are not required to participate in this research and you may discontinue your participation at any time without penalty or loss of benefits. You may also choose to skip questions if you prefer not to answer.

The possible risks associated with participation in this study include minor psychological risk as you are asked to reflect on negative experiences due to your major. If you should experience any emotional distress, please be aware that you may contact campus Counseling Services in Building 27 Room 135 at **(805) 756-2511** for assistance.

Your responses will be confidential, your name will not be used in any reports of this research. Potential benefits associated with the study include insight on the factors affecting the experiences of a Computer Science student at Cal Poly, and how these factors may be improved.

If you have questions regarding this study or would like to be informed of the results when the study is completed, please feel free to contact Diane Eykholt at deykholt@calpoly.edu. If you have concerns regarding the manner in which the study is conducted, you may contact Dr. Steve Davis, Chair of the Cal Poly Human Subjects Committee, at (805) 756-2754, sdavis@calpoly.edu, or Dr. Dean Wendt, Dean of Research, at (805) 756-1508, dwendt@calpoly.edu.

If you agree to voluntarily participate in this research project as described, please indicate your agreement by signing below and participation in the interview. Please keep a copy of this consent form for your reference, and thank you for you participation.

_____   _____   _____
Name of Volunteer   Signature   Date

F. Informed Consent Form (Rubric/Feedback Survey)

Informed Consent Form

INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT, "Discovering Factors Affecting Student Retention in Computer Science at Cal Poly"

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You are being asked to take part in this study by anonymously evaluating my work with the provided rubric. Your participation will take approximately 20 minutes. Please be aware that you are not required to participate in this research and you may discontinue your participation at any time without penalty or loss of benefits. You may also choose to skip questions if you prefer not to answer.

The possible risks associated with participation in this study are minimal, and include minor psychological risk as you are asked to reflect on negative experiences in your education and career. If you should experience any emotional distress, please be aware that you may contact campus Counseling Services in Building 27 Room 135 at **(805) 756-2511** for assistance.

Your responses will be confidential, your name will not be used in any reports of this research. Potential benefits associated with the study include insight on the factors affecting the experiences of a Computer Science student at Cal Poly, and how these factors may be improved.

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If you agree to voluntarily participate in this research project as described, please indicate your agreement by signing below and participation in the interview. Please keep a copy of this consent form for your reference, and thank you for you participation.

_____   _____   _____

Name of Volunteer   Signature   Date

G. Informed Consent Form (Survey)

Informed Consent Form

INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT, "Discovering Factors Affecting Student Retention in Computer Science at Cal Poly"

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You are being asked to take part in this study by completing the following questionnaire. These questions will ask you to reflect on your own experiences as a Computer Science student. Your participation will take approximately 20 minutes. Please be aware that you are not required to participate in this research and you may discontinue your participation at any time without penalty. You may also omit any items on the questionnaire you prefer not to answer.

The possible risks associated with participation in this study include minor psychological risk as you are asked to reflect on negative experiences due to your major. If you should experience any emotional distress, please be aware that you may contact campus Counseling Services in Building 27 Room 135 at **(805) 756-2511** for assistance.

Your responses will be provided anonymously to protect your privacy. Potential benefits associated with the study include insight on the factors affecting the experiences of a Computer Science student at Cal Poly, and how these factors may be improved.

If you have questions regarding this study or would like to be informed of the results when the study is completed, please feel free to contact Diane Eykholt at deykholt@calpoly.edu. If you have concerns regarding the manner in which the study is conducted, you may contact Dr. Steve Davis, Chair of the Cal Poly Human Subjects Committee, at (805) 756-2754, sdavis@calpoly.edu, or Dr. Dean Wendt, Dean of Research, at (805) 756-1508, dwendt@calpoly.edu.

If you agree to voluntarily participate in this research project as described, please indicate your agreement by completing and submitting the following questionnaire. Please print a copy of this consent form now for your reference, and thank you for your participation in this research.

Yes, I volunteer.	No, I do not volunteer.
(This "button" will open the survey.)	(This "button" will exit the survey.)