ATTRACTION AND RETENTION OF WOMEN IN COMPUTER SCIENCE AT WORCESTER POLYTECHNIC INSTITUTE

An Interactive Qualifying Project submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science Submitted

on March 3, 2017

Submitted by:

Christopher Hammer

Brian Keeley-DeBonis

Katherine LaPierre

Hope Wallace

Advised by:

Professor Kathi Fisler

ABSTRACT

This project is intended to help the Computer Science Department at Worcester Polytechnic Institute understand the underlying reasons why female students are underrepresented in the department. Based upon the analysis of 193 survey responses and several interviews, this project builds upon both existing research and the team's own investigations. Our in-depth analysis results in a series of recommendations to increase the number of women in computer science at the university.

ACKNOWLEDGEMENTS

Our team would like to extend a sincere thank you to the following individuals for their support and encouragement throughout the duration of this project:

Our project advisor, Professor Kathi Fisler, who supported our team throughout the entire duration of the project. Her enthusiasm and guidance increased our passion for the project, allowing our IQP to be as impactful as possible.

Professor Craig Wills, for his willingness to share our project with the entire department student body. His help allowed us to reach such a large number of Computer Science students that we would not have been able to access otherwise.

Carnegie Mellon University's School of Computer Science, for providing us with a basis for what an exceptional computer science department should be, in terms of both curriculum and culture. We also thank them for several interview questions we used, adapted from their 2002 Spring Semester Computer Science Seniors (Individual) Interview transcripts.

The University of Maryland, Baltimore County, for their 2016 Survey of College of Engineering & Information Technology Majors, which we adapted a majority of our survey questions from.

Professor Lane Harrison for providing us with Slack usage data from his B16 course, CS4241 (Webware).

Rick Mooney from WPI's Office of the Registrar for aiding us in gathering enrollment data.

All of the computer science club presidents who were willing to sit down with us and talk about their clubs.

The many students who gave us their input regarding the Department, whether it be through our survey, focus groups, interviews, or a combination of the three. Your opinions and concerns provided us with a strong basis for what needs to change in the Department.

Executive Summary

This project sought to identify problems, which persist in the computer science department effecting their culture and diversity, and identifies possible solutions. The computer science department has maintained a roughly 12% female population over the last decade with variation in both directions while almost all other WPI departments rose substantially. The computer science department over the last three years has averaged an 86% retention rate with females only returning at an 83% rate. Females going from their freshmen to sophomore year have the worst retention rate of just 77% over the last three years. Similar drops exist in minority groups relative to the typical student of the computer science department.

Identified Issues

Through our focus groups, interviews, and surveys, we identified the following issues that students feel are highly present within the Department.

1. Lack of peer engagement and community, as the Department does very little to engage students and students do little to engage each other.
2. Lack of productive and usable collaborative, social, and general work areas for Computer Science students
3. Academic advisors are severally underutilized and often fail to make connections with their assigned students
4. Student's with atypical complexions and genders relative to the department come in with less experience and often feel hopeless to catch up and succeed

Recommendations

Our Recommendations for Students:

1. Improve existing computer science clubs by advertising more on campus, hosting more events that the student body would be interested in, and reaching out to faculty advisors for support for their organization

2. Develop an extracurricular activity related to computer science project building to allow students to explore their interests outside the classroom
3. Create a student-run web portal for all Department happenings so students and faculty can remain up to date
4. Adopt a department wide Slack for students to use for various purposes (socialization, academic help, a way to look for personal project collaborators, etc.), as well as a Slack for each course in order for the students to more easily communicate with each other on a social and academic level

Our Recommendations for Faculty:

1. Become more involved in computer science clubs on campus and be a resource for them
2. Advise more proactively by reaching out to students and getting to know students on a more personal level to provide the best guidance possible
3. Better control students who show off in class by redirecting them to a more appropriate setting, such as office hours

Our Recommendations for the Department:

1. Form a better common space in Fuller Laboratories for students to gather
2. Continue to survey the students in the department, keeping up with the latest issues and concerns of students and faculty to ensure that these issues are known as being addressed
3. Conduct future IQP's to expand upon ours, such as improving our survey or analyzing the best way to design a potential new common space

AUTHORSHIP

This project represents the joint efforts of all four team members. Each team member contributed equally to the writing and research to the best of their ability.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

Computer Science departments at universities throughout the United States are plagued by diversity issues, particularly in regards to their gender composition. In 2012, 9,804 undergraduate degrees in computer science were conferred, 8,525 to men and 1,279 to women, equating to only 13% of degrees being awarded to women.[1] The issue of diversity in CS begins before university and college, having roots in the high school and grade school levels. For example, in 2013, women made up only 19% of the Advanced Placement Computer Science A test takers.[2] The underrepresentation of women participating in CS in high school persists at the university level, and is then carried over into the workforce; even at Google, one of the most progressive software giants, only about 19% of employed software engineers are female[3].

The same gender ratio issue is present within the CS Department at Worcester Polytechnic Institute, WPI. Over the past six years, the percentage of female enrollment at WPI as a whole has grown from 30% to 34%, yet the computer science department has only seen a 1% increase in female enrollment over the same time frame. CS has been the fastest growing major at WPI since 2011, and although the department's enrollment overall has more than doubled in size, the diversity of the student population, especially in regards to women, has not grown at the same rate. Since 2010, the department has been the most underrepresented by women undergraduates at WPI.

Several universities have decided that the representation of women within their CS departments was lower than they liked and resolved to take action. Universities that have been successful in making progress towards improving the representation of women in

---

[1] National Center for Education Statistics. (2013, July). Bachelor's, Master's, and Doctor's Degrees Conferred by Postsecondary Institutions, by Sex of Student and Discipline Division: 2011-12. Retrieved February 28, 2017, from Digest of Education Statistics, https://nces.ed.gov/programs/digest/d13/tables/dt13_318.30.asp

[2] Georgia Tech. (2014, November 12). AP data for the United States: 1998-2013. Retrieved February 28, 2017, from College of Computing, http://home.cc.gatech.edu/ice-gt/321

[3] Google. Google Diversity. Retrieved February 23, 2017, from Google Diversity, https://www.google.com/diversity/index.html

their CS departments began by identifying underlying causes. Most of these schools identified issues with department culture, introductory curriculum, clubs and activities, admission criteria, and the lack of mentorship. After finding the underlying issues, these universities addressed them, implementing curriculum overhauls, fostering stronger culture, and developing mentorship programs.

Despite several top universities conducting studies and looking into the issues of diversity within their CS departments, WPI has yet to assess why their CS Department's gender ratio and department diversity is so severe. The objective of this project is to gather data and identify the underlying reasons why WPI's CS Department is so greatly underrepresented by women, relate the gathered data and findings to existing research conducted by other universities, and finally, to put forward a set of carefully constructed recommendations. The main research questions we sought to answer were:

1. Do students feel comfortable in the Computer Science Department at WPI?
2. Do students feel connected to and supported by their peers and faculty?
3. Are students finding the desired opportunities to explore their more specific computer science interests through clubs and extracurriculars?
4. Is the introductory curriculum engaging to students of all levels of experience and backgrounds?

The implementation and evaluation of our recommended changes falls outside of the scope of this project.

2 BACKGROUND

2.1 WPI HISTORY: GENERAL & THE COMPUTER SCIENCE DEPARTMENT

Worcester Polytechnic Institute was founded in 1865 as one of the first technological and engineering universities in the United States. The school was founded as an all-male institution and remained that way until 1968 when, under the leadership of Harry P. Storke, the school became coeducational. Since this time, the school has slowly built up its female population, matching relatively closely to averages for tech and engineering schools around the nation.

Between the years 1989 and 2008, the national average of degrees awarded to women in engineering fields rose from 10% to 21%[4], and in the year 2008 Worcester Polytechnic Institute awarded 22% of their undergraduate engineering degrees to females (Biomedical Engineering, Chemical Engineering, Civil & Environmental Engineering, Electrical & Computer Engineering, and Mechanical Engineering). Since 2008 the percentage has risen to 38% in 2015.

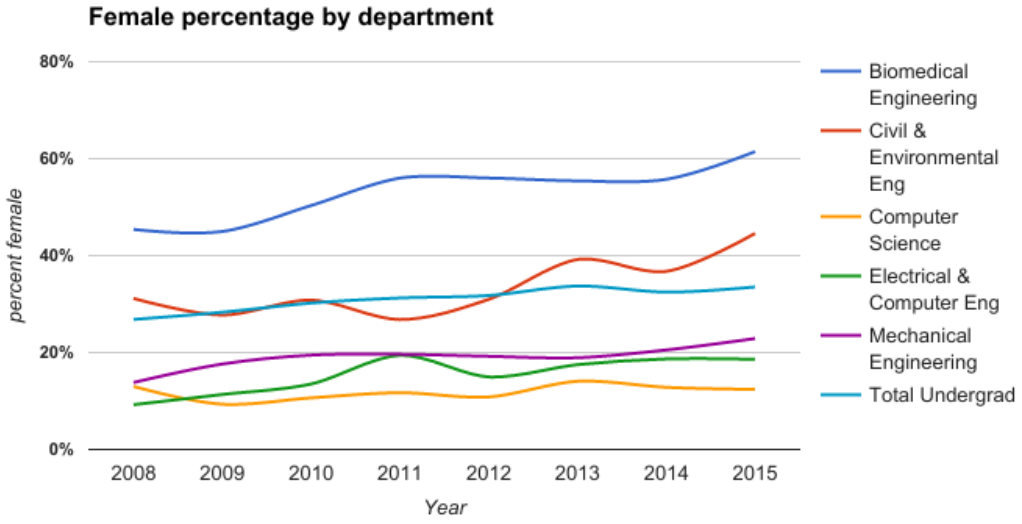


Figure 2.1: Female Enrollment Percentage by Department

[4] National Science Foundation. (2012, February 16). Undergraduate education, enrollment, and degrees in the United States. Retrieved February 27, 2017, from National Center for Science and Engineering Statistics, https://www.nsf.gov/statistics/seind12/c2/c2s2.htm

Of the degrees represented in the above statistics, it was Electrical & Computer Engineering, and Mechanical Engineering in both 2008 and 2015 with the lowest percentage of female graduates, standing at 9% and 14% respectively in 2008, improving to 19% and 23% respectively by 2015.

Worcester Polytechnic Institute, since 2008 has fairly consistently increased their female percentages in almost every major, especially when controlling for majors with fewer than 60 declared students. Amongst large departments, the clear exception is the Department of Computer Science (not included in above calculations for engineering to remove weighting towards itself). The computer science department fell from 13% to 12% female from 2008 to 2015 respectively. During the same time frame the department grew from 246 declared students to 476 declared students, a growth of 93%.

The computer science department at Worcester Polytechnic Institute had its start in the Gordon Library with the purchase and installation of an IBM 360/40 as the WACCC in the mid 1960's. The school first offered a Master of Science in 1968 and added undergraduate degrees in 1970.

The computer science department quickly outgrew the Gordon Library and took up new offices in Atwater Kent in 1980. By 1989, nine years after they began offering computer science degrees, they reached 165 undergraduate students and about 65 graduate students. In 1990, they moved into the newly constructed Fuller Laboratories.

During the late 1990's and early 2000's, computer science across the country went through a boom and bust in terms of the number of entering CS majors, largely as a result of the .com bubble. The Computer Science department swelled to 608 total undergraduate students, 210 of whom were freshmen in 2001. The following year, that freshmen class, along with the .com bubble burst and dropped to only 136 students as sophomores. At the same time, admissions dropped heavily as well. In 2008 the department had a total of 246 undergrad students, a drop of over 59% from seven years earlier.

Between 1998 and 2003, the number of computer science undergraduates more than doubled nationally, from about 27,000 to just less than 60,000. Because of this rapid expansion, many computer science departments around the country struggled to keep up with the growth rate and had to scramble to find the room, curriculum, and professors to

accommodate the mass expansion. Between 2004 and 2008, the number of computer science undergrads contracted from the 60,000 down to just about 40,000, a drop of around 33%. This boom-bust cycle has led many computer science departments and administrations to question if the current expansion, from that 40,000 up to 65,000 in 2014, is sustainable or another bubble.[5]

Issues like these bubbles exasperate the diversity issues, as they create lags in the expansion of computer science departments to meet the demands of a changing tech industry and changing complexion of those seeking degrees.

2.2 WPI Computer Science Related Extracurriculars

Outside of class, computer science students at WPI have few options for major related extracurriculars. ACM, the Association for Computing Machinery, is a national association open to all students in computer science and computer science related fields. Nationally, ACM has over 100,000 members. ACM on Worcester Polytechnic Institutes campus offers several events open to both members and nonmembers. These events include coding interview practice, occasional hack-a-thons, a coffee house event, and language labs. However, despite being the most general computer science related club, they have a low membership. ACM lists just 65 active members out of a department with around 500 undergraduate students.

WiCS, Women in Computer Science, is an organization open to all students with the added functionality of programming designed to cater more specifically to women. They hold weekly social events, engage in community outreach, and occasionally hold professional events with prospective employers. Their goal is to provide support for women in the field in the area of their "three pillars": social, career, and academics.

The Cyber Security Club facilitates events related to Computer Security and related topics. Events include weekly lunchtime meetings where current issues in Cyber Security are presented, weekly labs, where hands-on Cyber Security skills are taught, and competitions.

---

[5]Roberts, E. (2016). A History of Capacity Challenges in Computer Science, 1–24.

UPE, Upsilon Pi Epsilon, is a nationally affiliated honor society open to students who meet specific criteria to join. The criteria are purely academic requirements for GPA both in and out of computer science courses. They host several help sessions open to the student body, but after being initiated into the organization there are no formal requirements for members.

2.3 Other Universities' Approaches

Other American universities have already begun tackling the issue of the lack of women in computer science in their respective departments. Across studies from several major universities, similar conclusions emerge that the issue boils down to both culture and curriculum, with neither outweighing the other in importance. Cultural and curricular changes need go hand in hand in order to make a long-term impact.

2.3.1 Cultural Changes

Cultural changes have been very similar across several universities, notably the University of Pennsylvania, Stanford University, and Rice University. A common initiative that was established was to increase the amount of mentoring and support within the department, both from faculty members and from peers.

At the University of Pennsylvania, faculty felt they need to make themselves more approachable to undergraduates outside of scheduled office hours for their courses in order to foster strong student-to-faculty bonds. They established advising sessions where students were encouraged to come individually or in groups, simply to talk about course selection, research opportunities, career choices, or how their academics are going as a whole. Not only did this help build a bridge between students and faculty members, but it also helped the students form a sense of community with each other[6].

[6] Powell, R. M. (2008). Improving the persistence of first-year undergraduate women in computer science. ACM SIGCSE Bulletin, 40(1), 518. doi:10.1145/1352322.1352308

The department also put a heavy focus on pushing students, especially first years, to look into research opportunities, believing that undergraduates don't have to wait until they're more "experienced" in order to conduct meaningful research. This encouragement by faculty helped boost the confidence of female students especially, as research has shown that "it's not what faculty say to discourage, it's what they don't say to encourage." Small encouragements like these have been proven to help keep minorities and females in the major.

Stanford's study on the recruitment and retention of undergraduate women in computer science also notes the importance of faculty role models, both male and female, in women's learning experience. Through Stanford's Sophomore College program, students entering their sophomore year are given the opportunity to attend a series of intensive summer seminars relating to the different majors the university offers. Their computer science focused seminar, "The Intellectual Excitement of Computer Science", allows students to work alongside faculty on engaging research projects catered to their individual interests; in the past, projects have involved human-computer interaction, robotics, and artificial intelligence. They also receive lab tours and attend guest lectures. The goal of the seminar is to help "dispel the myth that computer science is only about computer programming". The program has proven to be successful, given that[7]:

> *"The women involved in the program overwhelmingly choose to major in computer science. Of the 22 women who have since declared a major, 17 have chosen to major in computer science with one of the remaining five deciding to major in another engineering discipline. This level of retention (74 percent) is marginally higher than the corresponding rate for men (72 percent)."*[8]

---

[7] Roberts, E. S., Kassianidou, M., & Irani, L. (2002). Encouraging women in computer science. ACM SIGCSE Bulletin, 34(2), 84. doi:10.1145/543812.543837

[8] Redmond, K., Evans, S., & Sahami, M. (2013). A large-scale quantitative study of women in computer science at Stanford University. *Proceeding of the 44th ACM Technical Symposium on Computer Science Education - SIGCSE '13*, 439–444. doi:10.1145/2445196.2445326

Peer mentoring, as argued by some universities such as Stanford, is equally (if not more) important than faculty mentoring. They argue that it's more difficult for undergraduates to see themselves in the shoes of a faculty member. Faculty members are almost always twenty or more years older than students are, while fellow undergraduates are only a few years ahead. It's easier for undergraduates to connect with peer mentors, and to see what they could become in just a few years. Stanford refers to these peers as "stepping-stone role models".

Another popular peer mentor program that was established at several of these universities, including Rice and University of Pennsylvania, was either through the extracurricular activity Women in Computer Science (WiCS) or CSters. WiCS's "big sister" programs and CSters pairs first year or incoming female computer science students with another female computer science major who is a few years older than they are. By having a "big sister" and also a community of other females in computer science that they can turn to, women reported feeling more supported and welcome in the computer science department at each university.[9] These organizations also would hold luncheon talks with faculty and industry members to further spark these women's interest in the major. They also helped send several members each year to the Grace Hopper Celebration of Women in Computing Conference.

2.3.2 CURRICULAR CHANGES

Curricular changes have also been a large part of the departmental revamp at these universities, a majority being focused on the introductory level courses. While different approaches have been taken at different universities, the consensus has remained unanimous — the first computer science course or two makes or breaks the major for many students, whether they be female or another minority group, or even men. As a result, these universities have found that their curricular changes aimed at increasing the

[9] Beretto, H. (2015, April 11). CSters empowers Rice women in computer science. Retrieved February 23, 2017, from Rice University Department of Computer Science, https://www.cs.rice.edu/content.aspx?id=870

retention rate of females have also decreased attrition for other minorities (racial, ethnic, etc.) and males.

The University of Virginia implemented three different sections of their CS101 course: one for students with a good amount of prior programming experience, one for the general population, and one course that was aimed at minorities in particular, named CS101X. This minority-targeted course covered the same material as the general and advanced level courses (partially in order to prevent it from being seen as a "remedial" level course), but it utilized a different format compared to the other two courses. Anybody was eligible to enroll in CS101X if they felt that the unique setup would benefit them; however, minorities who felt they would be better suited for a different CS101 course were encouraged to take that course instead. The enrollment number per section was kept small, with less than seventy students, in order to help foster community and encourage questioning and discussion. The students in this course also received double or triple the number of assignments, as did the students in the other CS101 courses, though the assignments were identical, just broken up into smaller sections. This was done to set the focus on small steps in problem solving. Students who had completed the course reported that shorter assignments helped them grasp the material better by focusing on one concept at a time.[10]

In the minority-focused course, lab and lecture were integrated into one section. Computers were always available for the students to work on during class; students were either required to bring their own laptop, or were provided one by the department for use in class in order to allow students to work on problems while the professor lectured and to give students who perhaps have less computer experience more experience actually working on the machine.

Since the students in the minority-focused course were assumed to be coming from a wide range of backgrounds, both in terms of programming and otherwise, the topics that were integrated into the curriculum were designed to appeal to a wide range of interests.

---

[10] Cohoon, J. P. (2007). An introductory course format for promoting diversity and retention. ACM SIGCSE Bulletin, 39(1), 395. doi:10.1145/1227504.1227450

Video game concepts, psychology, health, and business were all brought into the assignments that were given to the class. These topics were chosen based on an interest survey that was distributed to all of the students enrolled in the course. Not only did this help demonstrate to the students the different applications of computer science, it also helped engage them by offering assignments that aligned with their personal interests.

Over a five-year span, the impact of CS101X was deemed highly positive. Retention of students in the major, the number of students who declared computer science as their major after taking the course, and students' overall opinions of the course were all taken into account. Offered every semester, women and minorities were always overrepresented in the course; female enrollment was typically around 45%. Also, more minorities declared computer science as their major after taking CS101X, compared to the general or advanced courses. Students cited some of the unique aspects of the course as key factors in their success, including the high level of student-faculty interaction and the curricular focus on the importance of problem solving.[11]

While the University of Virginia focused their introductory classes on programming, some other universities such as the University of Maine and University of Illinois Urbana-Champaign took a different approach. UMaine implemented a new "Introduction to Computer Science" course that could be taken before the first computer science "programming" course. This course was intended for first semester freshmen; it explored the many disciplines of computer science, including what computer scientists in the workforce do and how they solve industry problems. There was also discussion of different applications of computer science, relating to operating systems, networks, cyber security, and more; their goal was to show that computer science is more than simply typing code. This course was meant to be kept small in enrollment and be mostly discussion based, especially focusing on discussing problem solving techniques. As the number of students interested in taking the course rose over the years and lectures could no longer be as small as the originally were, students were then "required to attend small recitation sections

[11] Cohoon, J., & Tychonievich, L. (2011). Analysis of a CS1 Approach for Attracting Diverse and Inexperienced Students to Computing Majors. *Sigcse'11*, 165–170. doi:10.1145/1953163.1953217

each week so that they [would] have an opportunity to get to know the teaching assistant."[12]

2.4 Points of Consensus and Debate

Universities that have successfully begun transforming their CS departments share specific points of consensus and debate about the underlying causes for the lack of diversity within their departments and largely agree on which actions are effective in improving the representation of women. Some specific approaches, which will be compared and contrasted below, are from: Carnegie Mellon, University of Pennsylvania, and Rice University.

2.4.1 Similar Interests in CS

The first point of agreement is that CS students develop a varied and wide array of interests within the discipline of CS. One gender is not less or more inclined to pursue a specific area of CS, e.g. systems programming, user experience, cyber security, web development, software engineering, or computational theory. However, there is a perception from many students who do not have prior CS exposure and non-CS majors that CS is a narrow field. Because this negative perception exists, it is important that introductory courses help alleviate this misconception by alluding to the broadness of opportunities within CS.

2.4.2 Importance of Clubs and Advising

There is widespread consensus that clubs and mentorship programs are vital to progressing, encouraging, and keeping women in CS. For example at CMU, the computing club Woman@SCS, was imperative to the successful transformation of their CS department[13]. Woman@SCS provided peer mentoring, support, and networking

---

[12] Turner, E., Albert, E., Turner, R., & Latour, L. (2007). Retaining majors through the introductory sequence. *SIGCSE '07: Proceedings of the 38th SIGCSE Technical Symposium on Computer Science Education*, 24–28. doi:10.1145/1227310.1227321

[13] Blum, L., & Frieze, C. (2005). The evolving culture of computing: Similarity is the difference. *Frontiers: A Journal of Women Studies*, *26*(1), 110–125. doi:10.1353/fro.2005.0002

opportunities that the women in CS at CMU would not otherwise have had due to their minority presence in the department. A study measuring the retention rate of freshmen women in CS at UPenn, also found that the strong presence of mentorship, especially peer mentoring, support, and professional development clubs was critical to improving retention within their department. Statistically, women entering CS as freshmen may not have the same level of pre-exposure to the broad applicability of CS. Related clubs and extracurriculars can help build confidence, and provide motivation to continue with the major[14].

2.4.3 Culture is More Important if Modern Curriculum Already in Place

There were varying opinions as to how much of an impact changing an introductory curriculum has on diversity as compared to changing and improving culture. For example, CMU ultimately concluded that changing culture and not curriculum was the most important factor for developing their progressive CS department and that any curriculum changes made with the intent to help specifically only women would just sideline women and setback progression[15]. However, a modern curriculum is important. At the University of Wisconsin — Madison, surveys were conducted in regard to student engagement and student frustration with assignments in introductory CS courses. The results showed that the most engaging assignments were often related to pure CS topics, like algorithms and data structures. They also found some interesting correlations between frustration levels and engagement. Assignments that were either too frustrating or too simplistic were found to be disengaging, whereas assignments that provided a healthy level of frustration and difficulty but were still feasible to complete, were considered the most engaging assignments[16]. Because of this, the faculty behind the survey urge using student feedback

---

[14] Powell, R. M. (2008). Improving the persistence of first-year undergraduate women in computer science. *ACM SIGCSE Bulletin*, *40*(1), 518. doi:10.1145/1352322.1352308

[15] Redmond, K., Evans, S., & Sahami, M. (2013). A large-scale quantitative study of women in computer science at Stanford University. *Proceeding of the 44th ACM Technical Symposium on Computer Science Education - SIGCSE '13*, 439–444. doi:10.1145/2445196.2445326

[16] Hansen, S., & Eddy, E. (2007). Engagement and frustration in programming projects. *ACM SIGCSE Bulletin*, *39*(1), 271. doi:10.1145/1227504.1227407

to improve assignments. Rice University also attributes a complete revamp to their introductory CS courses, making the courses more about computational thinking and less about traditional programming procedures and techniques, to engaging students both with and without prior programming experience, to their success in bringing the female student population up to 36% in 2015[17]. The fact the CMU's curriculum may have already resembled that of the modern, revamped curriculum of other schools, like Rice University, may be reason as to why they found minimal curriculum changes were needed in their approach to improve diversity within their CS department. It is worth noting that WPI's own introductory CS curriculum was revamped in 2004 by Kathi Fisler, Professor of Computer Science at WPI, and resembles that of a modern CS curriculum[18].

2.4.4 Short-lived Advantage from Prior CS Exposure

It is inevitable that students with prior programming experience will typically have an easier time with introductory level courses. However, most universities have found that beyond the introductory courses, the advantage possessed by students with prior CS experience is negligible. A study conducted by Stanford reports that prior exposure to CS helps only in the first year of introductory courses and that the advantage quickly subsides[19]. Stanford and CMU jointly agree that students both male and female who enter college without prior CS experience are no less likely to succeed than their counterparts who may have programmed for many years prior to college. Therefore, as demonstrated by the University of Virginia, having multiple versions of introductory courses that present material of a similar level but in different formats, can be imperative to keeping students who are new to CS in the major. Offering an alternative introductory course that targets students new to the subject, removes the opportunity for these students to negatively

---

[17] Kurp, P. (2015, September 9). Revamped curriculum leads to more women in CS. Retrieved February 23, 2017, from Rice University Department of Computer Science, https://www.cs.rice.edu/content.aspx?id=2147483798

[18] Worcester Polytechnic Institute. (2015). Computer Scientist Kathi Fisler Receives WPI's 2015 Chairman's Exemplary Faculty Prize. Retrieved from https://www.wpi.edu/news/chair

[19] Redmond, K., Evans, S., & Sahami, M. (2013). A large-scale quantitative study of women in computer science at Stanford University. *Proceeding of the 44th ACM Technical Symposium on Computer Science Education - SIGCSE '13*, 439–444. doi:10.1145/2445196.2445326

compare themselves to those with disproportionately more experience. By taking an alternative course, students are able to build up their confidence in preparation for intermediate and advanced levels courses, which are challenging to all students, instead of being overwhelmed or dissuaded from continuing their CS studies.

2.4.5 Correlation Between Culture and Diversity

Universities agree that changing culture is vitally important to transforming the student makeup to one that is more diverse. In a field that has long been predominantly male and in departments that are so lacking in diversity, it is only natural for students who are of the minority to feel uncomfortable and out of place. Changing culture and department makeup is a mutual process. As department culture improves, department diversity improves; as diversity improves, culture improves. Improving culture does not happen overnight, but schools like CMU have found that over time, as the gender composition of their CS department became more equal, the quality of their culture also significantly improved.

2.4.6 Summary

The collective findings from the above universities show that there are primarily three actions that are proven to improve the representation of women in CS. These actions are: (1) developing an inclusive, collaborative, and engaged CS culture, (2) revamping, if needed, the introductory curriculum to one that engages students with varying levels of experience, and (3) providing clubs, advising, and mentorship that promote peer mentoring, networking, opportunities, and support specifically for women and underrepresented minority groups within CS.

2.5 Measures of Success

For studies of retention rates of women in CS, success is measured using both statistics and student interviews and surveys. An increase in the retention rate of women in the respective CS department is the most straightforward way to show success. Some universities compare the number/percentage of women in their CS departments to that same number/percentage in previous years, while others compare their percentage of women to the national percentage of women in the major. Comparing interviews and

surveys with students before and after initiatives are taken to increase the retention rate of women can also be used to prove success in this field.

Studies at other universities were able to show an improvement in the gender ratio based purely on numbers. The University of Virginia reported that the percentage of women in their computer science department rose to "four percentage points higher than the national rate" after reworking their first year computer science curriculum.[20] Some universities, such as University of Illinois at Chicago, measured success based on their retention rate in the department as a whole, stating "addressing the factors that cause women to avoid CS, may also increase the number of men".[21] They measured their success based on the total number of students in the major because more students implies that there are more women, but not necessarily a higher percentage of women. Likewise, Stanford University said that their study "focused [...] on increasing the number of women enrolled in computer science, as opposed to the percentage".[22] These universities saw an increase in the number of women in their computer science department in the years following the changes they made based on their respective study results, but some were also able to measure success based on student feedback.

Carnegie Mellon University measured their success in changing the culture of their CS department by interviewing students. Studies conducted at CMU pre-1999 concluded that the overall student body believed that there were significant gender differences and that all of the students had similar interests to one another.[23] A few years after changing their admissions criteria, students within the CS department were interviewed regarding their perceptions of the culture in the department. The perceived gender differences

---

[20] Cohoon, J. P. (2007). An introductory course format for promoting diversity and retention. *ACM SIGCSE Bulletin*, *39*(1), 395. doi:10.1145/1227504.1227450

[21] Sloan, R. H., & Troy, P. (2008). CS 0 . 5 : A Better Approach to Introductory Computer Science for Majors. *Media*, 1–5. doi:10.1145/1352135.1352230

[22] Roberts, E. S., Kassianidou, M., & Irani, L. (2002). Encouraging women in computer science. *ACM SIGCSE Bulletin*, *34*(2), 84. doi:10.1145/543812.543837

[23] Frieze, C., & Quesenberry, J. (2015). *Kicking Butt in Computer Science: Women in Computing at Carnegie Mellon University*. Dog Ear Publishing.

among the students disappeared, as one female student put it, “Most people don’t really seem to care about my gender. They care about whether I can solve problems or not”. Another student said “There’s lots of people with lots of different interests and backgrounds”, suggesting that the department is more diverse than it was prior to changing admissions criteria. The interviews proved to Carnegie Mellon that changing admissions criteria changed the CS department’s culture.

3 METHODOLOGY

The main goal of our project was to gather data in order to identify the underlying reasons why WPI's Computer Science Department has such a low representation of women. In order to achieve this goal, we focused our research goals on creating a survey, as well as conducting focus groups and interviews with students who had some sort of experience within the CS department.

3.1 THE FOCUS GROUPS & INTERVIEWS

The team first decided to conduct focus groups and interviews prior to the survey's creation and distribution. During the first several weeks of our project, we decided that it would be beneficial to speak with several of our friends who are currently majoring in Computer Science in order to gauge which issues were the most apparent before crafting our survey. Our first focus group consisted of two males and two females; all were upperclassmen. Since these four people all seemed eager to participate, we assumed that they already had opinions to share, so we left the conversation completely open ended. The main topics that these students voluntarily brought up were:

- The apparent uselessness of labs in the introductory CS courses
- The lack of computer science related extracurriculars and events
- The lack of effective teamwork in both introductory classes and beyond
- The gap between the vocal, "overachieving" students and the majority

Based on their responses, as well as the background research we had conducted, we chose to focus on the following high-level research questions:

1. Do students feel comfortable in the Computer Science Department at WPI?
2. Do students feel connected to and supported by their peers and faculty?
3. Are students finding the desired opportunities to explore their more specific computer science interests through clubs and extracurriculars?
4. Does the introductory curriculum engage and build confidence in students of all levels of experience and backgrounds?

As the initial focus group mostly voiced concerns relating to culture, we chose to focus our survey heavily on that aspect, instead of curriculum. While most of our background research was curriculum-related, we knew that it would be more within our abilities to impact the culture of the department, as opposed to the curriculum.

We also decided to conduct several focus groups, as well as individual interviews, after the survey responses had concluded. While our goal for the original focus group was to try to determine what topics to focus on for our survey, the post-survey groups and interviews were to help us gather any important data or opinions that may been missed through survey questions alone, and to delve deeper into interesting points that were brought up by the survey.

Following the closing of the survey, follow-up emails were sent out to those who had indicated on the survey that they wished to be contacted for potential focus group or interview participation. Over the course of two weeks, we conducted two focus groups, one with four students in attendance, and the other with three students. We individually interviewed an additional seven students.

While the guided discussion of the focus groups and interviews pertained to the same topics from the survey, the questions we asked were more direct, mostly due to time constraints. We scheduled each focus group for one hour, and each interview for thirty minutes. A majority of the sessions lasted for the full scheduled time. Under the assumption that those who wished to be in a focus group or interview had thoughts they'd like to share, we tried to keep the format as unstructured as possible and the questions generic to encourage the participants to bring up the issues they felt impacted them the most.

Overall, the quality of responses we received from the focus groups and interviews were not as usable as the open response questions from our survey in which we offered a place for respondents to share any opinions, concerns, and potential changes they wish to see. While the survey responses were generally well thought out and phrased, the interview and focus group responses were not. We assumed this was because respondents had more time to collect and organize their thoughts while answering the survey questions on their own time. On the other hand, the focus groups and interviews had a time

constraint for participants to respond, and may have been an uncomfortable environment for some participants to voice all of their thoughts.

3.2 The Survey

Distributing a survey to students who may have valuable input regarding our research objectives was our main method of data collection. It was necessary to create a survey that was lengthy enough to cover all of the questions needed to provide a full understanding of the demographic, yet not too long as to discourage students from taking it. The questions needed to be clear and in a logical order that would make sense to the survey taker; we didn't want respondents to constantly be jumping back and forth between topics.

We debated whether or not to send out multiple surveys for multiple demographics: upper-class CS majors, underclass CS majors, CS minors, Robotics Engineering majors, etc. We decided against this idea because multiple surveys sent out by the same IQP group would most likely cause confusion among students as to which ones they've already taken or should take. Instead, we chose to create one master survey that could be sent to students of all demographics; we could filter the survey results afterwards in order to separate information from these different demographics.

One of our main target demographics for the survey was upperclassmen within the computer science major. We wanted students who have not only spent a significant amount of time within the department and could attest to its culture, but also students who have taken several computer science courses. The non-introductory computer sciences courses at WPI are structured very differently than the introductory ones, so we wanted input from students who had experienced both already. On the other hand, we also wanted the opinions of underclass students who had taken a CS course or two because we wanted to gauge their "first impressions" of the department (and whether or not those first impressions were positive).

The idea to create one master survey for all students to take was made possible by our use of Qualtrics. We chose Qualtrics as our survey host for several reasons. Since a large majority of surveys sent out by WPI and WPI student organizations and project groups such as ours use Qualtrics, we knew the system is well-trusted by the student body.

Qualtrics also provides a "skip logic" feature, which is what allowed us to only send out one survey for the entire student body. By utilizing skip logic, the survey can be set to either end, hide, or display certain questions/answers based on how the survey taker answers certain responses. For example, one of the first questions on the survey was the number of CS classes a person has taken; if they answered 0, the survey was set to end automatically. Skip logic was also used to prompt the survey taker to answer more specific questions if they answered "yes" to "have you considered changing your major?" A similar filter was used for the question "are you an international student?" If not, questions about their race and ethnicity were asked. By filtering out questions that were irrelevant for certain survey takers based on their previous responses, we were able to keep the survey as short as possible for everyone taking it.

Appendix A contains a complete copy of the survey. Appendix B has a breakdown of each survey question in terms of the higher-level research question it was designed to help us answer.

Using responses from our original pre-survey focus group, we crafted our survey questions based on the issues and topics they felt were most apparent. From our initial focus group, we realized that curriculum was not nearly as much of an issue as we expected it might be, while overall culture was a major concern. As a result, we chose to focus our survey more on the environment of CS at WPI, taking factors into consideration such as collaboration between students, the availability of faculty support, and how comfortable people feel in the department.

For the basis of our survey, we consulted a similar survey that the University of Maryland, Baltimore County (UMBC) created in 2016. The UMBC survey was a partner study between their Center for Women in Technology and their College of Engineering and Information Technology; the goal was to "learn more about the experiences of undergraduate students in engineering, computer science, and information systems majors at UMBC in order to inform changes to increase the success of all students in the college." Since our survey had a similar purpose, so we chose to keep and adapt many of the questions from their survey. We chose to remove any of the potential question responses that weren't relevant to WPI specifically, including answers referencing clubs or resources not available on our campus. We also removed many of the questions relating to future

careers, including ones such as “how important are the following characteristics of a career in computer science to your future plans?” While we did want to make sure that students felt they were receiving adequate pre-career planning advice, the specifics weren’t relevant to our study. Questions that seemed to be duplicates were also ignored; many questions in the UMBC survey alluded to gender and sexism, and while this was a topic we wanted to focus on, we didn’t see the need for several different questions that would probably yield similar data. We tried to cut down on as many questions as possible for two main reasons: we didn’t want to survey to be too long as to discourage students from taking it, and we also didn’t want to have too much data to try to piece together.

Our distributed survey consisted of 39 questions of varying types, including multiple choice, multi-check checkboxes, Likert questions on a 5-point scale, and open response. We broke the survey into sections based on general topic.

- **Section 1:** Basic background questions: major, year, number of computer science classes taken, gender, GPA, etc.
- **Section 2:** Overall atmosphere of the CS department, including how gender impacts experience, and if/why someone considered leaving the department
- **Section 3:** Blend of culture and curriculum, asking 1-5 rating questions such as “you collaborate with others during lab” and “you find it easy to find other students to work with on class related assignments”
- **Section 4**: Simple questions about extracurricular involvement in the CS department and on campus as a whole
- **Section 5:** Culture outside of the classroom, mainly in regards to faculty guidance and mentorship
- **Section 6:** Office hours and class participation
- **Section 7:** Open responses and additional feedback opportunities

Our main approach to the distribution and marketing of our survey was through the current Computer Science Department Head, Craig Wills. We also planned on contacting professors individually to either email their own students, or to mention our survey to

them during class. Other methods we planned to use were advertisements/posters, as well as individual outreach to students the team knows personally.

We first distributed posters with a QR code linking to our survey around campus, mostly focused in Fuller Laboratories, home of the CS department. We also planted posters in Gordon Library and Atwater Kent Laboratories. Qualtrics allowed us to track how many survey takers were directed to the survey through each poster's QR code. Based on the analysis from Qualtrics, the poster marketing method was not successful; only a dozen or so survey takers came from a QR code. We then all reached out to individuals we know personally who would most likely be interested in taking the survey; this warranted approximately 20 responses.

However, the most successful method of distribution was through Craig Wills. He emailed out a link to our online Qualtrics survey to all Computer Science, Interactive Media & Game Development, Robotics Engineering, and Bioinformatics & Computational Biology majors, as well as Computer Science minors. Through the 1000+ students who received the survey link, in a matter of days, we had reached almost 200 responses. With a goal of approximately 50 responses, we decided not to focus too heavily on our other marketing methods. We did not continue to individually reach out to friends, nor did we replenish the supply of posters in different buildings. We also chose not to personally contact professors in hopes that they would share the survey with their own students; however, we did have our advisor, Professor Fisler, send out the survey link to her current CS2102 (the second course in the introductory CS sequence) students, as well as other professors who may be interested in encouraging their students to participate.

In order to incentivize students to take our survey upon clicking on the link, we identified two important factors that we as students usually consider when taking a non-mandatory survey: monetary compensation (or equivalent), and knowing the results of the survey. Taking into account these two factors, we decided to give survey takers the option to provide their email address at the end of the survey, so they could be entered into a raffle for one of five $20 gift cards. We also, through Qualtrics, were able to provide another link to live-updating data with the results of the survey. This data was anonymous (any identifying information had been removed, including open response question results). While we cannot be sure how well the live data incentivized students, there were only a

handful of respondents that did not enter their email address to be entered into the raffle, so we can assume that it was an effective incentive. We also did mention in the introduction to our survey "[Their] responses could help improve the department and make a measurable impact." As this survey was almost entirely opinion based, we assumed that students would be more likely to share their thoughts and experiences if they knew that their input could potentially make a difference.

We chose to close the survey after three weeks, with a total of 193 responses, after the response rate started to slow down dramatically. Also, the distribution of students who had filled out the survey at this point was almost exactly where we wanted it to be. Graduation year was approximately 25% for each; the gender breakdown was 22.5% female and 73.6% male, which is closer to the WPI distribution than the CS Department distribution.

4 Data and Analysis

4.1 Introduction

The goal of our survey, interviews, and focus groups was to understand the current state of the CS culture at WPI. We gathered students' opinions about the advising and mentorship resources offered, determined the presence and level of activity of CS clubs, and looked at the introductory CS curriculum to see if it builds confidence in students from varying backgrounds and experience levels. These goals were motivated by the underlying requirements we identified in our background research (strong club presence, a confidence-building curriculum, and proactive advising) as critical aspects of a CS department that must be strong and present in order to develop a successful, diverse, and engaged CS department. The findings from our survey and focus groups were profound. We found the CS culture to be isolating and disengaged, learned that the majority of students do not seek available faculty advising, and discovered that clubs have a near nonexistent presence on campus with little student involvement.

4.2 Statistical Background

The following data give a good picture of where the department currently stands in terms of diversity.

	Overall Retention Rates			
	14-15	15-16	16-17	3 Year Average
Overall	85%	88%	86%	86%
Junior to Senior	91%	82%	90%	88%
Sophomore to Junior	86%	92%	88%	89%
Freshmen to Sophomore	80%	89%	81%	83%

Table 4.2.1: Overall Retention Rates[24]

[24]Data obtained from WPI's Office of the Registrar.

	Female Retention Rates			
	14-15	15-16	16-17	3 Year Average
Overall	84%	86%	78%	83%
Junior to Senior	100%	100%	81%	94%
Sophomore to Junior	71%	81%	94%	82%
Freshmen to Sophomore	75%	87%	68%	77%

Table 4.2.2; Female Retention Rates[25]

	Male Retention Rates			
	14-15	15-16	16-17	3 Year Average
Overall	85%	89%	87%	87%
Junior to Senior	89%	81%	91%	87%
Sophomore to Junior	87%	93%	87%	89%
Freshmen to Sophomore	81%	90%	84%	85%

Table 4.2.3: Male Retention Rates[26]

As would be expected, retention rate from freshmen to sophomore year are the lowest with an average of 83% over the last 3 years. Junior to senior and sophomore to junior retention rates are similar at about 88% and 89% on average. When split for gender the female population shows signs of struggle averaging 8% and 7% worse retention rates than males from freshmen to sophomore and sophomore to junior years respectively over the three year period.

Demographics for Overall Computer Science Department:

[25] Data obtained from WPI's Office of the Registrar.
[26] Data obtained from WPI's Office of the Registrar.

The CS department as whole breaks down according to the following demographics from the WPI 2016 Fact Book:

	Female percentage by year							
	2008	2009	2010	2011	2012	2013	2014	2015
Computer Science Department	13% (32)	9% (24)	11% (23)	12% (30)	11% (30)	14% (48)	13% (54)	12% (59)
Total WPI Undergraduate	27%	28%	30%	31%	32%	34%	32%	34%

Table 4.2.4: Female Enrollment by Year[27]

As previously discussed the computer science department has failed to sustain any growth in the female population relative to the growth as a department as whole. Instead their ratio seems to be holding steady despite nearly doubling its number of female students.

	Ethnicity Breakdown for Computer Science (Fall 2016)								
	Nonresident Alien	Hispanic/ Latino American	Indian/ Alaska Native	Asian	Black/African	White	Two or more	Unknown	Total
Female	24	14	0	11	1	27	5	8	90
Male	71	31	2	29	11	280	13	39	476

Table 4.2.5: Ethnicity Breakdown for CS Majors, 2016[28]

[27] Data obtained from WPI Fact Books 2008 through 2015.
[28] Data obtained from WPI Fact Books 2008 through 2015.

Survey Demographics:

Class Year	Male	Female	Total
Freshmen	29	8	37
Sophomore	26	7	33
Junior	26	11	37
Senior	31	11	42
Total	112	37	149

Table 4.2.6: Breakdown of Survey Takers by Gender & Year

Race	Male	Female
White American	79	22
Asian American	7	4
Latino/Hispanic American	4	1
African/Black American	1	1
Other	3	2

Table 4.2.7: Gender and Ethnicity Breakdown of Respondents

Experience Prior to coming to WPI:

	Male	Female
AP CS Course	41.59%	45.95%
Non AP CS Course(s)	57.52%	43.24%
No Formal CS Experience	26.55%	37.84%

Table 4.2.8: Survey Respondents' Computer Science Experience Prior to College

As background research suggested, females tend to have less experience than their male counterparts. Our survey showed an 11% gap between the percent of males to females who had some form of formal computer science experience prior to arriving at WPI.

4.3 Issues with Culture

4.3.1 Lack of Social Engagement

There exists a severe lack of social engagement and involvement from students within the CS department that is disproportionate to that of students of other majors on campus. Multiple factors may be contributing to this social engagement issue that are specific to the CS department. For one, the academic environment in CS promotes individualism and independence with its coursework. Students felt strongly, 4.12 out of 5 (where 5 is strongly agree), that collaboration in the introductory courses is important to building community. However, while the introductory courses encourage pair programming, many students shared negative experiences. One female senior said:

> *"Pair programming often felt competitive and felt more like who was the smartest or fastest partner and who could get the most work done. By adding another person or two to those projects, that reinforces and builds the team dynamic, rather than feeling one person is pulling the entire group."*

Software Engineering and a handful of 4000 level CS courses are among the few offerings that require teamwork beyond pair programming. As mentioned in our background section, pair programming is beneficial and has been shown to help with the development of programming skills. However, students in our focus groups expressed interest in having more experience and opportunities to work in larger groups. Because group work is uncommon in CS courses, we believe academically, the CS department does not help encourage students to work together outside of class.

CS is largely a digital practice, and students can work remotely on their assignments from any location. One student, a senior, stated in a focus group:

"The incentive to meet up is a lot less because of virtual ways of working, like using github. It is easier to work and collaborate digitally. Because the physical barrier is gone, what is the point in working together in person at a club?"

The need for a dedicated lab space has decreased greatly over the last several years, as more and more students have their own laptops. We believe that this convenience has negatively affected the culture and engagement of CS students by allowing them to naturally isolate themselves from others. Our survey study did not delve into what locations students tend to prefer for their CS related work. Looking closer into where students go to do CS related work would be an interesting follow up study.

The absence of a dedicated common space for undergraduate CS majors may also be contributing to the lack of social engagement. This issue will be discussed in further detail in section 10.3.1, which proposes solutions to this issue.

4.3.2 NONEXISTENT COMMUNITY

Our survey results showed that many students saw numerous issues with the CS department's community. Surveyed students believe that the environment in the CS department does not promote community, is not welcoming and supportive, and tends to be performance driven and competitive. As examined in our background research, factors like being supportive, welcoming, and collaborative area all critical to having a strong academic community. The fact that students view the CS department as being competitive and performance driven is not bad in itself, but in the absence of a feeling of community and belonging, the sentiment is concerning.

The data from our survey shows a large and shocking difference of opinion based on gender. Not a single female student who took our survey believes the CS department to be accepting of weakness. Only about 11% of female students feel the CS department is welcoming and that all students are treated the same. In stark contrast to the male perception, where 28.74% of males feel that the CS department is supportive, only 14.81% of females feel that the CS department is supportive. Interestingly, the male students feel the CS department is far more competitive, slightly less individualistic yet slightly more isolating, and more performance drive than their female peers. The data in the table below

clearly indicates and highlights a social and community issue within WPI's CS department. Students of both genders feel isolated, and women especially feel unwelcome and see a discrepancy in how students are treated.

Provided Description of CS Department	Percentage that Agreed with Description (118 total responses, including non-binary gender)	Male Percentage (87 Responses)	Female Percentage (27 responses)
Community-oriented	10.08%	11.49%	7.40%
Individualistic	37.82%	39.08%	33.33%
Competitive	53.78%	56.32%	44.44%
Performance-driven	55.46%	58.62%	44.44%
Accepting of weakness	10.08%	13.79%	0.00%
Isolating	30.25%	27.59%	33.33%
Supportive	24.37%	28.74%	14.81%
Welcoming	24.37%	29.89%	11.11%
Students are all treated the same	31.93%	37.93%	11.11%
Collaborative	37.82%	40.23%	33.33%

Table 4.3.2.1: Breakdown of Males & Females Agreeing with Descriptions

As a response to our survey, one student said:

"WPI CS overall exhibits less of a community feeling than other majors. Other CS majors tell me as much, particularly double-majors (which I am not), who will say, e.g. that they feel more connected to Math/RBE/whatever majors. I think the CS community is more fractured."

Another surveyed student said,

"I think the CS department is excellent academically but lacks a sense of community. I think the ECE community in Atwater Kent is an example of a great academic community as there are many people who spend large amounts of time in the building. People can discuss academics there and meet new people outside of classes."

An alarming 30.25% of surveyed students explicitly stated that they find the atmosphere in the CS department to be isolating. The feeling of a lack of community most likely stems from the small number of students involved in CS related clubs, the individualistic nature of the coursework, and the lack of extracurricular CS activity students do outside of class. Commenting on the stagnate nature of the CS culture at WPI, one surveyed student complained,

"It's boring. The courses and material are fun, and the professors are great, but outside of work, CS at WPI is boring. Need more events, socials, hackathons, coding competitions, and so on."

4.3.3 INACTIVE CS CULTURE

Surveyed students showed that they do not work on personal or extracurricular CS projects outside of class, (2.22 out of 5). While not every student is interested in working on side projects, the same students said that finding a student run project to work on was very difficult (1.94 out of 5 where 5 represents students strongly agreeing that projects were easy to find). These students readily agreed that working on such projects would help build confidence in their CS abilities (3.96 out of 5).

We believe that the lack of non-academic CS activity exists for two reasons. First, so few students may be working on projects outside of class simply because they are unable to socially connect with their peers and find ways to collaborate. Second, students may need some guidance from faculty or students with prior project experience. Determining the scope and requirements for a project and choosing which projects are worth pursuing can be a daunting task. Looking further into the underlying reasons and solutions to this problem would be an interesting follow-up to this IQP.

It is evident that there is a lack of energy and activity in WPI's CS culture. ACM recently put on a hackathon, an event where people interested and involved in the computer science field meet, collaborate, and compete for a period of time, at WPI on January 13th, 2017. Slightly over 300 people registered for the event but the actual turnout was about 100, and of that third, few remained for the entire duration. Even though the hackathon event was well funded by the WPI's Student Government Association and multiple tech company sponsors, the audience for such events does not currently exist at WPI. The isolating atmosphere and lack of community in the CS department may be correlated to the disengagement of students from participating in such activities.

4.3.4 Common (Waiting Room) Space

Our data shows that the common space the CS department currently has for undergraduate students is not sufficient. One student said, "Fuller Commons is not an optimal space [for collaboration]". We believe that this may have to do with the location of the common space, which is in front of the largest lecture hall in the CS building, Fuller Laboratories. Our personal observations have led us to conclude that the location of the common space makes it a place where students often wait for their lecture to start. These students are not all CS majors, as many different classes are held in this lecture hall, so the common space often has a random mix of students in it. Because of all of the traffic of non-CS majors, it's difficult for CS students to use the space for CS projects and collaboration; the common space feels more like a waiting room than a project room.

Students' desire for better common spaces is supported by research that suggests students who use university common spaces are more engaged than students who do not. The University of Queensland's research also claims that engagement may be able to be correlated to personal satisfaction within the major, academic success, and retention. Common spaces act as more than just a place to gather. If actually used and enjoyed by students, they can have a highly positive impact on students from both academically and socially. As the University has also found:

> *"Particularly for new students, integration into both the academic and social culture of the university is essential in their transition period. This finding provides further*

evidence that these informal learning spaces are achieving their intended goal of building a sense of belonging and cohort identity amongst the science students and increasing positive peer-to-peer and student-to-staff interactions." [29]

Other majors at WPI have effective common spaces where students connect with one another to work on projects. For example, Robotics Engineering (RBE) has a lab that encourages students to work with one another. One student majoring in RBE said:

"There is a stronger sense of community [in the RBE program] because there are a lot of students who hang around and help each other with assignments."

This experience helps to support the claim that students, WPI undergraduates included, who spend time in common spaces feel more connected with their major and their peers.

Several other students believed that the common spaces in Fuller Laboratories are insufficient.

"The CS department does not really have a common space, besides the Fuller Commons, but it is already used for the ACM meetings. There is the Zoo Lab, [but it] is more of a sit down focus-on-work or office hours place."

"I have had some bad experiences in the Fishbowl (Fuller Commons). Someone told me somebody else usually sits there. I think I must have been sitting in the [CS club] president's seat, and I was very turned off by that. People think it is their home there. Just chill, please."

"The computer science department would be better served with more common spaces."

---

[29] Matthews, K. E., Adams, P., & Gannaway, D. (2010). The impact of social learning spaces on student engagement. *The Annual Pacific Rim First Year in Higher Education Conference*, (Sfc), 1–10.

The Interactive Media and Game Development (IMGD) program has a lab where students regularly work on assignments. The lab is also used for various events held by the Game Development Club. The IMGD lab is only available to IMGD majors, as it requires ID card key access, which limits its use to only those that the lab space was created for. This lab space brings the IMGD majors together, as it's a common space that only IMGD majors can access, it holds interesting events for IMGD majors, and it's used to work on assignments so students can help one another.

4.3.5 Underutilized Advising and Mentorship

Students do not favorably view the advising and mentorship resources provided by WPI. Surveyed students indicated that they do not view their assigned advisor as a resource and rarely meet to speak with them (2.38 out of 5). Surveyed students implored,

> *"Train advisers to be more invested and helpful with their students; have them email their newest students each year more often than just at academic advising days."*

> *"Finding a mentor is very useful. When I needed help the people I turned to had mentors that helped make them the knowledgeable students they were. I wanted to find a mentor but had no idea how to go about finding someone."*

> *"I'd want an advisor who is proactive. Someone who would reach out to me first and have genuine interest in me as a student and my goals."*

> *"The faculty are not trained or well experienced in how to interact with students at a guidance level."*

> *"I would like a faculty member to talk to me about job prospects and professional development."*

> *"I don't know what the role of the advisor is supposed to be."*

"If I had had [a better advisor], I think my experience at WPI would have been vastly different."

Most surveyed students said they would consult their peers and upperclassmen when they needed CS-related help or advising. We believe that students find it easier and more comfortable to reach out to their fellow classmates than it is to reach out to their advisor. Several students supported this claim:

"The biggest mentors I've had have been older students. They've helped mentor me with job advice. They've been the most present in my life."

"I'd rather reach out to someone I feel is my equal than someone who is more advanced than me. I feel less timid asking questions."

"I looked at her and thought, 'wow, you're doing a really good job'. She was older and in the CS department, and she kind of inspired me. She was an SA and now I'm an SA. Otherwise, I don't really have any other mentors."

The disconnect between students and faculty in terms of advising is an issue. Two students, a junior and a senior, expressed in individual interviews that they were unhappy with their assigned advisor and were unaware that advisors could be changed. As a result, one of these students did not seek further faculty advising during their undergraduate career. It is important to note that students may not always be aware of the resources and options they have available. As referenced in our background research, strong and proactive advising has been demonstrated to improve diversity and culture within CS departments at other schools.

Students in the focus groups similarly expressed an interest in receiving more proactive advising in which faculty reached out to them more regularly. We believe that more concentrated efforts made by faculty to engage their advisees would be beneficial for the students in the CS department. Students who may need the advising the most may not

be comfortable or confident enough to reach out to their advisors on their own. Based on the responses we got from students, the desires for advising ranges from career advice to what courses to take and even to a more personal connection with faculty.

Club leaders from ACM and WiCS both expressed that they do not meet with their club advisors regularly and do not take advantage of, or even know what they would ask, their advisors.

Our survey also highlighted the underrepresentation of women as mentors for students in CS. When we asked students in our survey if they had any male mentors (faculty, student internship connections, etc.), 93 out of 160 surveyed students said they had a male mentor. However, only 54 out of 157 surveyed students said they had a female mentor. As our background research showed, mentorship is an important factor in building confidence and comfort for students. In our CS department, for the 88.89% of female students who do not think the department is welcoming, it is severely important to recognize the lack of female mentorship and proactive advising that is currently present at WPI. The table below best summarizes the demographics of CS mentors students within our department are connected to.

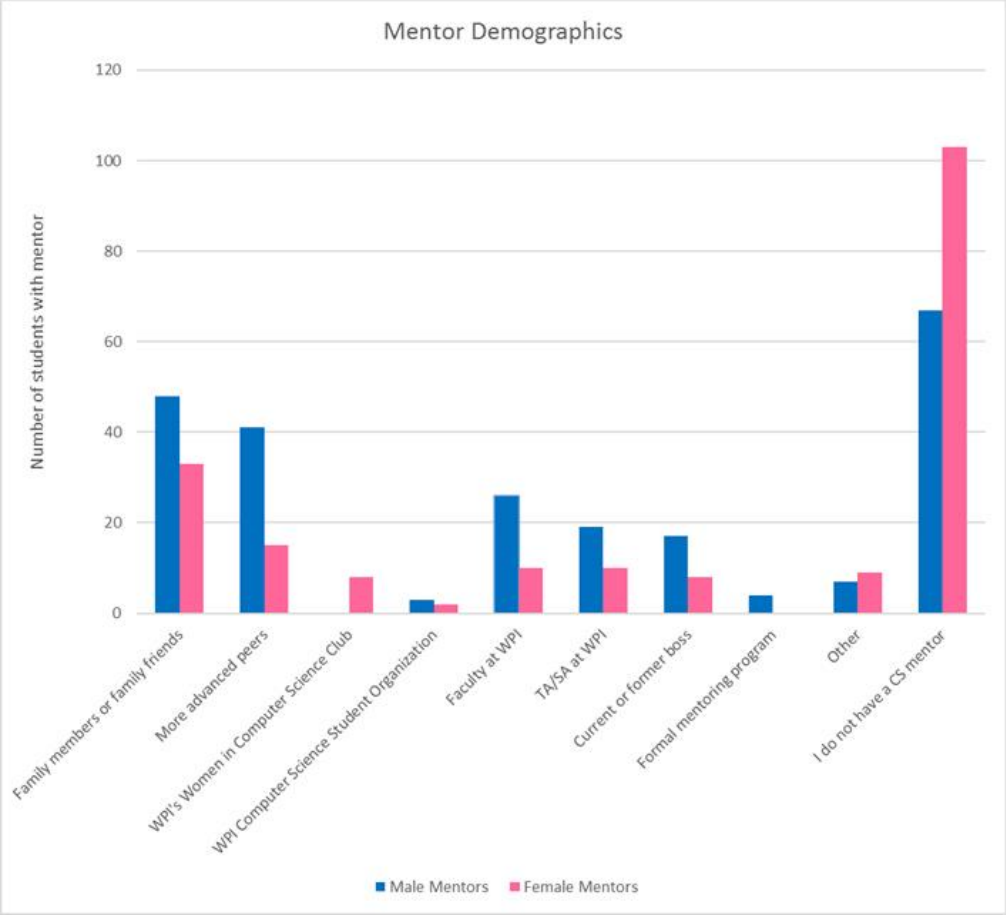


Figure 4.3.5.1: Demographics of Mentors Students Claimed to Have

4.3.6 CLUBS UNSUCCESSFUL AT REACHING FULL POTENTIAL

Our data shows that the CS clubs on campus have multiple issues and are not meeting students' wants and needs. WPI's CS clubs do not have enough active members, are not publicized enough, do not hold enough relevant events, and can feel exclusive to some students.

Following is a list of all the CS related clubs on campus and a brief description from their respective websites on Orgsync[30], WPI's online portal for student organizations on campus.

[30] Worcester Polytechnic Institute TechSync. Retrieved February 23, 2017, from https://orgsync.com/home/412

- **Upsilon Pi Epsilon (UPE):** "Upsilon Pi Epsilon is the national Computer Science honorary society [...] We hold a number of events throughout the year, such as programming classes, and help sessions for [undergraduate] courses."
- **Cyber Security Club (CSC):** "The Cyber Security Club facilitates events related to Computer Security and related topics. Events include weekly lunchtime meetings where current issues in Cyber Security are presented, weekly labs, where hands-on Cyber Security skills are taught, and competitions [...]."
- **Women in Computer Science (WiCS):** "Women in Computer Science is an organization dedicated to help encourage and support women in Computer Science and related fields. We support women in the field through three pillars: social, career, and academics. We hold weekly social events, engage in community outreach and occasionally hold professional events with prospective employers."
- **Association of Computing Machinery (ACM):** "The ACM is devoted to advancing computing as a science and a profession. [At] WPI, our goal is to represent the Computer Science students as a liaison to the Computer Science department and strengthen the bonds of community among students and faculty alike."

The most striking observation we made was the lack of student involvement in CS clubs. Our survey data shows that 71% of the students surveyed do not consider themselves an active part of any of the CS clubs, yet 80% of students surveyed said they're an active member of one or more clubs on campus. This information about student involvement shows that lack of club participation is not a campus-wide issue, nor does it reflect a lack of interest in clubs from CS majors; it is exclusive to the CS department activities. Due to the lack of involvement in CS clubs in particular, we believe that CS clubs are either not holding enough events to keep students interested, are not advertising their events well enough, or simply are not catering to what the student population wants. One student claimed,

> *"There's an abundant amount of [CS clubs], but nothing that gets people interested in the major. There are no exploratory clubs on campus."*

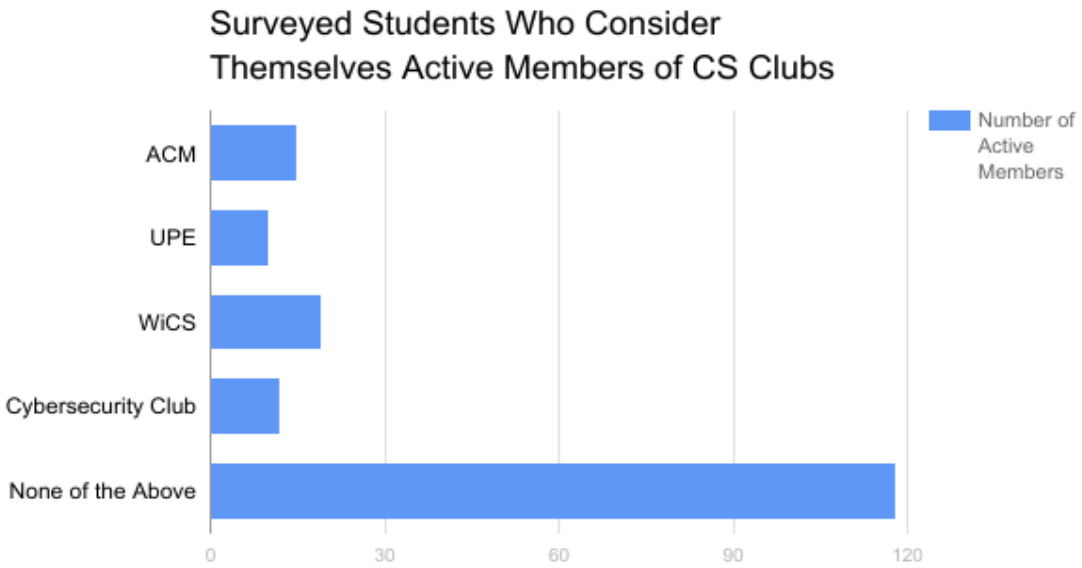


Figure 4.3.6.1: Surveyed Students' Computer Science Club Involvement

Another important observation we made was that students believe that the CS clubs are exclusive and feel that they are not allowed to join. For example, many students believe that the Women in Computer Science Club (WiCS) is exclusive to women, which is not the case. Due to this belief in WiCS being the "women's CS club", the Association of Computing Machinery (ACM) is typically seen as the "men's CS club". These beliefs must bring down the membership numbers for both clubs, as men do not tend to join WiCS and women do not tend to join ACM.

CS clubs are also not putting on enough events that students care about and are interested in attending. Many of the students who took our survey felt as though they are not prepared for technical interviews or software engineering jobs. One student said,

> *"After taking 6 CS classes, I do not feel that I am prepared at all to take on internship interviews."*

While this may point to a larger issue within the CS courses, CS clubs could try to help students by organizing and running workshops related to the aforementioned issues.

The CS honor society, Upsilon Pi Epsilon (UPE) "has put in efforts to work [on interview preparation]" as one student put it; other clubs could do the same.

Many students mentioned that they weren't sure how to get involved in CS-related clubs. Several students mentioned in our survey that they wanted a "CS community portal that lists all the active clubs, projects, and ways to get involved". There seems to be a lack of communication about what CS clubs are doing, and therefore, students don't know how to get involved. As one interviewed student put it:

> *"I don't really know what ACM does. I know they're a thing, but I don't think I've ever attended an event, and if I did, I didn't know it was them."*

4.3.7 CLUB PRESIDENT INTERVIEWS

The current presidents of the computer science clubs on campus had both positive and negative things to say about their respective clubs.

4.3.7.1 President of Upsilon Pi Epsilon

The president of Upsilon Pi Epsilon (UPE) discussed with us both the strengths and weaknesses of UPE at WPI. He stated that as an international honor society, UPE has a clearly defined purpose: to promote scholarship. In addition to that purpose, the Alpha Chapter at WPI is also intended to be an asset the CS community, promote a strong and healthy culture, and be mentors to other students. He mentioned that UPE puts on events every term that are open to all students like debugging workshops and mock technical interviews. The president noted that UPE makes a conscious effort to accept students into their organization who are not only in the top 30% academically, but will also uphold UPE's positive and professional image on campus.

Being an exclusive organization, UPE does not need to improve its membership count but does not need to improve the level of activity of its members. The UPE president said that the biggest problem with the honor society was engagement. He said that many members see the honor society as more or less a "resume item" and therefore don't actively engage themselves in the organization. The positive impact UPE can have on the rest of the CS community at WPI is largely dependent on the engagement of its members. The

president noted the difficulty of getting and keeping members engaged, and said that he has been discussing the idea of requiring a higher level of activity and engagement from members in order for them to retain membership. The president also mentioned that he regularly communicates with their faculty advisor, Craig Wills.

4.3.7.2 President of Association of Computing Machinery

The president of the Association of Computing Machinery (ACM) told us that ACM puts on many events for the computer science community, but has problems with not holding enough academically focused events and advertising the club.

ACM has quite a few events throughout the year, but their president said that these events are mostly social. He sees ACM as a club that should focus more on helping CS students by having language labs, organizing networking opportunities, and providing homework help to students in the computer science department.

The president also said that ACM needs to get its name out more. He said that most people do not seem to know what ACM is, and suggested that the club be renamed to something more obvious such as the "Computer Science Club". Another way he would like to try combating this issue is to table sit in WPI's Campus Center to promote events and show the students on campus that they are.

4.3.7.3 President of Women in Computer Science

The president of WiCS told us that the club is doing a good job being active on campus and gets a lot of positive feedback from members about the club being helpful to them. She said that WiCS puts on a lot of networking events and tech talks that are open to the entire campus. The president also said that members have told her how useful it is to have a space where women can share their experiences within the computer science department.

One problem with WiCS that she mentioned was the lack of "events related to activism and equity". She would like to see WiCS promote women in tech more than they currently are. She did mention, however, that they are currently organizing a way to get involved with Girls Who Code next school year, which will help the club in this area.

4.3.7.4 President of Cyber Security Club

The president of the Cyber Security Club believes that generally the student body of the Computer Science Department isn't particularly interested in taking part in clubs and other extracurricular activities. Overall, he believes the club has a good core of students who fully participate and make the most out of the club but advertising to new students who feel they don't know enough can be an issue. They mostly advertise through word of mouth.

4.4 Curriculum and Perceptions

Intro curriculum does not completely fill the confidence and experience gaps between males and females and students with no prior experience to those with prior experience, nor would we necessarily expect it to if improved. Males on average come to WPI with a significantly higher confidence rating their skills at a 4.097 on average on a 5 point scale with 2 or fewer classes of experience. This is higher than the average for females with similar WPI experience who rate themselves at 2.875. Meaning there is roughly a 1.2 point confidence gap before getting into advanced curriculum which is statistically significant at a .9 p-value.

In addition, the numbers confirm that females generally perceive themselves as worse off than the rest of their peers. Females place themselves at -1.125 point ability deficit with 2 or fewer classes. The curriculum does show promise here as females with 3 or more classes place themselves at only slightly less skilled, a -.179 point gap.

	3 or more classes taken		
	Males	Females	Total
Rate your computer Science ability	4.08	3.4	3.93
Rate the average skill of your peers	3.46	3.57	3.53
Confidence gap	0.61	-0.17	0.40
	2 or fewer courses taken		
	Males	Females	Total
Rate your computer Science ability	4.09	2.88	3.78
Rate the average skill of your peers	3.88	4	3.91
Confidence gap	0.22	-1.13	-0.12

Table 4.4.1: Self-Rated Computer Science Ability of Males and Females

Comparatively males highly rate themselves at +.222 and +.616 relative to the skill levels of their peers with 2 or fewer classes and those who have taken 3 or more classes respectively. Males have a far higher opinion of their skills and this likely helps them buffer setbacks in classes where they may feel a little behind. Females, when facing these same setbacks will have a tougher time recovering and may be shaken to the point of giving up. This is not a unique problem to WPI, nor to Computer Science but it is a factor to keep in mind for improving the department.

Another contributing factor to these confidence gaps may be students who show off. It is common for students with more experience to do better on assignments, quizzes, and tests, but they can have a potentially negative effect on others learning experience when they over participate in class asking questions beyond the scope of the lesson or over answering questions. These occurrences are common in the CS department, and certainly in the intro curriculum with students responding to the prompt “Some students routinely show off in class” with an average of 4.1 on a scale of 1 to 5 with over 80% of all respondents rating it either a 4 or a 5.

Showing off would not be as significant of an issue if professors properly mitigated it. Unfortunately, students don’t feel that it is occurring responding to the prompt “My professors are effective at managing students who show off in class.” with a poor rating of 2.8 with almost half of all respondents giving professors a 2 or 1 in this category. A student

mentioned “it’s really discouraging when people are actively trying to outwit the professors”. As several other students put it:

> *“I notice people all the time in class who show off. I sometimes get very pissed off. Just shut and listen to lecture. It can be intimidating. Just hearing them talk makes me feel like I am not smart enough to be in the class. When a teacher positively acknowledges showoffs, I think that is the level we are expected to be [at].”*

> *“Sometimes in the introductory courses, those that come in with programming experience sidetrack the professor with much more advanced questions, and it tends to make me feel like I don’t belong because I don’t have this prior knowledge, even though it is an introductory course.”*

> *“There needs to be less of an air of one-upsmanship in the major. Everyone seems to feel like the best way to pass their classes is to make yourself the best. People feel like they need to be miles better than everyone else.“*

For students already struggling with confidence and not performing well on coursework, hearing a couple of students routinely show off and ask questions beyond what you are expected to know and maybe beyond their comprehension could be potentially devastating for their already shaken confidence. There is a clear need to get those showing off either into a more advanced class, or to better control their interactions. The department has already taken steps toward this initiative, as they implemented an advanced introductory class in 2004, CS 1102, as an alternative to the classic CS 1101. In 2016, an accelerated introductory object oriented course (CS 210X) was added as an experimental course that is now expected to become a permanent course offering. This should help separate those struggling from those far ahead, but it will be an important factor to continue to watch in the coming years through more surveying as additional adjustments may need to be made.

Students also find homework assignments frustrating and often feel unprepared for them. Of respondents, 51% rated the statement “Homework/Projects are frustrating” a 4 or

5 on the 1 to 5 scale. It's important that homework assignments challenge the students, but there is a balance to be had to prevent disheartening students. This question received a pretty wide spread of responses with 30% of students being at the opposite end of the spectrum saying homework assignments weren't frustrating rating the prompt a 1 or 2.

	Projects/homework are interesting.	**Projects/homework are frustrating.**
Freshman	3.97	2.91
Sophomore	3.42	2.90
Junior	2.73	3.42
Senior	2.95	3.68

Table 4.4.2: Student Ratings by Year of Engagement & Frustration

The solution to this problem is not clear, as learning is often best done through struggle, but this problem can be traced back to showing off problem where simply creating a higher and a lower paced class at the intro levels may achieve the desired effect. Students typically think that the material in taught in class was properly represented on the homework assignments with almost 60% of students responding to the prompt "What was taught in class was enough for you to succeed on homework, labs, quizzes, and exams." with either a 4 or a 5. In contrast 30% said it was not, giving the prompt a 1 or 2. Data will need to be collected in future years to measure the changes in this problem from efforts already in place before further steps can be properly inspected.

Labs are another area that the data shows could improve but does not give very clear direction. To the prompt "labs are interesting", the population was almost exactly split with fewer than 40% holding a negative view of labs (giving it a 1 or 2) and just under 40% percent viewing them positively (giving it a 4 or 5). Students further split on the prompt "Labs are frustrating" answering along the same lines. Students do prefer lab to conferences, however, at a 60% strong preference rate.

4.5 Women's Perspective

Based on information we gathered from our focus groups and interviews, some women see problems in the department relating to their general acceptance. One woman said the following during an interview:

> *"I have heard things like, 'you got into this school because you are a girl.' Because you are not of the majority— male."*

This perception in the department that women are not supposed to be here is detrimental to women's confidence and sense of belonging. There also seems to be a problem with other students' thoughts towards women in the CS department. These students believe that women are not smart enough to be computer science majors simply because they are women, as one woman stated in an interview:

> *"There are sometimes a few students in the class who doubt my ability [due to my gender]."*

Apparently it is not just students who make the department unwelcoming towards women. One student stated:

> "*Some professors try be funny about being inclusive to females."*

When both professors and students are insensitive towards women's feelings, it's no wonder why there are so few women in the CS department - nobody wants to be in a place where they feel like they don't belong. The lack of women in the department only exacerbates the issue, as part of feeling a sense of belonging is having other people who are similar to yourself in the same situation and environment. A couple women commented on having other women to look up to:

> *"When you don't see yourself reflected in an environment, it's almost subconsciously harder to see yourself being able to do well."*

"The fact that I'm looking up to women in the field gives me motivation."

All of the above points are reasons why women may feel uncomfortable in the CS department and not confident in their abilities. We have data (explained in the section "Curriculum and Confidence") that shows that women in the CS department are less confident in their abilities than their male counterparts.

4.6 HOPELESSNESS

Students feel powerless and have negative outlooks on the prospect of developing a strong community and more active and diverse CS department. In the survey data, it is clear that students are not enthused or inclined to partake in the clubs that serve the department. Of survey respondents 30% said they were a part of a computer science related club, which is likely a skewed result towards higher participation as a result of your distribution methods. Through conversations with club presidents, they estimate a number more consistent with ten percent or less of the computer science department. Those in the CS department often do not view it as a community-based major. The demographic that most thought the CS department was community oriented were females who were members of Greek Life organizations at 15%. The next highest demographic were males who were members of CS related clubs and organizations at 13%, while all other demographics responded below 10% to the prompt.

Whilst interviewing students, they often expressed a feeling of indifference to the idea of improved clubs and department activities. They didn't know what a better club/department culture would feel like and how it might improve their experience. As such, despite telling us culture was underwhelming and clubs were not typically viewed as valuable, most students said that change was not necessary.

Another issue of may be students' feelings of uncertainty towards their career prospects. Almost 44% of all students believe their gender will affect their career potential and many students said they were unsure what exactly they would or even could use a computer science degree to do after graduation. Student's feel as if their performance in their courses may be less meaningful or adversely affected by their gender for their career

options. This can be either a contributing or result of the confidence gaps discussed above. Looking into ways to mitigate these sorts of thoughts and perceptions in the future may be valuable to the students.

4.7 Other Feedback

This section compiles a series of quotes collected from our survey, focuses groups, and interviews that did not apply to a specific topic from this chapter. Despite the fact that these quotes were not directly related to any of the above topics, they all provide powerful student insight into the CS department at WPI.

Courses:

- *"The carryover from one introductory course to another was not present."*
- *"Conflict mediation is a thing that should be a prerequisite project like Software Engineering. Because of the short time frame in a quarter system, and the competitive nature of the CS department, it is tough to resolve issues with teammates."*
- *"I would like to see a ⅙ credit course that teaches teamwork/conflict mediation skills as a degree requirement before taking [software engineering]."*
- *"I would like to see more team projects freshman and sophomore year."*
- *"[The] only time I got to work in a group setting was during Software Engineering."*

Professors:

- *"There is a real disconnect between students and professors."*
- *"Sometimes the professors are more focused on their research than their students."*
- *"The professors who are passionate and willing to teach are the reason I stayed in the major."*
- *"Many professors make a huge effort to get to know all their students in their classes."*
- *"I am a junior and I do not know any CS professors. It is really hard to get know the professors. There are only a couple office hours a week and after every class there is a long line waiting to talk to the professors."*
- *"I don't really know what a sustained relationship with a professor would be like. "*

- *"All the professors I've had seem to be very interested in what they're teaching and they want students to be interested in their teaching. They encourage students to get help outside of class. Professors want to see their students succeed."*
- *"I'm so thankful for the few faculty I have connected with during my time here at WPI."*

Personal Confidence:

- *"I thought the reason I wasn't doing well was because I wasn't smart enough."*
- *"A lot of the criticism comes from inside; it's personal. I've never had someone say 'this isn't the right thing for you.'"*
- *"The CS department is not an atmosphere where it is comfortable to share feelings."*
- *"People are afraid to show weakness in the CS department because they do not want to be seen as indispensable for group projects."*
- *"The resources weren't there for me to get help because office hours were always packed and I felt so far lost that the questions I had weren't helpful to other students, so I didn't bother asking them in class."*

5 RECOMMENDATIONS

The goal of our IQP is to highlight current issues within the CS Department and recommend changes that will help improve the CS Department's representation of female students as well as noticeable cultural issues within the department that affect all students. The recommendations we have concluded are a direct result of the data we gathered and analyzed from our comprehensive survey and series of focus groups. Supporting literature and strategies from exemplary universities who have successfully transformed their departments reinforces these solutions we are putting forth.

We identified three specific audiences to which our recommendations are directed: CS students, CS faculty, and the CS department. We believe that issues need to be addressed at every level in order to improve culture and ultimately improve the representation of women in CS at WPI. We also ranked these recommendations with a priority and difficulty rating, 1 being low, 2 being moderate, and 3 being high. "Difficulty" means how challenging the recommendation would be to carry out.

5.1 RECOMMENDATIONS FOR STUDENTS

5.1.1 IMPROVE CLUBS

(Priority 3, Difficulty 1)

There are quite a few issues with clubs that are causing students to not engage with each other or get involved with the CS department. Clubs don't have enough members, aren't organizing enough events that students care about, and aren't involving faculty enough.

To combat these issues, we recommend that club leaders advertise more on campus, which can be done through table sitting, posters, or emails. Advertising more would most likely lead to more students attending events or becoming active members of the clubs.

Clubs could also send out surveys to CS undergraduate students to see what kinds of events students would like to see happen throughout the year. Getting and taking suggestions from CS students may make those students more likely to join a club or go to a

club-run event. Creating another club that organizes student run projects is also something to consider, although a club like ACM might be able to handle this on its own.

We also recommend that club leaders reach out to their advisors and other faculty members in the CS department to help plan and run events. Faculty members could help plan events for clubs or provide guidance for club leaders. Faculty members could also reach out to their personal connections to get guest speakers or run workshops for students outside of class.

As stated in (Background, The Importance of Clubs and Advising), Women in Computer Science organizations are of vital importance to the retention rates of women in CS departments. The Women in Computer Science Club at WPI doesn't have enough members, nor are they meeting their own personal goals, which include reaching out to the female students of Worcester to promote computer science and promoting women in computer science on campus.

To improve upon these issues, WiCS should hold more events related to promoting women in computer science and advertise more heavily on campus to get more students aware of and involved with the club. They could reach out to their advisor for help as they see fit. We recommend that they also reach out to educators in the Worcester community to organize outreach events.

5.1.2 CLUB FOR EXTRACURRICULAR PROJECT DEVELOPMENT (Priority 1, Difficulty 1)

WPI lacks a student run CS organization that develops or contributes to software projects and promotes a spirit of building and creating. Many highly regarded universities with prestigious computer science departments have a strong student club or clubs that focus on developing open source software and student projects outside of class. UPenn has an initiative called PennLabs[31] that has numerous student projects and startups featured on their website. Cornell University has multiple student teams, an app development team,

[31] Penn Labs. Projects. Retrieved February 23, 2017, from Made at Penn, http://madeatpenn.pennlabs.org/

an ACM competitive programming team, and a data science team.[32] UC Berkeley, CMU, Stanford, and Texas A&M all have similar programs that encourage a creative and entrepreneurial tech atmosphere.

WPI's community would greatly benefit from a club that is about creating software and technology. We recommend that members of existing CS clubs consider the current void in the club space and consider working together to form such a club or initiative. This effort would require more experienced students to lead the software projects and organize the less experienced students. Faculty involvement and support would also be beneficial, but ultimately the success of such a club is dependent on the commitment and interest of the students.

5.1.3 Improve Engagement from Students (Priority 3, Difficulty 2)

Engagement issues go beyond clubs. Improving social engagement is necessary for correcting the overall nonexistent CS culture at WPI. We encourage that students make an effort to attend faculty presentations, info sessions, and candidate talks on a more regular basis. We recommend that extracurricular clubs make a better effort and appeal to a broader range of students in the CS department. We also recommend the installation, promotion, and use of a student run web portal or online forum to allow students to connect with their CS peers, discuss courses, show off projects, and find people to collaborate with.

One strong option for an online platform is Slack. We believe that students would benefit from a department wide Slack channel that is for all CS students. Right now, most CS clubs have a Slack but it is exclusive to them. By creating a web portal that is open to all CS students, the opportunity for students to communicate and be informed of events may become easier and more frequent. Slack was used successfully by Professor Lane Harrison's CS 4241 course during B Term 2016. During the seven-week term, there were

[32] Cornell University. (2017). Student Groups. Retrieved February 23, 2017, from Department of Computer Science, https://www.cs.cornell.edu/undergrad/ugroups

an astounding 9.1k total messages, in which 20% of messages were written in public channels. If Slack could be introduced and leveraged by the entire CS student body, communication and engagement that is currently not taking place may begin to occur.

5.2 Recommendations for Faculty

5.2.1 Club Involvement
(Priority 2, Difficulty 2)

Faculty members in the CS department are not involved in the student run CS clubs. Even CS clubs' specific advisors are not actively engaged in the clubs and are not aware of everything the clubs are doing. Becoming more involved with student run clubs would help bridge the gap between student and faculty relations, as it would foster relationships between students and faculty outside of the classroom.

We recommend that faculty, especially club advisors, reach out to student club leaders to see how they can participate. Suggestions for things faculty could do to help clubs include: coming up with ideas for events, providing contacts for personal connections who could be part of an event, or teaching small scale language labs.

5.2.2 Stronger Advising and Mentorship Opportunities
(Priority 3, Difficulty 2)

The majority of students expressed they do not view their faculty advisor as a resource and do not speak regularly with them. Only 28.74% of male and 14.81% female students reported that they felt supported by the CS department. This is an appallingly low number. As our background research has shown, strong advising is vitally important to developing confidence and comfort within the major, especially among underrepresented groups.

In order to improve this severe issue, we recommend that faculty be required to reach out and engage the students they are supposed to be advising on a regular basis, or at least once per semester. Advising should be more than just looking over a student's schedule and checking if they can graduate on time. Advising needs to be an active attempt to get to know students and help with their academic and professional development. As mentioned in section 2.3.1, faculty at University of Pennsylvania felt a need to make themselves more approachable to students outside of scheduled office hours. The faculty

decided to initiate advising sessions open to all students to help them explore research, internship, and academic opportunities.

Opportunities need to be provided for students to find the right advisor for themselves. Students need to be both encouraged and aware that they can change their faculty advisor if they feel the match is not good. Based on our data, females feel disproportionately less support from the department than males, a concern that needs to be immediately recognized and addressed. Our data is not nuanced enough to determine what specifically "not feeling supported" entails as our survey did not probe deeper than the outer question.

In addition to advising, students of both genders could benefit from connecting with WPI CS alumni working in the industry. Some students reported feeling underprepared for internships or jobs. By forming relationships and acquiring industry mentors from WPI's own pool of alumni, students could be more prepared and have a better perspective on academic and career paths available to them.

5.2.3 Better Curb Students During Lecture (Priority 2, Difficulty 2)

Many students articulated through our survey and interviews that a main source of a lack of confidence stems from peers who show off in class. We believe that this is a serious issue that CS faculty members need to address, because even if students did not directly tell us that they felt this way, the average response for the survey prompt "My professors are effective at managing students who show off in class." was 2.8. Students who ask questions or provide comments that are beyond the scope of the course can make students with less experience feel as though they don't belong or they aren't smart enough for the course— even if the course is introductory with few to no prerequisites.

There are several steps that professors can take to manage students in class. Carnegie Mellon University's Eberly Center for Teaching Excellence & Educational Innovation provides a guide for professors to remedy issues they see in their classrooms by using a three step technique: identifying problems, reasons, and strategies.

Regarding students who tend to be "show offs" in class, CMU recommends that professors address the comments immediately and firmly. "It's important to recognize and

reward the individual student's intellectual curiosity while also firmly steering the conversation back to where the rest of the class can engage and benefit," the Eberly Center explains[33]. Politely cut them off as soon as it seems appropriate to do so, and redirect the conversation. If this doesn't get the message across to a student, professors should try to reach out to them outside of class to describe how their behavior is impacting the class and what they can do differently. However, professors shouldn't automatically assume that students are giving these sorts of comments in class simply to show off their knowledge; sometimes a student genuinely won't know that their questions are negatively impacting other students' experience in the course[34]. By talking to the student outside of class, the professor can address the in-class behavior, as well as commend the student for their sincere interest and knowledge of the topic. As long as the discussion is friendly and supportive, not accusatory, the student should feel like the faculty member is trying to help them, not hinder them. The faculty member may choose to offer to meet with the student one-on-one, outside of class or scheduled office hours for the class, to discuss any questions that may not be appropriate to pursue in class. During class, the professor can draw attention to the types of comments and questions asked by students that are relevant and appropriate, if the "show off" student still had trouble understanding what is appropriate for the class.

5.2.4 REACH OUT TO STUDENTS (Priority 3, Difficulty 2)

One of the problems highlighted in our data was a lack of intersection between faculty and student life that results in students feeling a low levels of institutional support. Increasing students exposure to professors through department-sponsored events will lead to students feeling more integrated. Encouraging students to find their own advisors and

[33] Carnegie Mellon. (2008). One student monopolizes class. Retrieved February 24, 2017, from Eberly Center: Teaching Excellence & Educational Innovation, https://www.cmu.edu/teaching/solveproblem/strat-monopolizes/index.html

[34] Carnegie Mellon. (2008). Students' background knowledge and skills vary widely. Retrieved February 24, 2017, from Eberly Center: Teaching Excellence & Educational Innovation, https://www.cmu.edu/teaching/solveproblem/strat-backgroundknowledge/index.html

make connections with other professors through these events will also enable the students to find mentors and people who can help them make positive decisions and navigate a computer science department that can be intimidating to new individuals especially if they lack background. Finally, giving professors training on supporting their students and making sure they are knowledgeable about the students options can go a long way towards encouraging students to view their advisors and professors as the resources they can and should be.

5.2.5 GROUP WORK
(Priority 2, Difficulty 2)

Computer Science at WPI is largely an individualistic major. For the majority of classes, work is individual. Pair programming is encouraged in the introductory CS courses. However, because working in pairs is optional, student often opt out and work alone whether out of convenience, level of comfort, or simply not wanting to work with someone else. As a result, there is little positive reinforcement originating from coursework that builds the necessary community and collaboration between students. There are a few courses, such as CS 3733 (Software Engineering), which demands group sizes of usually five or more that are exceptions to this statement.

We recommend that the department raise concerns with faculty about the individualistic nature of CS work for students at WPI and the negative effects it may be having on department culture. We encourage the department and faculty to look into ways of incorporating more group work into their courses, introductory or advanced, where it is to the benefit of the students to successfully work in groups rather than opt out and work individually.

5.3 RECOMMENDATIONS FOR DEPARTMENT

5.3.1 CREATE A BETTER COMMON SPACE
(Priority 2, Difficulty 3)

Research at other universities suggests that students who utilize common spaces are more engaged than students who do not, and the need for better common spaces for CS students was clearly articulated through our surveys and focus groups. Another university

in Massachusetts, University of Massachusetts Amherst, recently completely redesigned the common space in one of their first year residence halls. While residential hall spaces do differ from spaces in academic buildings, we believe that both essentially serve the same purpose (to foster both an academic and social community between students), so many of the same elements can be applied to both.

In accordance with the newly designed space at University of Massachusetts Amherst, an ideal common space for today's students should be technology enabled (not necessarily technology rich), support both group work and individual work, and should provide students a sense of ownership of the space[35].

Since computer science is a largely digital practice, an ideal common space would support students who need to be working on a computer. However, as a large majority of students have laptops now, it's not necessary to flood the room with desktops for students to work on. Instead, there should be plenty of outlets so students can plug in any technology they need.

The space should also be open, inviting, and have room for multiple activities to be going on at once. An area that supports multiple activities is less intimidating and more social for students. With many students working on different things, students coming into the space will feel less intrusive than if there's a single table with everyone doing the same thing. The size of the space would ideally offer students enough room to have their own areas for individual work, as well as areas where students can collaborate. This can be achieved by offering different sized tables and seating. Tables small enough for one student to spread their work on would be helpful, as well as larger seating areas for students to do group work or simply sit near other people. As for seating, chairs are usually preferred to couches or benches because for students, it can be awkward sharing a seat with someone they don't know well. This limits the seating available for students if no one feels comfortable sharing their seat.

---

[35] Nugent, J. (2012). Residential Common Spaces that Really Work. *Planning for Higher Education*, *41*(1), 234.

Students find a sense of ownership in a space if they feel at home and in control of the space. An ideal common area would be homey in addition to welcoming and functional. Natural light, warm color schemes, and certain building materials (i.e. wood instead of concrete) have been proven to be more appealing to students. Students don't necessarily want a room with as much glass and bright colors as possible; they want it to feel like a familiar place they're comfortable in. Students are also able to feel in control of the space if there are movable elements that they can customize to their needs. Chairs should be able to be easily moved, as well as smaller sized tables— they can be brought together for groups, and separated for individuals. Moveable whiteboards are also popular because they can help students "box off" a certain area if they'd like, using the whiteboards as movable walls.

It's important to note that while some of these recommendations would not be feasible to implement in the current lounge, Fuller Commons, such as adding more natural light to the room or changing the room's size, many of these changes can be made fairly easily. Adding different tables, seating, whiteboards, and outlets to the space could be the first step in creating a better environment for students to work and collaborate in. If ever plausible in the future, the department could consider moving the lounge out of the current spot and finding a more ideal area size and architecture wise somewhere else in Fuller Laboratories.

Several other IQP's have been conducted involving the best designs for project-based learning spaces on campus; since these projects have been WPI-specific, the department may be interested in taking some of their recommendations as well.

5.3.2 CONTINUE TO SURVEY THE DEPARTMENT
(Priority 3, Difficulty 1)

If the department wants to make progress towards the goals laid out above it is important to monitor that progress. Making use of the survey we have created in future years will give the department a good base of data to work from. It's important to identify what is working and what isn't. Surveys ought to be released early B term to get fresh

impressions of the computer science department as well as get to the students before most IQP and MQP surveys are released.

Altering our survey and using smaller sections may help drill down on larger problems and get more focused answers. Doing so is recommended for future IQPs working on sub problems but the department should attempt at least one full scale survey a year to maintain historical data.

5.3.3 RUN FUTURE IQPS

(Priority 3, Difficulty 1)

In areas of this project we have suggested large changes that can be implemented in many different ways. Running IQPs on these more specific problems that the department chooses to address will find the optimal solutions and continue to address issues potentially missed or beyond the scope of this IQP. Several potential IQP ideas for the department moving forward may be:

- The actual design and implementation of a better common space in Fuller Laboratories for computer science students
- Revamp the survey and interview questions we used for students to apply to faculty in order to gain insight in to how they view the Department as well
- Delving into more successful advisor systems and the creation of those positive relations
- Looking at WPI's admission system for potential ways to change acceptance process power from a general admission system to the department

6 CONCLUSION

The goal of this IQP was to identify the underlying reasons as to why the Computer Science Department at WPI is so greatly underrepresented by women. In conducting our research, we found that the best ways to make the department more inviting, supportive, and engaging for females were the same ways to make the department better for all undergraduate students. Based on our survey, interview, and focus group results, we have compiled a list of recommended courses of action to help the Computer Science Department improve their attraction and retention rate of undergraduate majors, women included. In order for change to occur, students, faculty, and the Department will all need to make individual efforts that, when brought together, should improve the overall atmosphere of the department.

Our Recommendations for Students:

1. Improve existing computer science clubs by advertising more on campus, hosting more events that the student body would be interested in, and reaching out to faculty advisors for support for their organization
2. Develop an extracurricular activity related to computer science project building to allow students to explore their interests outside the classroom
3. Create a student-run web portal for all Department happenings so students and faculty can remain up to date
4. Adopt a department wide Slack for students to use for various purposes (socialization, academic help, a way to look for personal project collaborators, etc.), as well as a Slack for each course in order for the students to more easily communicate with each other on a social and academic level

Our Recommendations for Faculty:

1. Become more involved in computer science clubs on campus and be a resource for them
2. Advise more proactively by reaching out to students and getting to know students on a more personal level to provide the best guidance possible

3. Better control students who show off in class by redirecting them to a more appropriate setting, such as office hours

Our Recommendations for the Department:

1. Form a better common space in Fuller Laboratories for students to gather
2. Continue to survey the students in the department, keeping up with the latest issues and concerns of students and faculty to ensure that these issues are known as being addressed
3. Conduct future IQP's to expand upon ours, such as improving our survey or analyzing the best way to design a potential new common space

All of these recommendations are designed to positively impact the overall atmosphere of the Computer Science Department at WPI. Ideally, these recommendations would make the department more welcoming and engaging for all students, thus hopefully increasing the enrollment and retention of female students in the Computer Science Department.

7 REFERENCES

Beretto, H. (2015, April 11). CSters empowers Rice women in computer science. Retrieved February 23, 2017, from Rice University Department of Computer Science, https://www.cs.rice.edu/content.aspx?id=870

Blum, L., & Frieze, C. (2005). The evolving culture of computing: Similarity is the difference. *Frontiers: A Journal of Women Studies*, *26*(1), 110–125. doi:10.1353/fro.2005.0002

Carnegie Mellon. (2008). One student monopolizes class. Retrieved February 24, 2017, from Eberly Center: Teaching Excellence & Educational Innovation, https://www.cmu.edu/teaching/solveproblem/strat-monopolizes/index.html

Carnegie Mellon. (2008). Students' background knowledge and skills vary widely. Retrieved February 24, 2017, from Eberly Center: Teaching Excellence & Educational Innovation, https://www.cmu.edu/teaching/solveproblem/strat-backgroundknowledge/index.html

Cohoon, J. P. (2007). An introductory course format for promoting diversity and retention. ACM SIGCSE Bulletin, 39(1), 395. doi:10.1145/1227504.1227450

Cohoon, J., & Tychonievich, L. (2011). Analysis of a CS1 Approach for Attracting Diverse and Inexperienced Students to Computing Majors. *Sigcse'11*, 165–170. doi:10.1145/1953163.1953217

Cornell University. (2017). Student Groups. Retrieved February 23, 2017, from Department of Computer Science, https://www.cs.cornell.edu/undergrad/ugroups

Frieze, C., & Quesenberry, J. (2015). *Kicking Butt in Computer Science: Women in Computing at Carnegie Mellon University*. Dog Ear Publishing.

Georgia Tech. (2014, November 12). AP data for the United States: 1998-2013. Retrieved February 28, 2017, from College of Computing, http://home.cc.gatech.edu/ice-gt/321

Google. Google Diversity. Retrieved February 23, 2017, from Google Diversity, https://www.google.com/diversity/index.html

Hansen, S., & Eddy, E. (2007). Engagement and frustration in programming projects. *ACM SIGCSE Bulletin*, *39*(1), 271. doi:10.1145/1227504.1227407

Kurp, P. (2015, September 9). Revamped curriculum leads to more women in CS. Retrieved February 23, 2017, from Rice University Department of Computer Science, https://www.cs.rice.edu/content.aspx?id=2147483798

Matthews, K. E., Adams, P., & Gannaway, D. (2010). The impact of social learning spaces on student engagement. *The Annual Pacific Rim First Year in Higher Education Conference*, (Sfc), 1–10.

Nugent, J. (2012). Residential Common Spaces that Really Work. *Planning for Higher Education*, *41*(1), 234.

Penn Labs. Projects. Retrieved February 23, 2017, from Made at Penn, http://madeatpenn.pennlabs.org/

Powell, R. M. (2008). Improving the persistence of first-year undergraduate women in computer science. *ACM SIGCSE Bulletin*, *40*(1), 518. doi:10.1145/1352322.1352308

Redmond, K., Evans, S., & Sahami, M. (2013). A large-scale quantitative study of women in computer science at Stanford University. *Proceeding of the 44th ACM Technical Symposium on Computer Science Education - SIGCSE '13*, 439–444.

doi:10.1145/2445196.2445326

Roberts, E. (2016). A History of Capacity Challenges in Computer Science, 1–24.

Roberts, E. S., Kassianidou, M., & Irani, L. (2002). Encouraging women in computer science. ACM SIGCSE Bulletin, 34(2), 84. doi:10.1145/543812.543837

Sloan, R. H., & Troy, P. (2008). CS 0 . 5 : A Better Approach to Introductory Computer Science for Majors. *Media*, 1–5. doi:10.1145/1352135.1352230

Turner, E., Albert, E., Turner, R., & Latour, L. (2007). Retaining majors through the introductory sequence. *SIGCSE '07: Proceedings of the 38th SIGCSE Technical Symposium on Computer Science Education*, 24–28. doi:10.1145/1227310.1227321

Worcester Polytechnic Institute. (2015). Computer Scientist Kathi Fisler Receives WPI's 2015 Chairman's Exemplary Faculty Prize. Retrieved from https://www.wpi.edu/news/chair

8 APPENDIX

8.1 APPENDIX A: BROAD RESEARCH QUESTIONS

These broad research questions were developed before the creation of our survey.

CULTURE

Do students feel comfortable in the CS department?

a. Are students comfortable seeking academic help?
b. Do students feel like they belong in CS?

Do students feel connected to and supported by their peers and faculty?

c. Do students engage with faculty outside of the classroom?
d. Do students engage with student outside of the classroom?

Are students finding the desired opportunities, if any, to explore their more specific CS?

e. Are students satisfied with the range of options available for getting involved in CS outside of the classroom?
f. Do students work on and collaborate on personal CS projects?

CURRICULUM:

Is the introductory curriculum engaging to students of all levels of experience and backgrounds?

a. Do students feel exposed to broad CS applications during the introductory courses?
b. Are students active and engaged during labs?
c. Would they/are they benefiting from it?
d. Are students satisfied with the level of collaboration / working in pairs for projects and assignments?
e. Do students find assignments both challenging and interesting?

8.2 APPENDIX B: BREAKDOWN OF SURVEY QUESTIONS BY RESEARCH QUESTION

CULTURE

Do students feel comfortable in the CS department?

a. You feel at home with the CS major.
b. You can influence what my experience in the CS major is like.
c. Students in the CS major encourage each other to succeed.
d. Which of the following words describe the general atmosphere in the CS department, in and outside of classes? (Check all that apply)
    i. Friendly
    ii. Too focused on academics
    iii. Encourages asking for help
    iv. Community-oriented
    v. Individualistic
    vi. Differences of opinion are respected
    vii. Tolerant/open-minded
    viii. Fun
    ix. Supportive

x. Chilly/cold
xi. Collaborative
xii. Welcoming
xiii. Isolating
xiv. Boring
xv. Intellectually stimulating
xvi. Competitive
xvii. Collegial
xviii. Students are all treated "the same"
xix. Performance-driven
xx. Accepting of weaknesses
xxi. Too hard/challenging

e. Some students routinely show off in class.
f. My professors are effective at managing students who show off in class.
g. Have you considered changing your major?
    i. No
    ii. Yes, to computer science
    iii. Yes, to another computing or engineering major besides computer science
    iv. Yes, to a major outside of computing or engineering
h. Which of the following reasons/issues have you considered when thinking about changing your major away from CS? (Check all that apply)
    i. I was not very interested in CS to begin with
    ii. I am really interested in another major
    iii. Poor grades in introductory CS courses
    iv. Classes are too academically demanding
    v. Workload is too much for me
    vi. Others seem to know so much more than me
    vii. Other students say or do things that discourage me
    viii. Faculty say or do things that discourage me
    ix. I don't fit in as an CS major

x. Unsure about the type of work I would do after graduation
xi. Not interested in the careers associated with the major
xii. Doubt/not confident that I can be successful in future coursework
xiii. Doubt/not confident that I can be successful in as a computer scientist/ engineer
xiv. Other (please specify)

i. In your opinion, how are women treated as compared to men in your major?
    i. Better
    ii. Same
    iii. Worse
    iv. Other (please specify)
j. Has your gender had an impact on your experience in your major?
    i. Yes -- positive impact
    ii. Yes -- negative impact
    iii. No impact
    iv. Other (please specify)
k. Do you believe that your gender impacts your career path?
    i. Yes -- positive impact
    ii. Yes -- negative impact
    iii. No impact
    iv. Other (please specify)

Are students comfortable seeking academic help?

a. Office hours are a good way to find help.
b. Office hours are held in appropriate locations.
c. It is easy to get timely help during office hours.
d. Office hours are held at accessible times.
e. It is easy to get questions answered in office hours.
f. You feel more confident after attending office hours.
g. How often do you attend: (Never, Rarely, Sometimes, Often, Very Often)
    i. TA Office Hours

ii. Professor Office Hours
iii. Review Sessions

h. You feel comfortable raising your hand during introductory CS courses.
i. You feel comfortable raising your hand during upper level CS courses.
j. You feel comfortable contacting Professors outside of class and office hours.
k. When you have a question about an assignment or project in one of my CS classes or labs, you ask (Check all that apply):
    i. No one
    ii. Felt too embarrassed to ask for help
    iii. Waited too long to seek help
    iv. Other students in the class
    v. The professor teaching the class
    vi. A professor not teaching the class
    vii. The TA/SA
    viii. A parent or sibling
    ix. Another student who previously took the same course
    x. Students in my residence hall
    xi. Tutors from the ARC/MASH

Do students feel like they belong in CS?

a. You fit in amongst your CS peers.
b. You are comfortable with the CS students around you.
c. The CS courses at WPI aligns directly with your interest.
d. You belong in WPI's CS department.

Do students feel connected to and supported by their peers and faculty?

a. There are lots of ways to get involved with the CS department.
b. The CS department as a community is connected.
c. You regularly socialize with CS students outside of class.

Do students engage with faculty outside of the classroom?

a. I have had positive interactions with professors outside of class.
b. I consider the professors to be very approachable.
c. I view my advisor as a resource, and regularly speak with them.
d. Faculty in the CS major show interest in me.
e. My professors encourage me to continue in the major.
f. My professors help me understand the career options for my major.
g. My professor's mentor me about how to succeed in CS.
h. Overall, CS professors are good role models.

Are students satisfied with the range of options available for getting involved in CS outside of the classroom?

a. Do you consider yourself an active member at any of the following clubs/organizations? (Check all that apply)
    i. Association of Computing Machinery (ACM)
    ii. Women in Computer Science (WiCS)
    iii. Cybersecurity Club
    iv. Upsilon Pi Epsilon - Computer Science Honor Society (UPE)
b. Have you attended an event run by one of the following clubs/organizations in the past year? (Check all that apply)
    i. Association of Computing Machinery (ACM)
    ii. Women in Computer Science (WiCS)
    iii. Cybersecurity Club
    iv. Upsilon Pi Epsilon - Computer Science Honor Society (UPE)
    v. Not sure
c. How many non CS related clubs/organizations do you consider yourself an active member of? (Check all that apply)
    i. None
    ii. 1
    iii. 2
    iv. 3
    v. 4

vi. 5+

Do students work on and collaborate on personal CS projects?

a. You work on personal CS projects outside of class by yourself.
b. You work on personal projects outside of class with others.
c. It's easy to find student run projects to work on.
d. Working on projects outside of class, either by yourself or with others, builds your confidence in your CS abilities.

CURRICULUM

Does the introductory curriculum foster students' interest in computer science?

a. I was more interested in computer science as a whole after taking the introductory computer science courses.

Do introductory labs help build students' confidence in their computer science abilities?

a. Introductory CS labs are interesting.
b. Introductory CS labs are frustrating.
c. You would prefer to have conference instead of lab.
d. You utilize the full lab time.
e. You collaborate with others during lab.
f. Lab assistants provide good support, feedback, and direction during lab periods.
g. Attending lab makes you feel more confident about the course.

Does student collaboration and working in pairs for projects and assignments help build confidence in their computer science skills?

a. You enjoy working with other students on CS homework/projects
b. It would benefit me to work on CS homework/projects with other students
c. You regularly consult and seek help from my peers on CS assignments

d. You have had positive experiences in design teams or doing other collaborative work in CS.
e. Collaborating with other students is important in order to succeed in CS.
f. You have worried that talking to other students about assignments in my CS classes could be interpreted as cheating.
g. A lot of students in my CS classes think that working with other students is cheating.
h. Professors expect students to talk with each other about course material during class time (lecture and/or lab).
i. Collaboration is a great way to build community and culture within introductory courses.
j. You find it easy to find other students to work with on class related assignments.
k. Do students find assignments both challenging and interesting?
l. Introductory CS course assigned projects are interesting.
m. Introductory CS course assigned projects are frustrating.
n. What was taught in class was enough for you to succeed on homeworks, labs, quizzes, and exams.
o. You feel that your programming ability is stronger after taking an introductory course.

8.3 Appendix C: Breakdown of Interview & Focus Group Questions by Research Question

Culture

Do students feel comfortable in the CS department?

a. What do you think is the men-to-women overall ratio now in Computer Science at WPI?
b. Do you think WPI should make any efforts to attract and retain more women in computer science?

c. What has it been like being a woman in CS overall? (ask men to speculate)
d. Based on your gender, what do you see as the pros/cons of being a CS major?
e. What advice would you give to an incoming WPI student who is planning on majoring in computer science?
f. Would your advice be different, depending on whether the new student was male or female?

Do students feel like they belong in CS?

a. How would you describe the atmosphere in the CS Department?
b. Has it changed since you first came here?
c. Can you describe for me the characteristics of computer science students?
d. Is this you? Do you fit in? Not fit in? Why is that?

Do students feel connected to and supported by their peers and faculty?

a. Have you ever felt discouraged in CS?
b. Where do you go when you feel discouraged?

Do students engage with faculty outside of the classroom?

a. Do you have a faculty mentor?
b. Has it/would it have helped?
c. If no faculty mentor do you feel you have a mentor? (for CS or 'Life' in general?)

Are students satisfied with the range of options available for getting involved in CS outside of the classroom?

a. Do you find it difficult to balance your CS workload with a social life?
b. Do you believe the workload of a CS major is greater than that of other engineering majors?
c. Do you know about the student organizations—WiCS/ACM/CSC/UPE?
d. What's your impression of WiCS/ACM/CSC/UPE?
e. Have you had any contact or experiences with these organizations?

f. Has it had any effect on your experiences at WPI?

General Background

a. What is the best thing about doing this major?
b. What is the worst thing?
c. What would you change about the CS major if you could?
d. What do you see as the program's strengths?
e. What do you see as the program's weaknesses?
f. Have you ever thought about switching out?
g. What has kept you going?
h. Were there any particularly difficult terms? Or years? (is it freshman year?)
i. Did you grow up with a computer in the house? (more than one computer?)
j. Did you have your own computer? (Tell me about that, e.g., when did you get it?)
k. When and how did you get interested in computers and computing?
l. Listen for and ask about:
m. When did you become interested?
n. What interested you?
o. Who introduced you to computers?
p. Where did you become interested?
q. Schooling experiences (elementary, middle, high, summer program, work)
r. Affective experience (love, one interest among many, mixed, slow to warm)
s. Tell me about your decision to major in Computer Science.
t. The experience most responsible for the decision to major:
    i. Mentors
    ii. Peers
    iii. Parents
    iv. Teachers
    v. Interests
    vi. Aspirations

u. What interests you most about Computer Science?
v. Why do you think that is?
w. What interests you least about Computer Science?
x. Why do you think that is?
y. What projects are you drawn to?
z. Do you like/dislike programming? Why?
aa. What skills do you need for good programming?
bb. Do you have them?
cc. What do you regard as your academic strengths?
dd. Are these the same as your academic likes or interests?
ee. What helps you to learn best?
ff. What did you expect the Computer Science department to be like?
gg. Can you remember if it met your expectations?
hh. What was the best thing about doing CS at WPI?
ii. What was the worst thing about CS at WPI?

COPY OF SURVEY QUESTIONS

Culture, Atmosphere, and Curriculum in Computer Science at WPI

This survey is an effort to understand how culture, atmosphere, and curriculum influence the experiences of students in WPI's Computer Science Department. This survey should take you approximately 10-15 minutes to complete. Please answer all of the questions honestly. The results of this survey are completely anonymous. You will get access to the live results of this survey when you finish. You will also have the option to enter our raffle for one of five $20 gift cards. Your opinion is important to our IQP group and the Department. Your responses could help improve the department and make a measurable impact. Thank you!

Q2 What is your declared or intended major? Check all that apply.

- Computer Science (1)
- IMGD Tech (2)
- Robotics Engineering (3)
- Electrical & Computer Engineering (5)
- Management Information Systems (6)
- Other (8)

Q3 What year are you?

- Freshman (1)
- Sophomore (2)
- Junior (3)
- Senior (4)
- Mass Academy Student (6)
- Graduate Student (7)

Q4 How many Computer Science courses have you taken at WPI?

0 (1)

1 (2)

2 (3)

3 or more (4)

If 0 Is Selected, Then Skip To End of Survey

Q5 Which of the following intro level CS courses have you taken or are taking? Check all that apply.

1101 - Intro to Program Design (1)

1102 - Accelerated Intro to Program Design (2)

1004 - Intro to Programming for Non-Majors (3)

2102 - Object-Oriented Design Concepts (4)

None of the above (5)

Q6 What is your gender?

Female (1)

Male (2)

Non-binary/third gender (3)

Prefer to self-identify (4) _____

Prefer not to say (5)

Q7 Are you an international student?

Yes (1)

No (2)

Display This Question:

If Are you an international student? No Is Selected

Q8 Please specify your ethnicity. Check all that apply.

- African/Black American (1)
- Asian American (6)
- Native American (2)
- Latino/Hispanic American (3)
- White American (4)
- Other (5)

Q9 Are you the first in your family to attend college?

- Yes (1)
- No (2)

Q10 What was your cumulative college GPA at the end of the most recent academic semester/term?

- 2.00-2.50 (1)
- 2.51-3.00 (2)
- 3.01-3.50 (3)
- 3.51-3.99 (4)
- 4.0 (5)
- Prefer not to say (6)

Q11 Are you a member of a social sorority or fraternity?

- Yes (1)
- No (2)

Q12 How would you rate your computer science ability, and the computer science abilities of your peers (1 being very weak, and 5 being very strong)?

_____ Rate your computer science ability (1)

_____ Rate the average skill of other CS students in your classes (2)

Q13 Did you take AP Computer Science in high school?

Yes (1)

No (2)

Q14 Did you take a non-AP Computer Science course in high school?

Yes (1)

No (2)

Q15 Do you have a GitHub or similar?

Yes (1)

No (2)

I don't know what GitHub is (3)

Q16 Have you attended a Hackathon?

Yes (1)

No (2)

I don't know what Hackathon is (3)

Q17 Which of the following have you participated in during the last year? Check all that apply.

Internship (1)

Co-Op (2)

Undergraduate research with a faculty member (3)

On campus job related to computer science (4)

Off campus job related to computer science (5)

None of the above (6)

Q18 What assumptions do you think people have about computer science? Check all that apply.

CS is too hard for most people. (1)

CS is not appropriate for women. (2)

CS is not appropriate for men. (9)

A person has to give up outside interests to study or work in CS. (3)

People in CS are one dimensional. (4)

CS is for a certain type of person only. (5)

CS is not for someone who is a “people person”. (6)

People only pursue CS to make a lot of money. (7)

None of the above (8)

Q19 Please rate the following statements, with 1 being you strongly disagree with the statement and 5 being you strongly agree with the statement.

_____ You feel at home within the CS major. (1)

_____ You can influence what your experience in the CS major is like. (2)

_____ Students in the CS major encourage each other to succeed. (3)

_____ Some students routinely show off in class. (4)

_____ My professors are effective at managing students who show off in class. (5)

Q20 Which of the following words describe the general atmosphere in the CS department, both in and out of classes? Check all that apply.

Friendly (1)

Encourages asking for help (2)

Too focused on academics (3)

Community-oriented (4)

Individualistic (5)

Differences of opinion are respected (6)

Tolerant/open-minded (7)

Fun (8)

Supportive (9)

Collaborative (10)

Welcoming (11)

Isolating (12)

Boring (13)

Intellectually stimulating (14)

Competitive (15)

Students are all treated the same (16)

Collegial (17)

Performance-driven (18)

Accepting of weaknesses (19)

Too hard/challenging (20)

Q21 Have you considered changing your major?

If What is your declared or intended major? Computer Science Is Not Selected

Yes, to computer science (1)

If What is your declared or intended major? Computer Science Is Selected

Yes, I changed to computer science (2)

No (3)

Yes, to another computing major besides computer science (MIS, IMGD Tech, ECE, RBE) (4)

Yes, to a major outside of computing (5)

Display This Question:

If What is your declared or intended major? Computer Science Is Selected

And Have you considered changing your major? Yes, to another computing or engineering major besides computer science Is Selected

Or What is your declared or intended major? Computer Science Is Selected

And Have you considered changing your major? Yes, to a major outside of computing or engineering Is Selected

Q22 If you have considered changing your major away from CS, which of the following reasons/issues have you considered when thinking about changing? Check all that apply.

- I was not very interested in CS to begin with (1)
- I am really interested in another major (2)
- Poor grades in introductory CS courses (3)
- Classes are too academically demanding (4)
- Workload is too much for me (5)
- Others seem to know so much more than me (6)
- Other students say or do things that discourage me (7)
- Faculty say or do things that discourage me (8)
- I don't fit in as an CS major (9)
- Unsure about the type of work I would do after graduation (10)
- Not interested in the careers associated with the major (11)
- Doubt/not confident that I can be successful in future coursework (12)
- Doubt/not confident that I can be successful in as a computer scientist (13)
- Other (14)

Q23 In your opinion, how are women treated as compared to men in your major?

- Better (1)
- Same (2)
- Worse (3)

Q24 Has your gender had an impact on your experience in your major?

Yes -- positive impact (1)

Yes -- negative impact (2)

No impact (3)

Q25 Do you believe that your gender impacts your career path?

Yes -- positive impact (1)

Yes -- negative impact (2)

No impact (3)

Q26 Please rate the following statements regarding introductory computer science courses (1101, 1102, 2102), with 1 being you strongly disagree with the statement and 5 being you strongly agree with the statement.

_____ You were more interested in computer science as a whole after taking the introductory computer science courses. (1)

_____ Projects/homeworks are interesting. (2)

_____ Projects/homeworks are frustrating. (3)

_____ What was taught in class was enough for you to succeed on homeworks, labs, quizzes, and exams. (4)

_____ You feel that your programming ability is stronger after taking an introductory CS course. (5)

_____ Labs are interesting. (6)

_____ Labs are frustrating. (7)

_____ You would prefer to have conference instead of lab. (8)

_____ You utilize the full lab time. (9)

_____ You collaborate with others during lab. (10)

_____ Lab assistants provide good support, feedback, and direction during lab periods. (11)

_____ Attending lab makes you feel more confident about your ability to succeed in the course. (12)

_____ Collaboration is a great way to build community within introductory courses. (13)

Q27 Please rate the following statements regarding collaboration in computer science, with 1 being you strongly disagree with the statement and 5 being you strongly agree with the statement.

_____ You enjoy working with other students on CS homework/projects. (1)

_____ It would benefit me to work on CS homework/projects with other students. (2)

_____ You regularly consult and seek help from your peers on CS assignments. (3)

_____ You have had positive experiences in design teams or doing other collaborative work in CS. (4)

_____ Collaborating with other students is important in order to succeed in CS. (5)

_____ You have worried that talking to other students about assignments in your CS classes could be interpreted as cheating. (6)

_____ Professors expect students to talk with each other about course material during class time (lecture and/or lab). (7)

_____ You find it easy to find other students to work with on class related assignments. (8)

Q28 Do you consider yourself an active member at any of the following clubs/organizations? Check all that apply.

Association of Computing Machinery (ACM) (1)

Women in Computer Science (WiCS) (2)

Cybersecurity Club (3)

Upsilon Pi Epsilon - Computer Science Honor Society (UPE) (4)

Game Development Club (GDC) (6)

None of the above (5)

Q29 Have you attended an event run by one of the following clubs/organizations in the past year? Check all that apply.

Association of Computing Machinery (ACM) (1)

Women in Computer Science (WiCS) (2)

Cybersecurity Club (3)

Upsilon Pi Epsilon - Computer Science Honor Society (UPE) (4)

Game Development Club (GDC) (7)

Not sure (5)

No (6)

Q30 How many non-CS related clubs/organizations do you consider yourself an active member of?

0 (1)

1 (2)

2 (3)

3 (4)

4 (5)

5+ (6)

Q31 Please rate the following statements, with 1 being you strongly disagree with the statement and 5 being you strongly agree with the statement.

_____ You are comfortable with the CS students around you. (1)

_____ The CS courses at WPI align directly with your interests. (2)

_____ The CS department as a community is connected. (3)

_____ There are lots of ways to get involved within the CS department. (4)

_____ You regularly socialize with CS students outside of class. (5)

_____ You have had positive interactions with professors outside of class. (6)

_____ You consider the professors to be very approachable. (7)

_____ You view your advisor as a resource, and regularly speak with them. (8)

_____ Faculty in the CS major show interest in you. (9)

_____ Your professors encourage you to continue in the major. (10)

_____ Overall, CS professors are good role models. (11)

_____ You work on personal CS projects outside of class by yourself. (12)

_____ You work on personal projects outside of class with others. (13)

_____ It's easy to find student run projects to work on. (14)

_____ Working on projects outside of class, either by yourself or with others, builds your confidence in your CS abilities. (15)

Q32 Do you have any male mentors who are in computer science or in a CS related field? Check all that apply.

Family members or family friends (1)

More advanced peers (2)

WPI Computer Science Student Organization (3)

Faculty at WPI (4)

TA/SA at WPI (5)

Current or former boss (6)

Formal mentoring program (7)

Other (8) _____

I do not have a male CS mentor (10)

Q33 Do you have any female mentors who are in computer science or in a CS related field? Check all that apply.

Family members or family friends (1)

More advanced peers (2)

WPI's Women in Computer Science Club (3)

Another WPI Computer Science Student Organization (9)

Faculty at WPI (4)

TA/SA at WPI (5)

Current or former boss (6)

Formal mentoring program (7)

Other (8) _____

I do not have a female CS mentor (10)

Q34 Please rate the following statements, with 1 being you strongly disagree with the statement and 5 being you strongly agree with the statement.

_____ Office hours are a good way to find help. (1)

_____ Office hours are held in appropriate locations. (2)

_____ It is easy to get timely help during office hours. (3)

_____ Office hours are held at accessible times. (4)

_____ It is easy to get helpful information in office hours. (5)

_____ You feel more confident after attending office hours. (6)

_____ You feel comfortable raising your hand during introductory CS courses. (7)

_____ You feel comfortable raising your hand during upper level CS courses. (8)

_____ Rate this statement 4 if you are paying attention. (9)

_____ You feel comfortable contacting professors outside of class and office hours. (10)

Q35 Please rate the following statements by how often you attend, with 1 being very rarely and 5 being very often.

_____ TA/SA Office Hours (1)

_____ Professor Office Hours (2)

_____ Review Sessions (3)

Q36 When you have a question about an assignment or project in one of your CS classes or labs, you ask (Check all that apply):

Other students in the class (2)

The professor teaching the class (3)

A professor not teaching the class (4)

The TA/SA (5)

A parent or sibling (6)

Another student who previously took the same course (7)

Students in my residence hall (8)

Tutors from the ARC/MASH (9)

No one (1)

Display This Question:

If When you have a question about an assignment or project in one of my CS classes or labs, you ask (Check all that apply): No one Is Selected

Q37 Was it because you felt too embarrassed to ask for help and/or waited too long to seek help?

Yes (1)

No (2)

Q38 Did you like this survey?

1 (1)

2 (2)

3 (3)

4 (4)

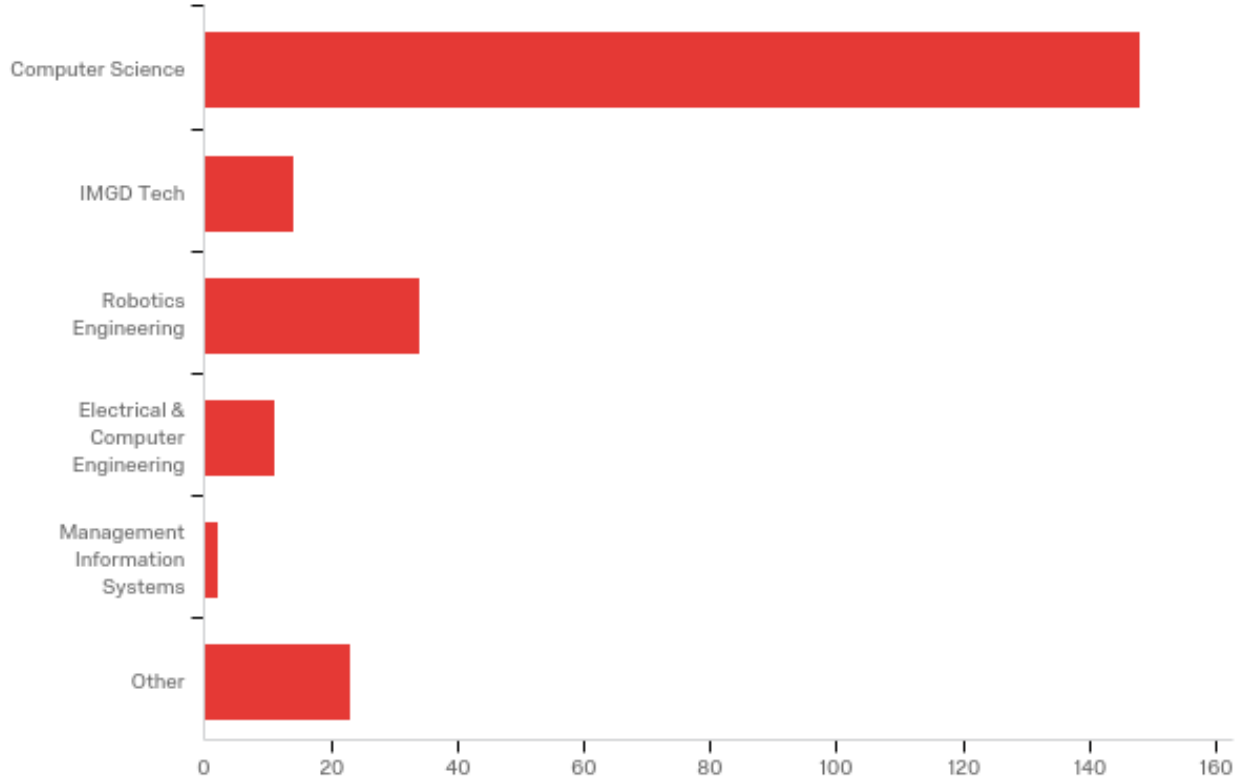
5 (5)

Q39 Are there any actions you would suggest taking to improve the CS Department at WPI?

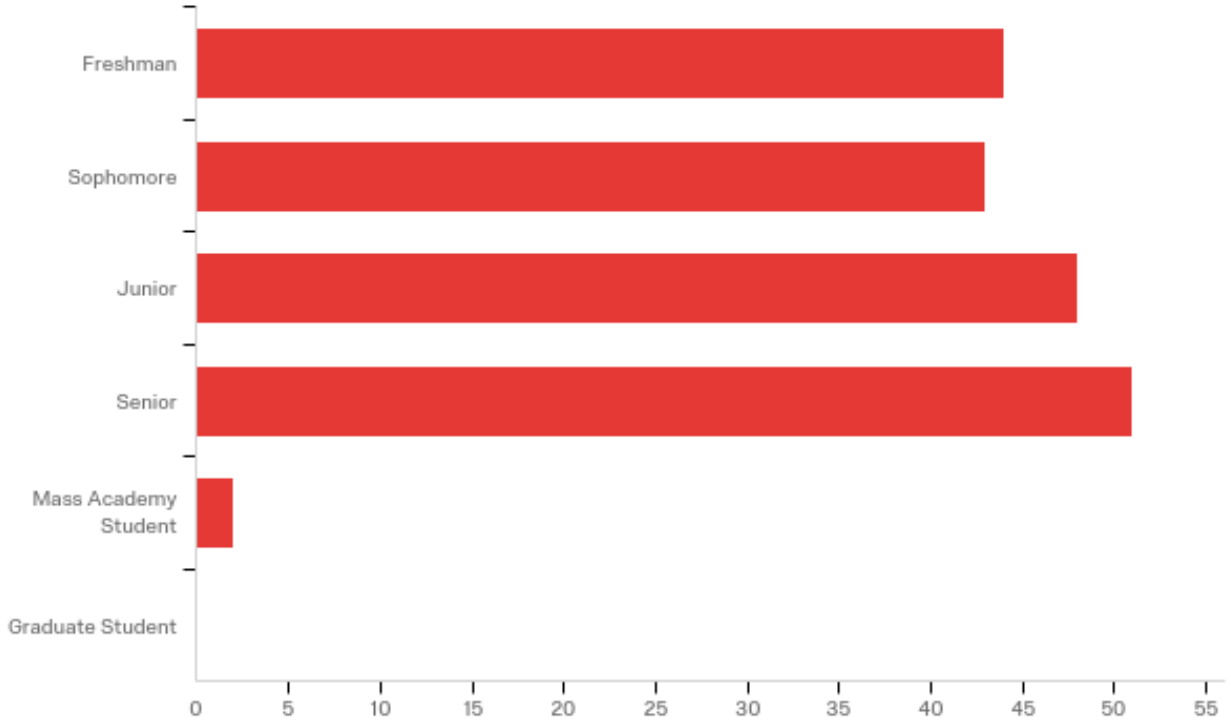
Q40 Do you have anything else you'd like to tell us about your experience within the CS Department at WPI?

8.4 Appendix D: Survey Data

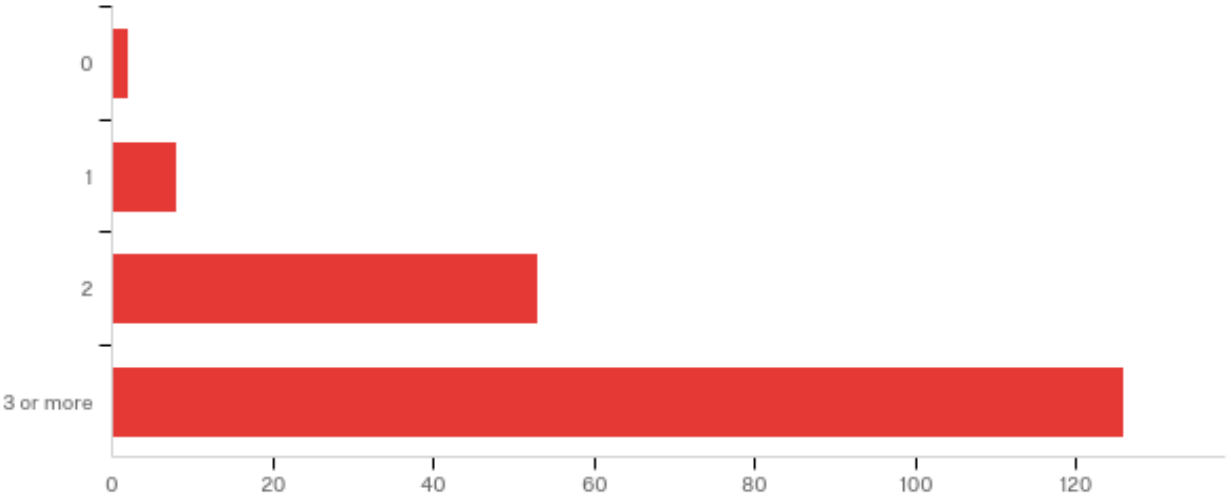
Q2 - What is your declared or intended major? Check all that apply.



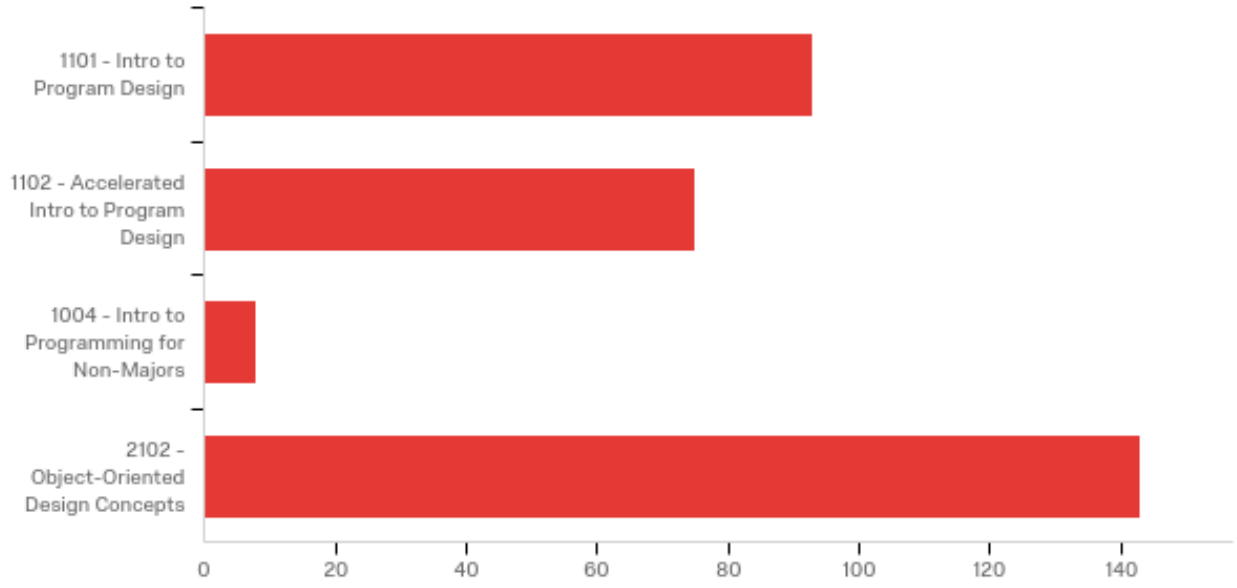
Q3 - What year are you?



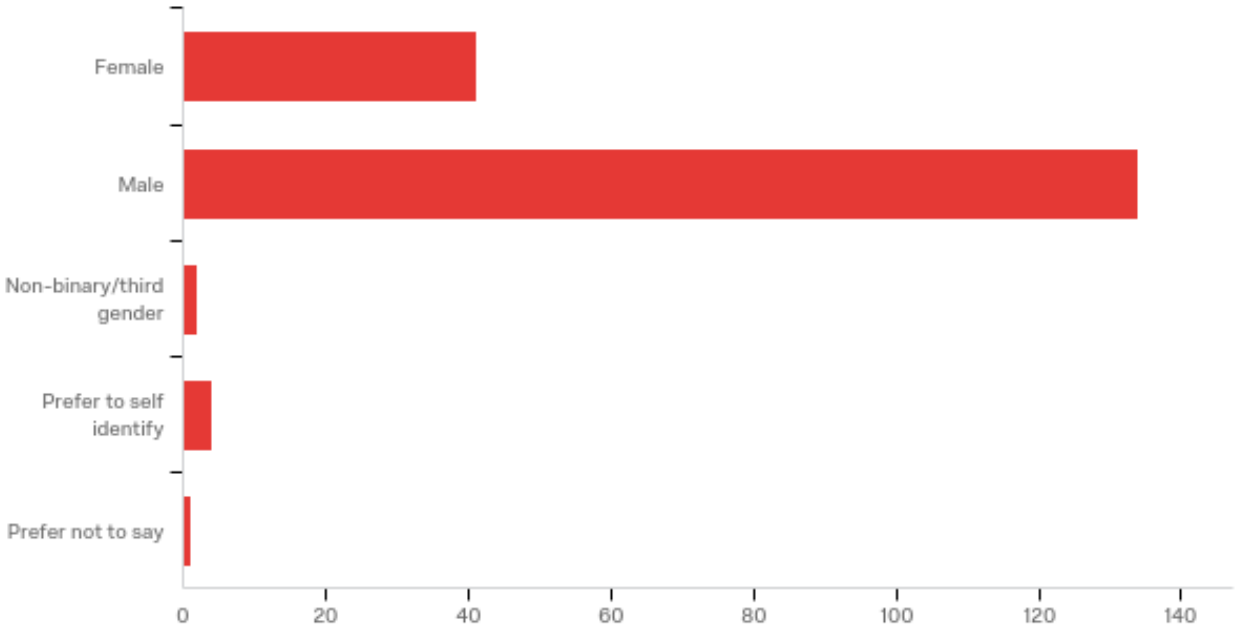
Q4 - How many Computer Science courses have you taken at WPI?



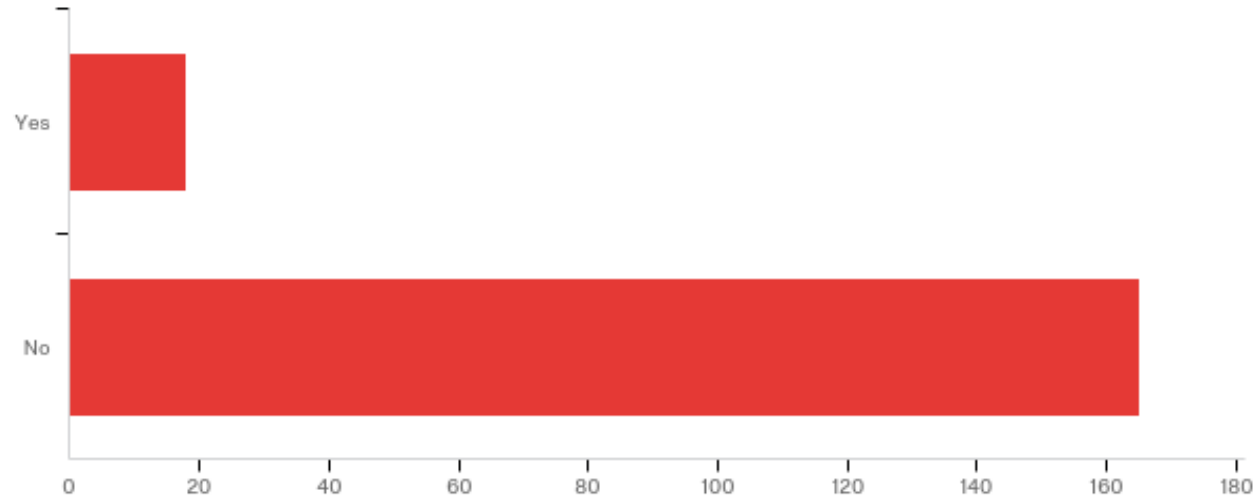
Q5 - Which of the following intro level CS courses have you taken or are taking? Check all that apply.



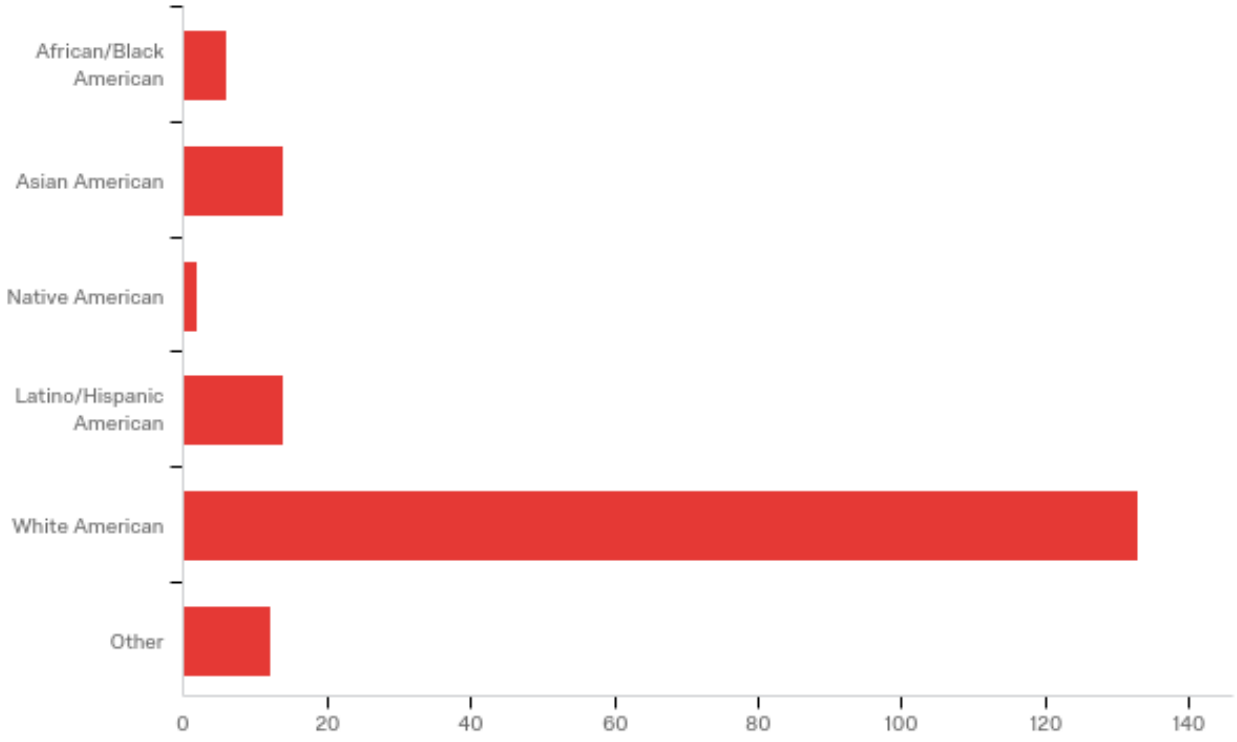
Q6 - What is your gender?



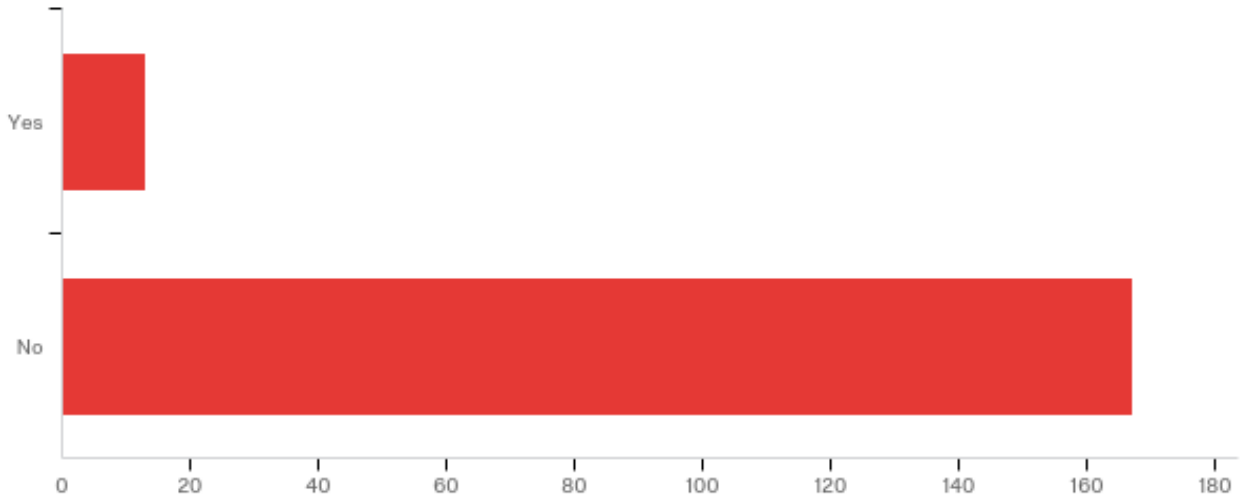
Q7 - Are you an international student?



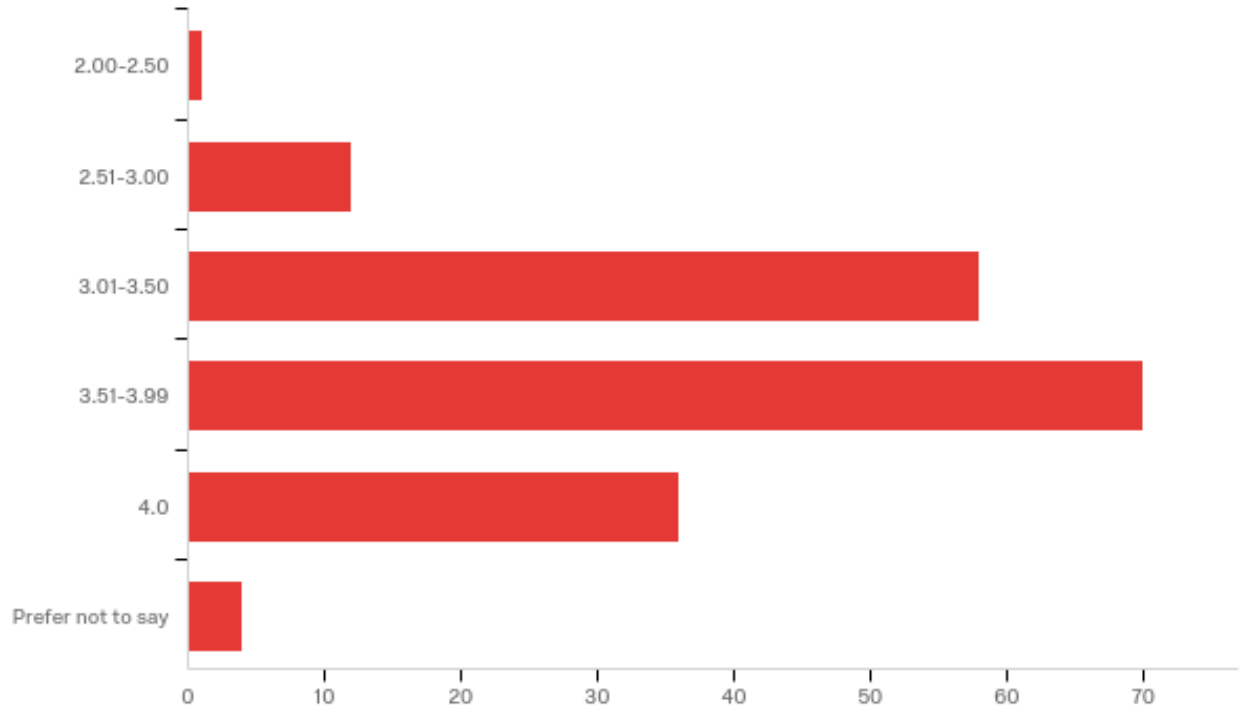
Q8 - Please specify your ethnicity. Check all that apply.



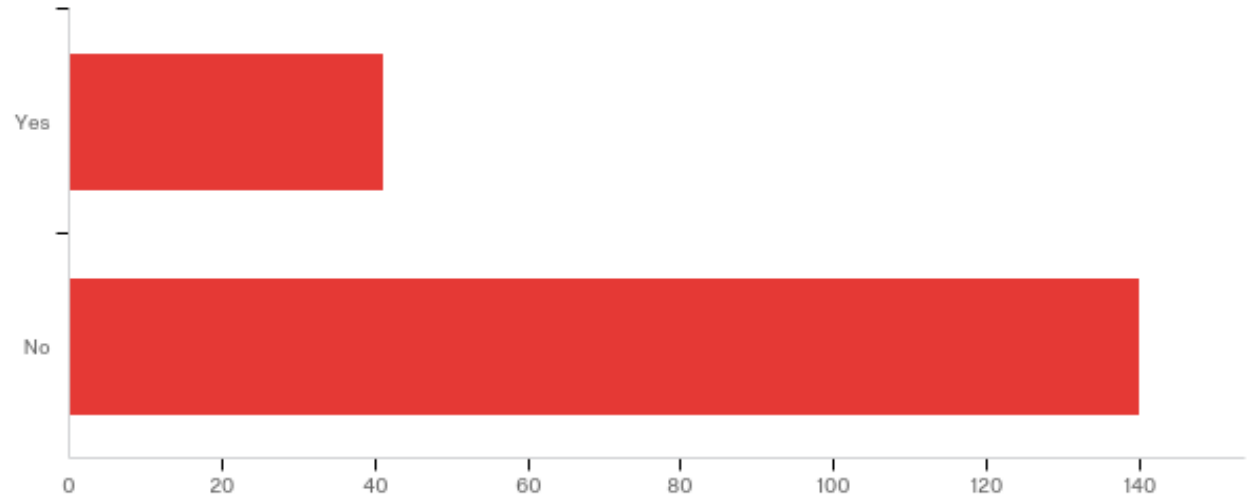
Q9 - Are you the first in your family to attend college?



Q10 - What was your cumulative college GPA at the end of the most recent academic semester/term?



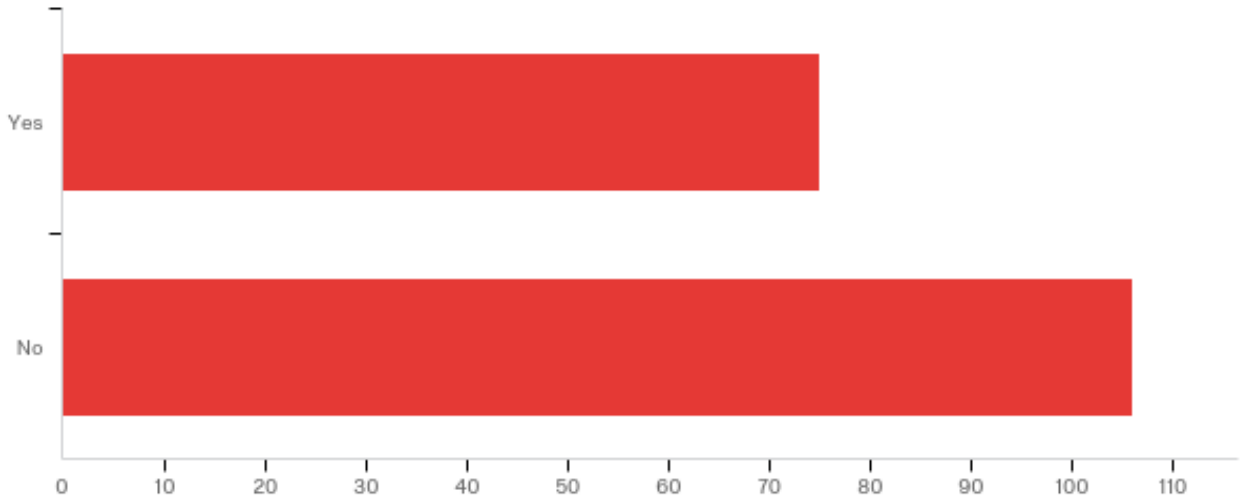
Q11 - Are you a member of a social sorority or fraternity?



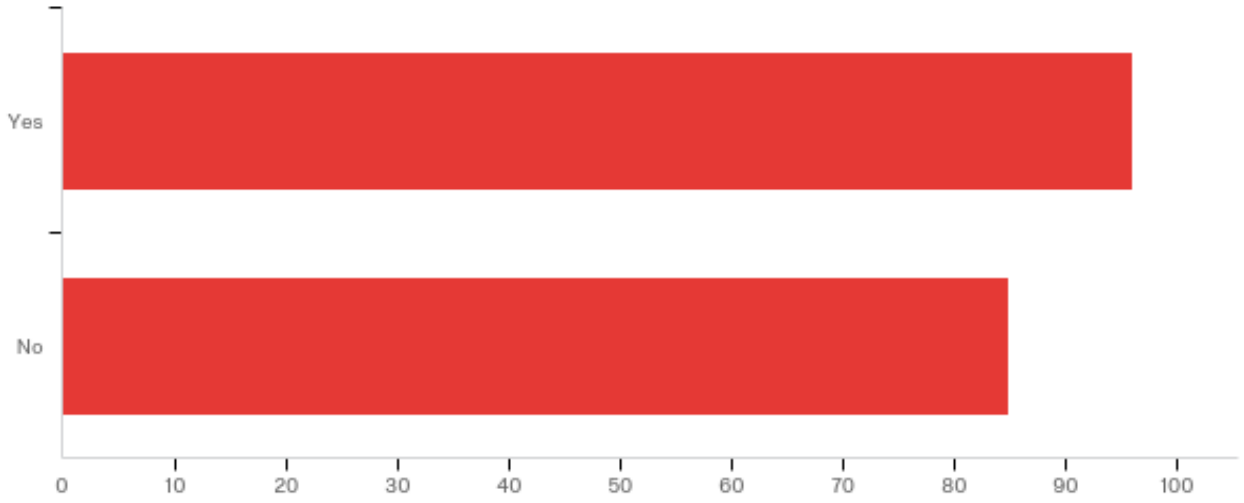
Q12 - How would you rate your computer science ability, and the computer science abilities of your peers (1 being very weak, and 5 being very strong)?

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
Rate your computer science ability	1.00	5.00	3.90	0.92	0.85	159
Rate the average skill of other CS students in your classes	1.00	5.00	3.65	0.73	0.54	148

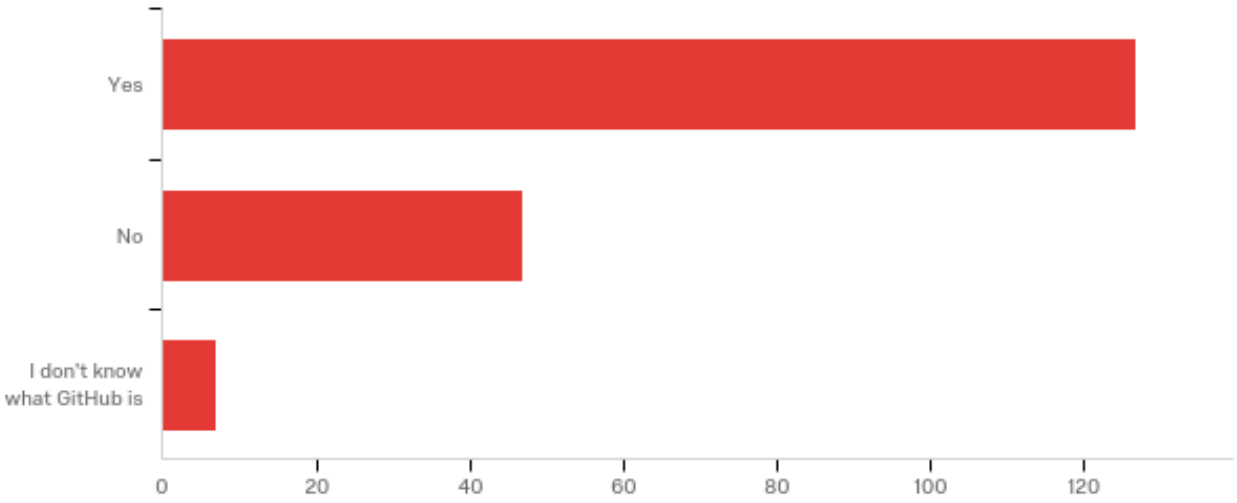
Q13 - Did you take AP Computer Science in high school?



Q14 - Did you take a non-AP Computer Science course in high school?

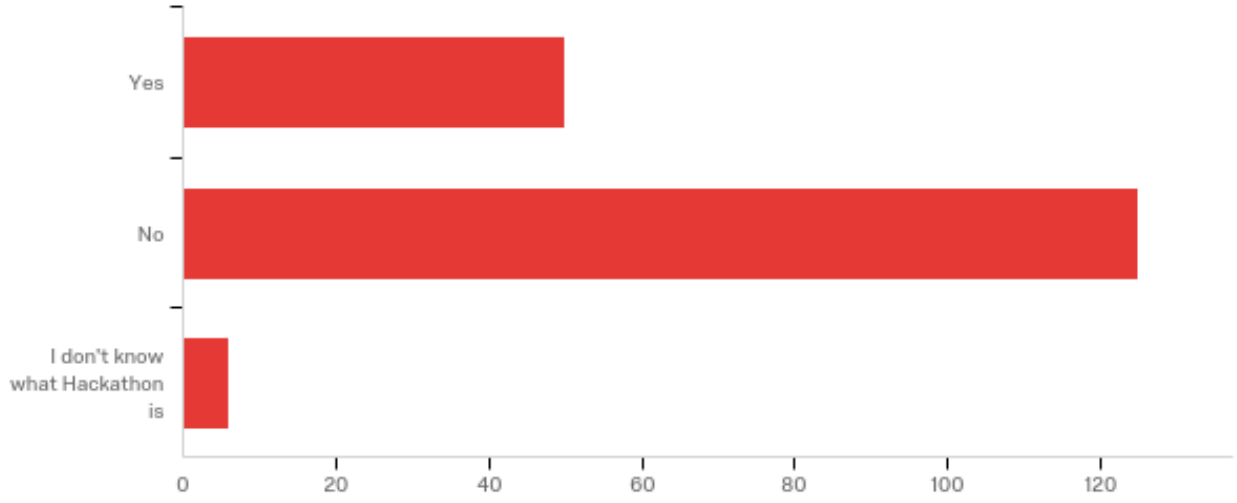


Q15 - Do you have a GitHub or similar?



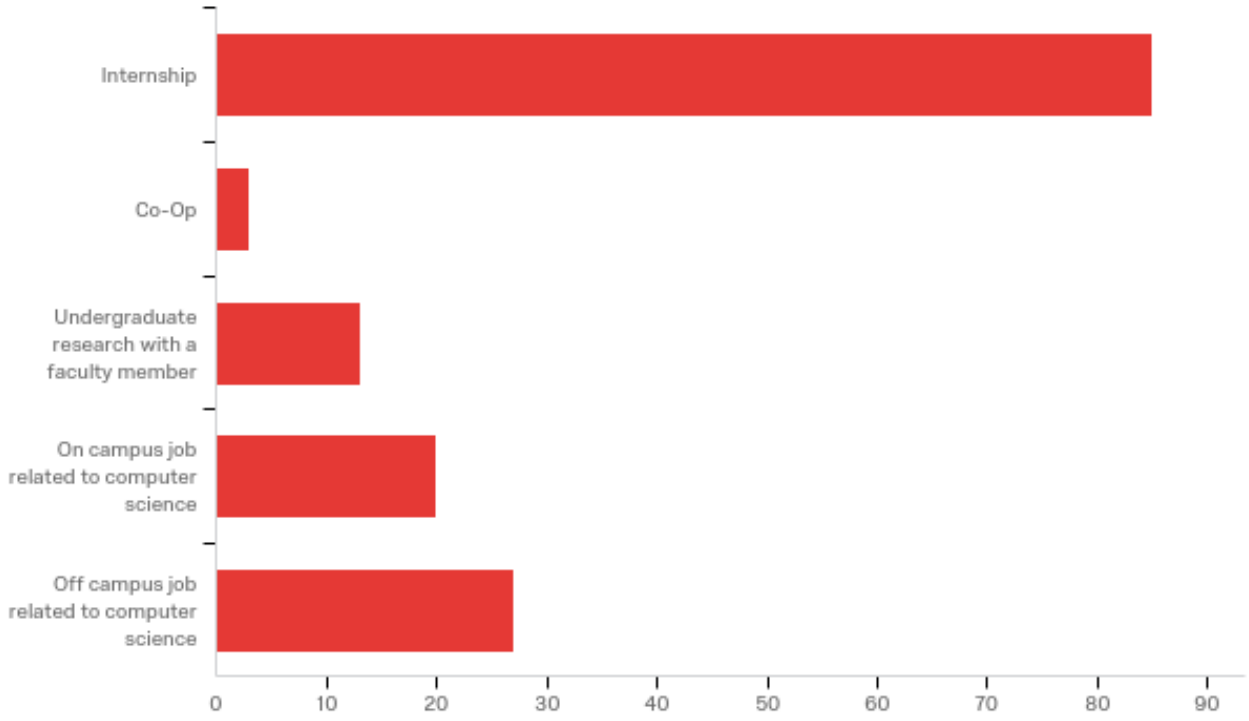
#	Answer	%	Count
1	Yes	70.17%	127
2	No	25.97%	47
3	I don't know what GitHub is	3.87%	7
	Total	100%	181

Q16 - Have you attended a Hackathon?

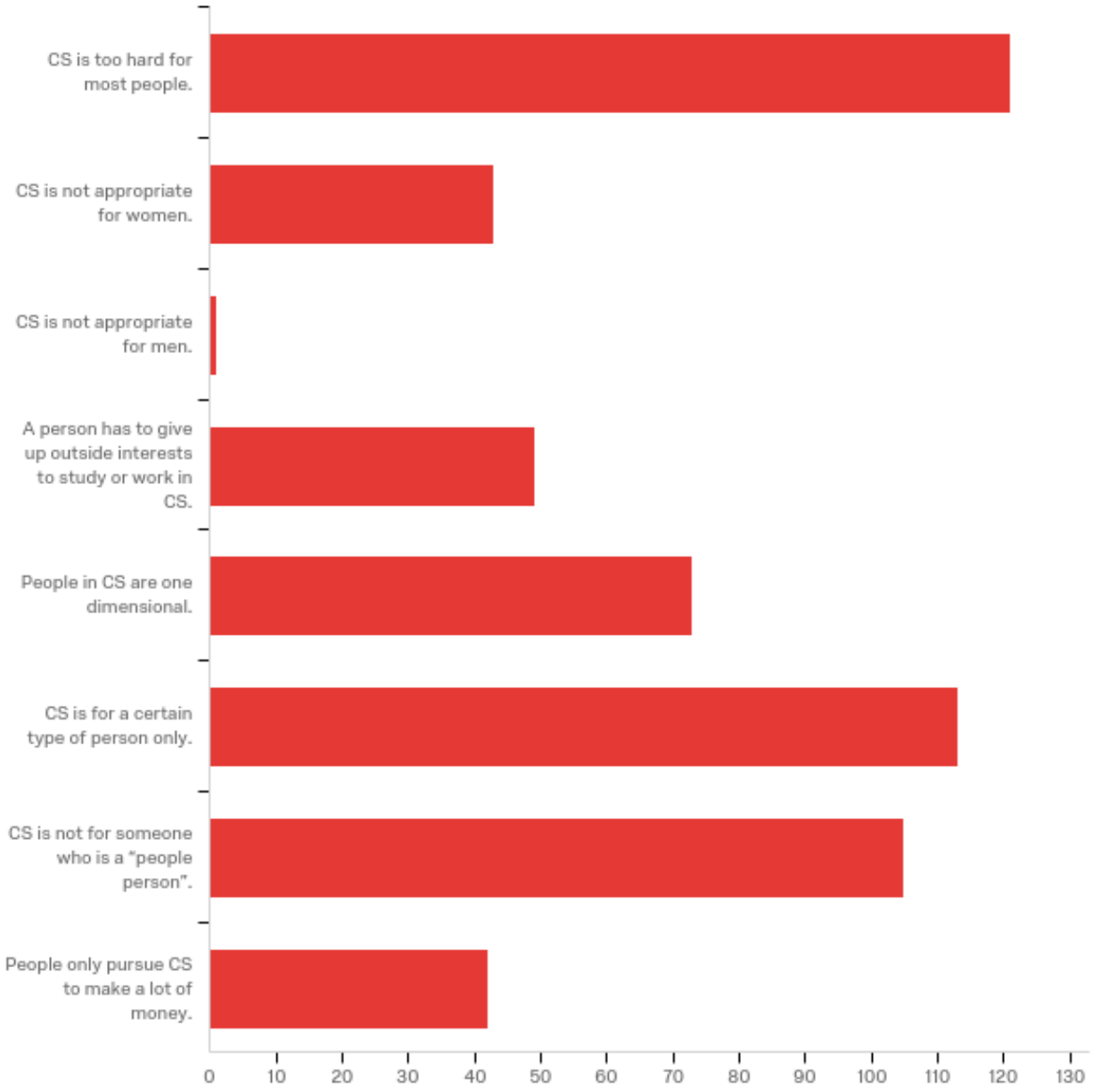


#	Answer	%	Count
1	Yes	27.62%	50
2	No	69.06%	125
3	I don't know what Hackathon is	3.31%	6
	Total	100%	181

Q17 - Which of the following have you participated in during the last year? Check all that apply.



Q18 - What assumptions do you think people have about computer science? Check all that apply.



Q19 - Please rate the following statements, with 1 being you strongly disagree with the statement and 5 being you strongly agree with the statement.

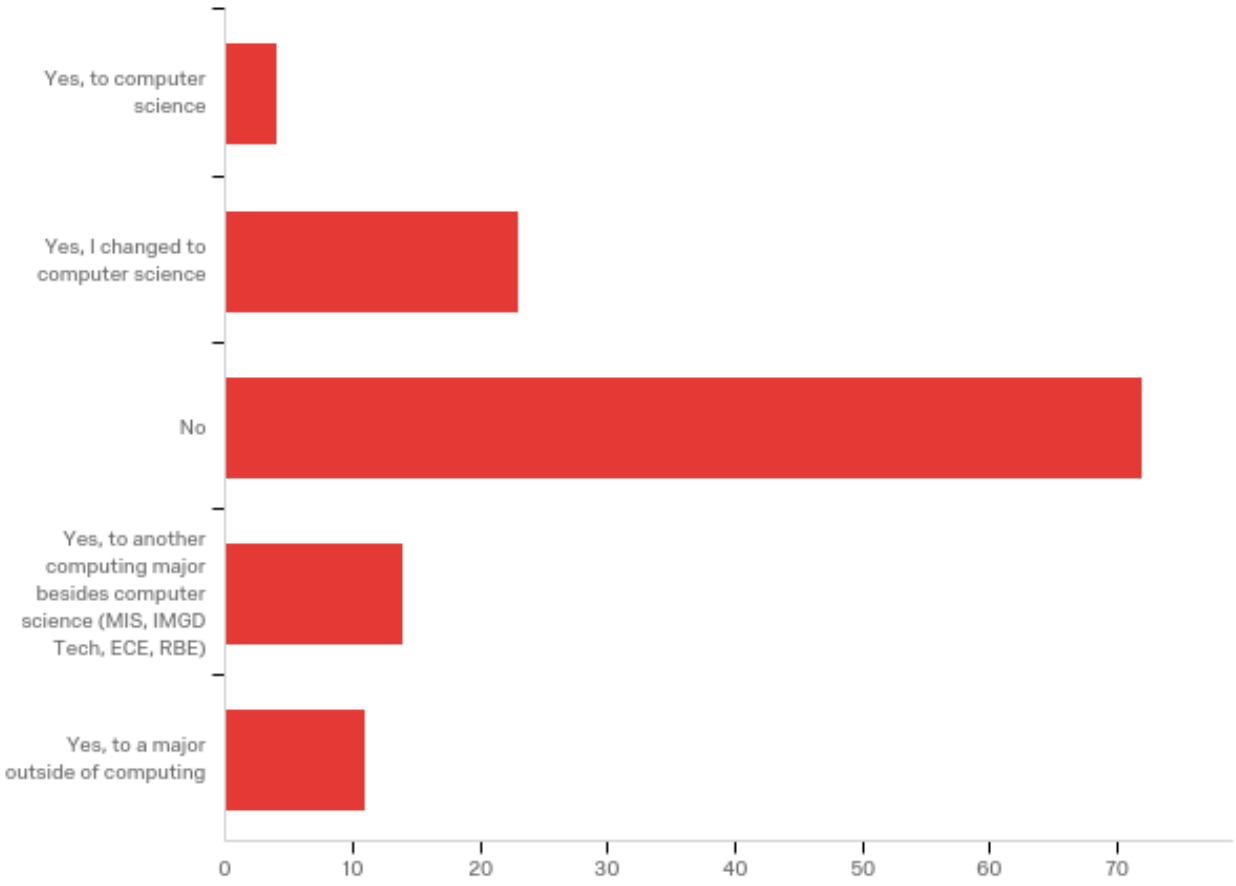
Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
You feel at home within the CS major.	1.00	5.00	3.61	1.27	1.62	107
You can influence what your experience in the CS major is like.	1.00	5.00	3.52	1.11	1.22	109
Students in the CS major encourage each other to succeed.	1.00	5.00	3.34	1.24	1.55	98
Some students routinely show off in class.	1.00	5.00	4.07	1.11	1.24	108
My professors are effective at managing students who show off in class.	1.00	5.00	2.75	1.05	1.11	100

Q20 - Which of the following words describe the general atmosphere in the CS department, both in and out of classes? Check all that apply.

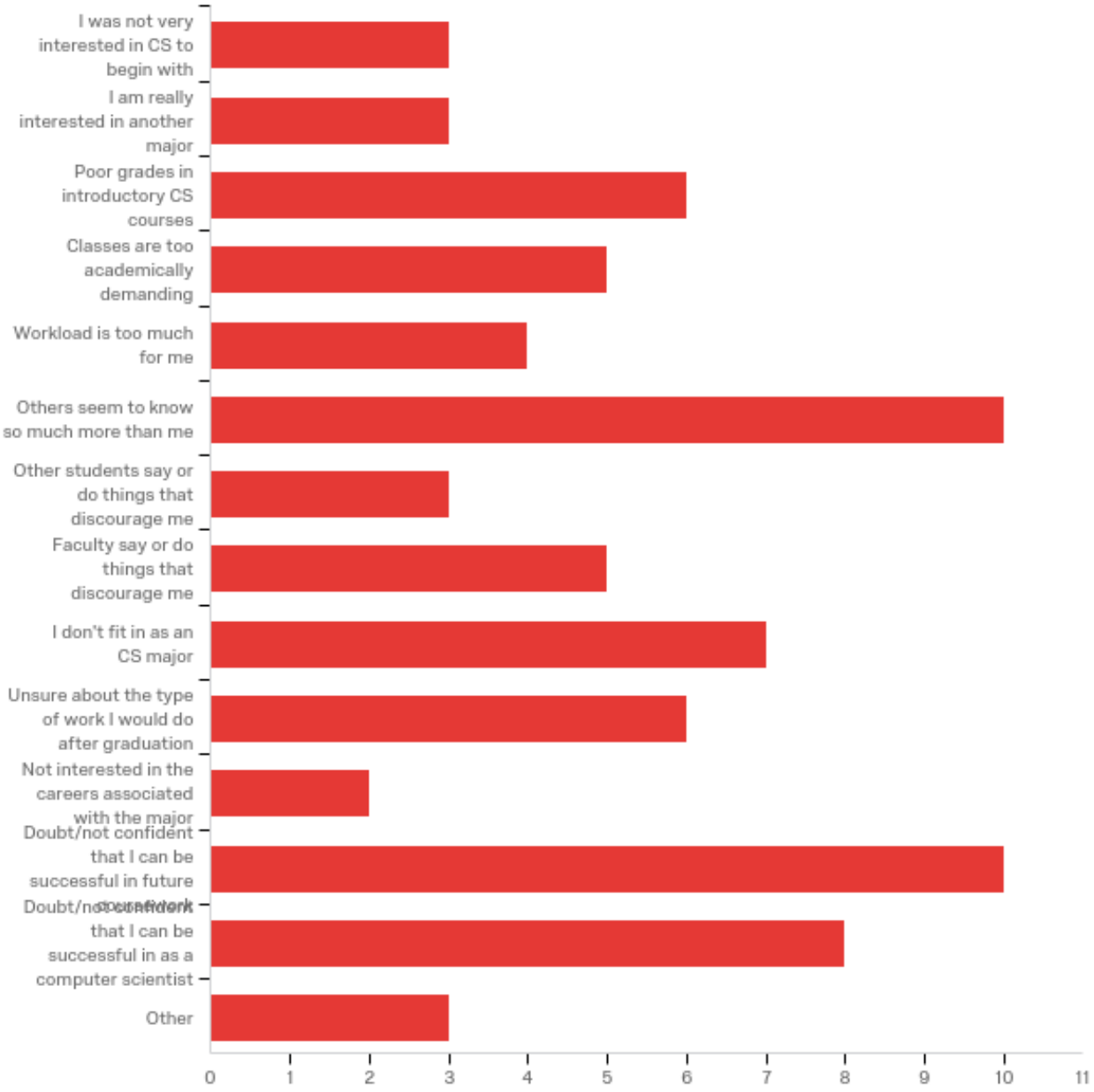
#	Answer	%	Count
1	Friendly	41.18%	49
2	Encourages asking for help	47.06%	56
3	Too focused on academics	28.57%	34
4	Community-oriented	10.08%	12
5	Individualistic	37.82%	45
6	Differences of opinion are respected	30.25%	36
7	Tolerant/open-minded	21.85%	26
8	Fun	22.69%	27
9	Supportive	24.37%	29
10	Collaborative	37.82%	45
11	Welcoming	24.37%	29
12	Isolating	30.25%	36
13	Boring	17.65%	21
14	Intellectually stimulating	52.94%	63
15	Competitive	53.78%	64
16	Students are all treated the same	31.93%	38
17	Collegial	14.29%	17
18	Performance-driven	55.46%	66
19	Accepting of weaknesses	10.08%	12
20	Too hard/challenging	15.13%	18
	Total	100%	119

#	Answer	%	Count
1	Friendly	41.18%	49
2	Encourages asking for help	47.06%	56
3	Too focused on academics	28.57%	34
4	Community-oriented	10.08%	12
5	Individualistic	37.82%	45
6	Differences of opinion are respected	30.25%	36
7	Tolerant/open-minded	21.85%	26
8	Fun	22.69%	27
9	Supportive	24.37%	29
10	Collaborative	37.82%	45
11	Welcoming	24.37%	29
12	Isolating	30.25%	36
13	Boring	17.65%	21
14	Intellectually stimulating	52.94%	63
15	Competitive	53.78%	64
16	Students are all treated the same	31.93%	38
17	Collegial	14.29%	17
18	Performance-driven	55.46%	66
19	Accepting of weaknesses	10.08%	12
20	Too hard/challenging	15.13%	18
	Total	100%	119

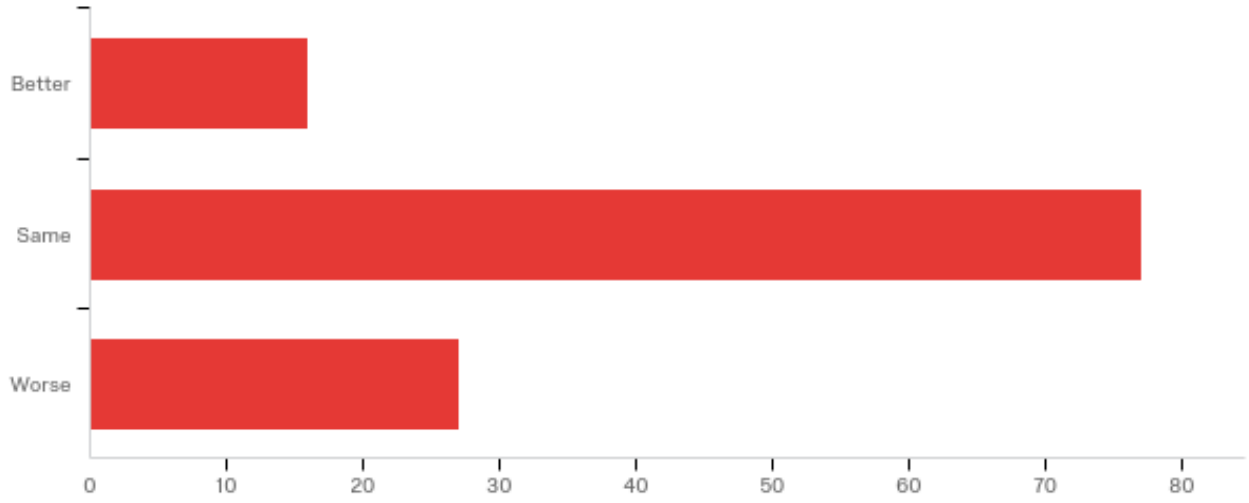
Q21 - Have you considered changing your major?



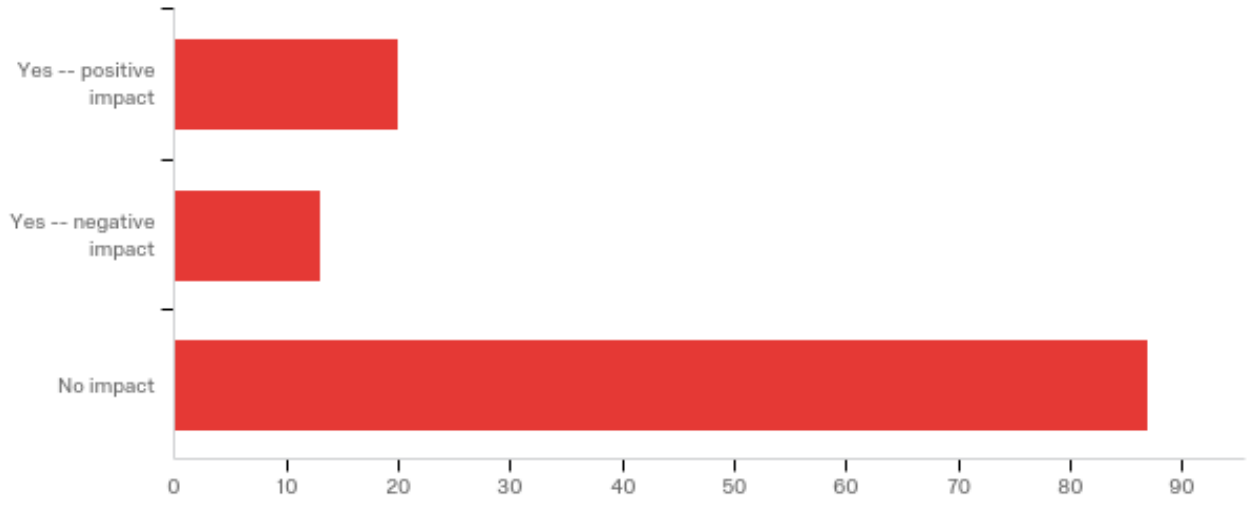
Q22 - If you have considered changing your major away from CS, which of the following reasons/issues have you considered when thinking about changing? Check all that apply.



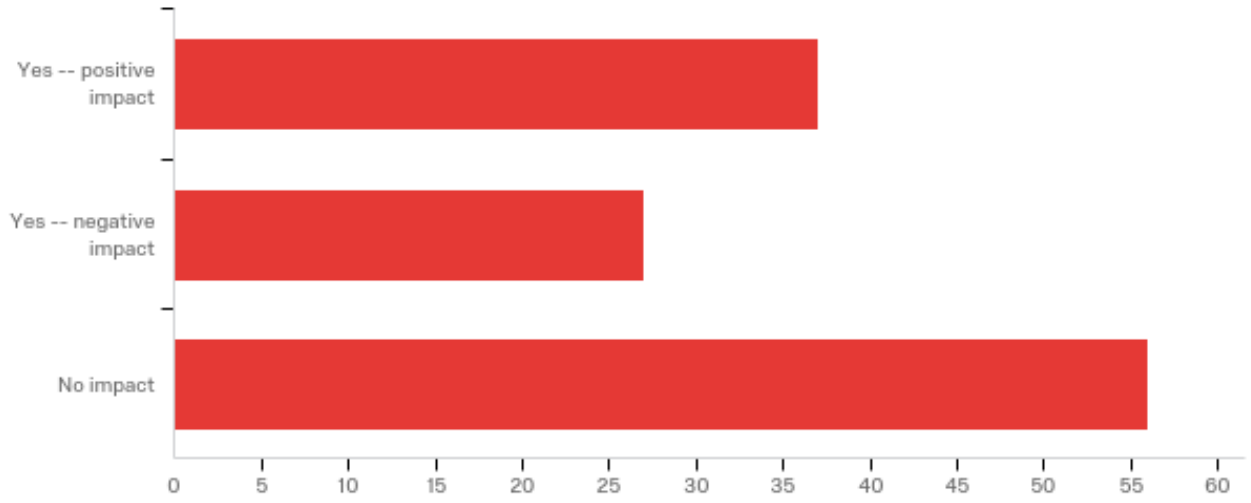
Q23 - In your opinion, how are women treated as compared to men in your major?



Q24 - Has your gender had an impact on your experience in your major?



Q25 - Do you believe that your gender impacts your career path?



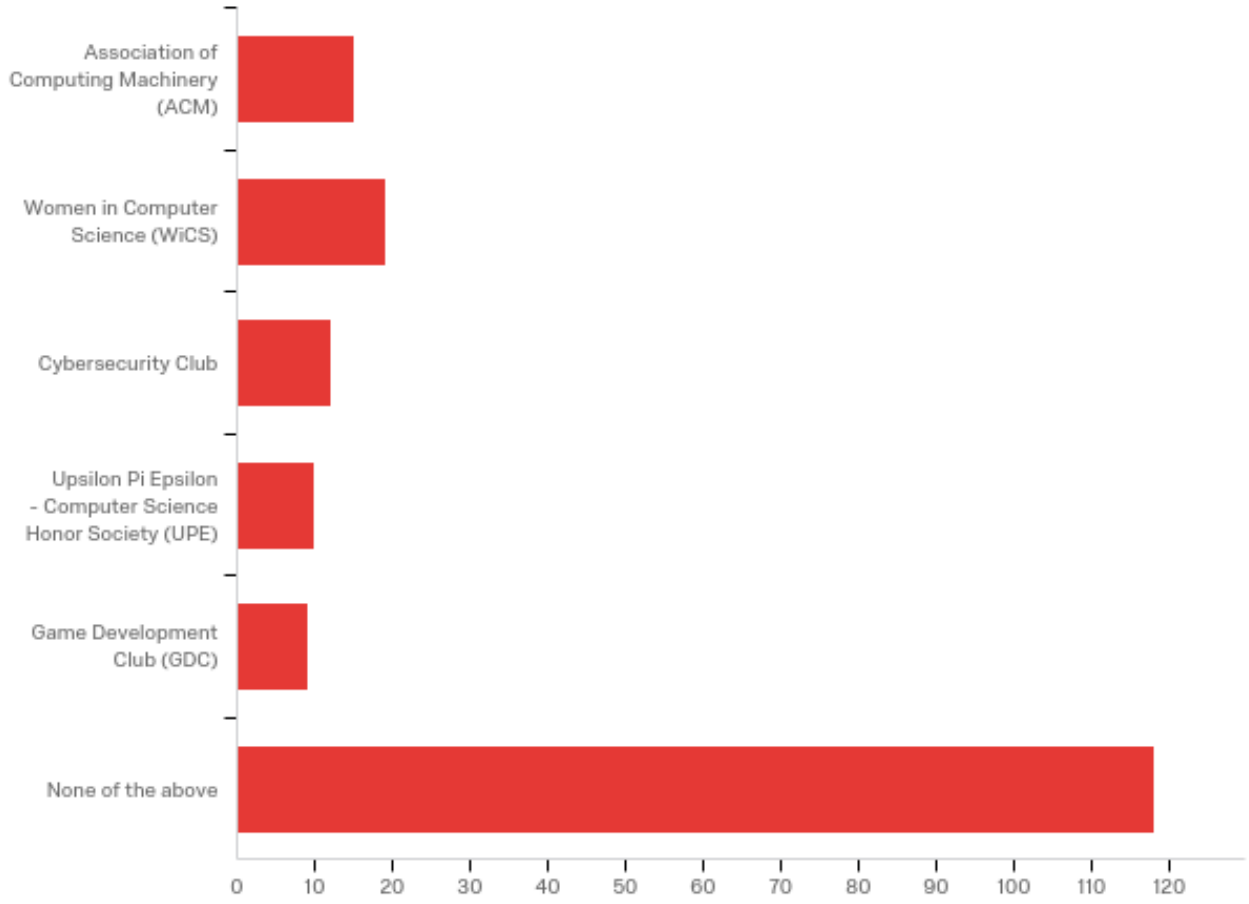
Q26 - Please rate the following questions on a scale of 1 to 5. 1 meaning strongly disagree, and 5 meaning

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
You were more interested in computer science as a whole after taking the introductory computer science courses.	1.00	5.00	3.26	1.38	1.89	147
Projects/homeworks are interesting.	1.00	5.00	3.22	1.24	1.55	144
Projects/homeworks are frustrating.	1.00	5.00	3.27	1.26	1.60	147
What was taught in class was enough for you to succeed on homeworks, labs, quizzes, and exams.	1.00	5.00	3.44	1.33	1.76	153
You feel that your programming ability is stronger after taking an introductory CS course.	1.00	5.00	3.42	1.31	1.71	153
Labs are interesting.	1.00	5.00	2.90	1.14	1.29	146
Labs are frustrating.	1.00	5.00	2.59	1.23	1.52	142
You would prefer to have conference instead of lab.	1.00	5.00	2.32	1.42	2.02	151
You utilize the full lab time.	1.00	5.00	3.16	1.31	1.71	157
You collaborate with others during lab.	1.00	5.00	2.47	1.34	1.79	152
Lab assistants provide good support, feedback, and direction during lab periods.	1.00	5.00	3.49	1.11	1.24	148
Attending lab makes you feel more confident about your ability to succeed in the course.	1.00	5.00	3.12	1.17	1.37	149
Collaboration is a great way to build community within introductory courses.	1.00	5.00	4.06	0.89	0.80	153

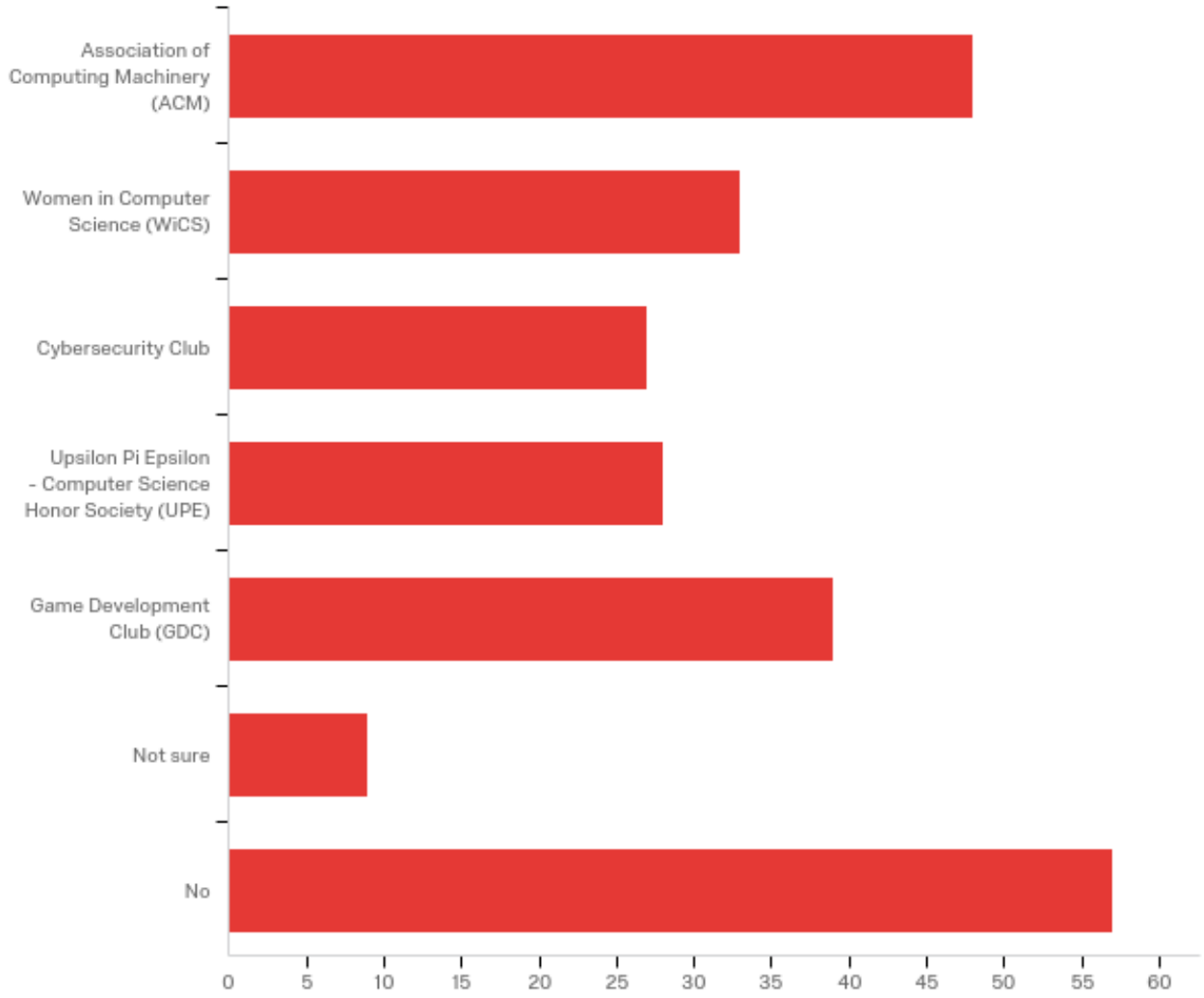
Q27 - Please rate the following statements regarding collaboration in computer science, with 1 being you strongly disagree with the statement and 5 being you strongly agree with the statement.

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
You enjoy working with other students on CS homework/projects.	1.00	5.00	3.63	1.19	1.41	161
It would benefit me to work on CS homework/projects with other students.	1.00	5.00	3.72	1.13	1.28	156
You regularly consult and seek help from your peers on CS assignments.	1.00	5.00	3.31	1.39	1.94	157
You have had positive experiences in design teams or doing other collaborative work in CS.	1.00	5.00	3.62	1.11	1.24	160
Collaborating with other students is important in order to succeed in CS.	1.00	5.00	3.99	1.11	1.24	158
You have worried that talking to other students about assignments in your CS classes could be interpreted as cheating.	1.00	5.00	2.58	1.39	1.93	163
Professors expect students to talk with each other about course material during class time (lecture and/or lab).	1.00	5.00	3.08	1.16	1.35	158
You find it easy to find other students to work with on class related assignments.	1.00	5.00	3.11	1.22	1.49	152

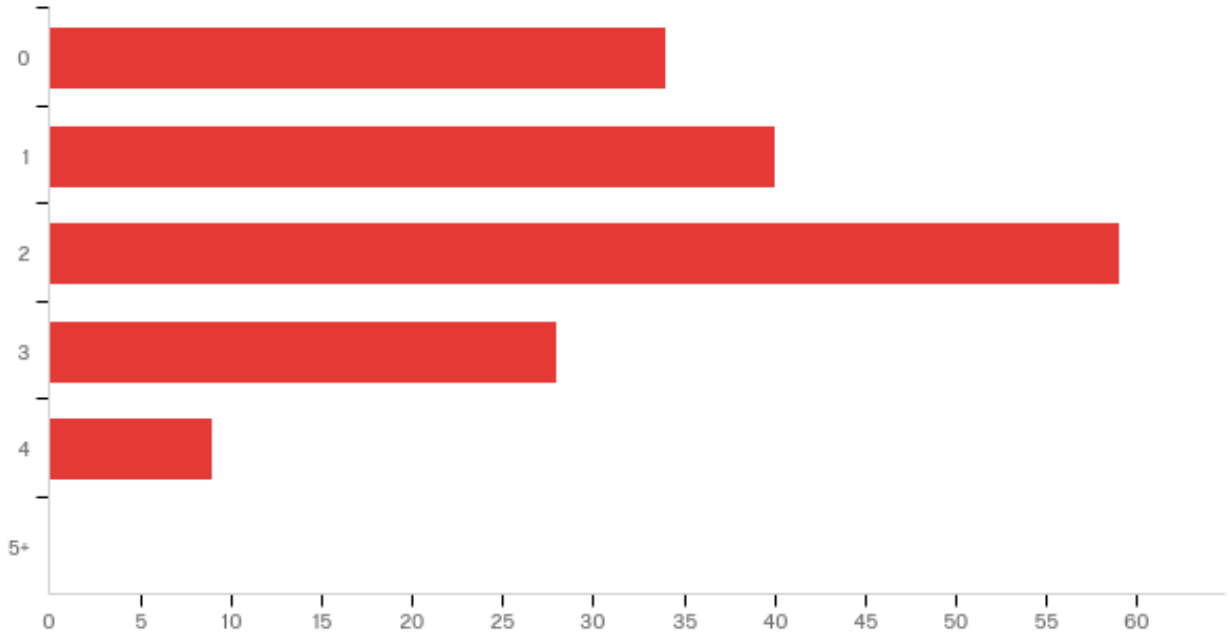
Q28 - Do you consider yourself an active member at any of the following clubs/organizations? Check all that apply.



Q29 - Have you attended an event run by one of the following clubs/organizations in the past year? Check all that apply.



Q30 - How many non-CS related clubs/organizations do you consider yourself an active member of?



Q31 - Please rate the following statements, with 1 being you strongly disagree with the statement and 5 being you strongly agree with the statement.

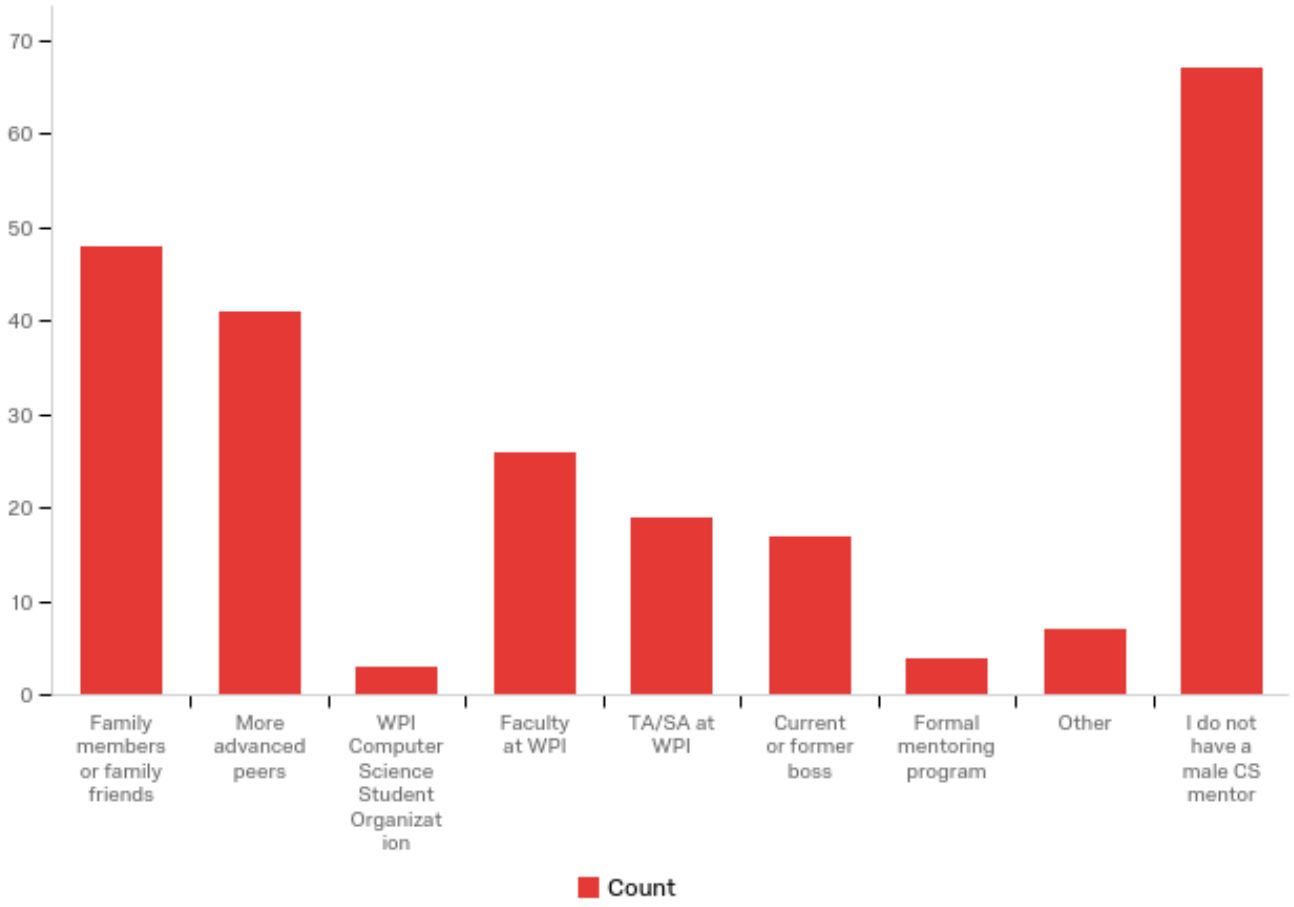
Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
You are comfortable with the CS students around you.	1.00	5.00	3.60	1.07	1.14	151
The CS courses at WPI align directly with your interests.	1.00	5.00	3.40	1.09	1.19	151
The CS department as a community is connected.	1.00	5.00	2.98	1.07	1.15	138
There are lots of ways to get involved within the CS department.	1.00	5.00	3.18	1.04	1.09	141
You regularly socialize with CS students outside of class.	1.00	5.00	2.98	1.36	1.86	148
You have had positive interactions with professors outside of class.	1.00	5.00	3.67	1.11	1.24	147
You consider the professors to be very approachable.	1.00	5.00	3.68	1.08	1.16	146
You view your advisor as a resource, and regularly speak with them.	1.00	5.00	2.38	1.14	1.29	146
Faculty in the CS major show interest in you.	1.00	5.00	2.91	1.18	1.39	141
Your professors encourage you to continue in the major.	1.00	5.00	3.45	1.05	1.10	133
Overall, CS professors are good role models.	1.00	5.00	3.72	0.98	0.96	146
You work on personal CS projects outside of class by yourself.	1.00	5.00	3.30	1.56	2.43	153
You work on personal projects outside of class with others.	1.00	5.00	2.22	1.38	1.89	153
It’s easy to find student run projects to work on.	1.00	5.00	1.94	1.01	1.02	140
Working on projects outside of class, either by yourself or with others, builds your confidence	1.00	5.00	3.96	1.08	1.16	146

in your CS abilities.						

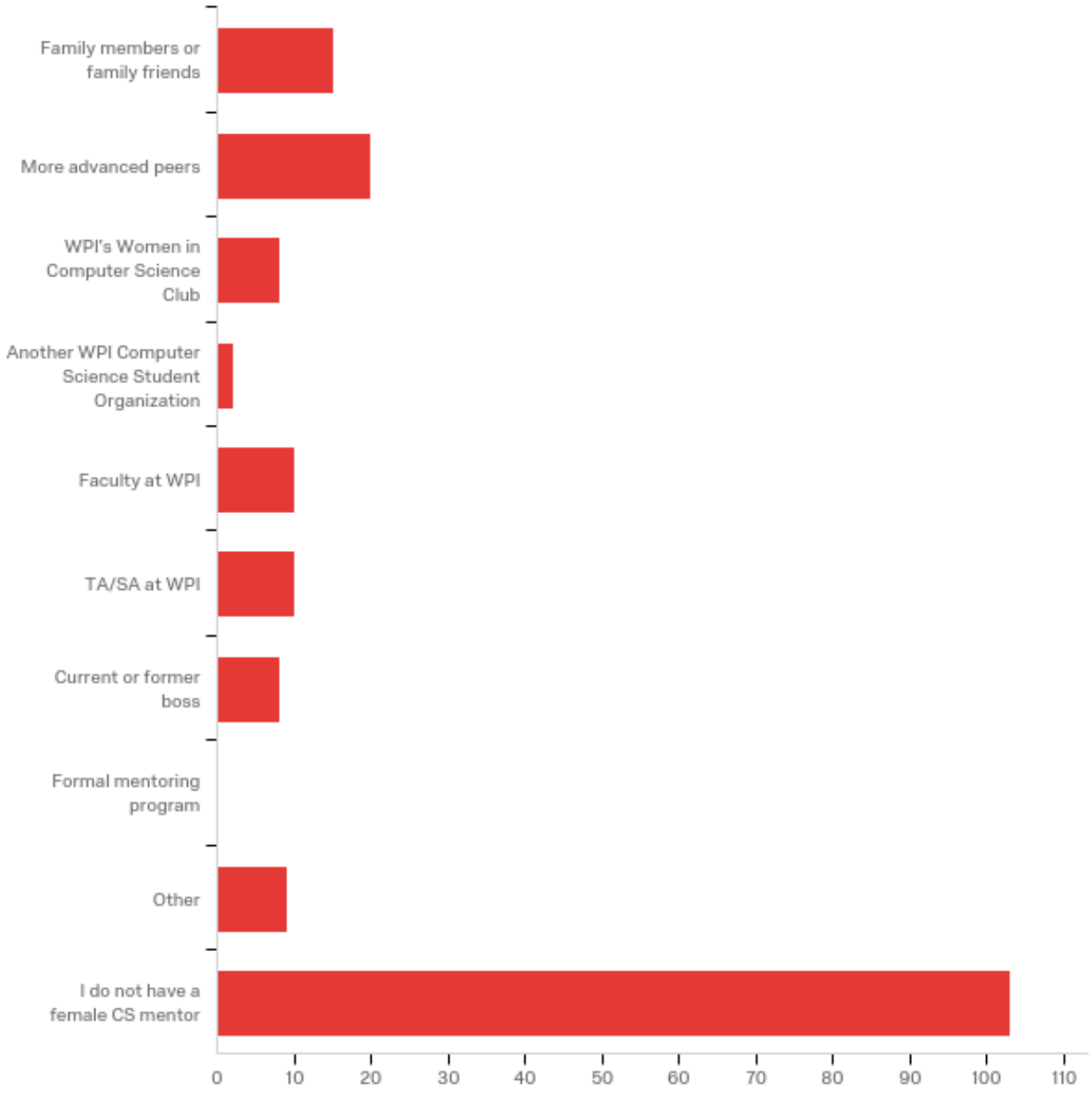
Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
You are comfortable with the CS students around you.	1.00	5.00	3.60	1.07	1.14	151
The CS courses at WPI align directly with your interests.	1.00	5.00	3.40	1.09	1.19	151
The CS department as a community is connected.	1.00	5.00	2.98	1.07	1.15	138
There are lots of ways to get involved within the CS department.	1.00	5.00	3.18	1.04	1.09	141
You regularly socialize with CS students outside of class.	1.00	5.00	2.98	1.36	1.86	148
You have had positive interactions with professors outside of class.	1.00	5.00	3.67	1.11	1.24	147
You consider the professors to be very approachable.	1.00	5.00	3.68	1.08	1.16	146
You view your advisor as a resource, and regularly speak with them.	1.00	5.00	2.38	1.14	1.29	146
Faculty in the CS major show interest in you.	1.00	5.00	2.91	1.18	1.39	141
Your professors encourage you to continue in the major.	1.00	5.00	3.45	1.05	1.10	133
Overall, CS professors are good role models.	1.00	5.00	3.72	0.98	0.96	146
You work on personal CS projects outside of class by yourself.	1.00	5.00	3.30	1.56	2.43	153
You work on personal projects outside of class with others.	1.00	5.00	2.22	1.38	1.89	153
It’s easy to find student run projects to work on.	1.00	5.00	1.94	1.01	1.02	140
Working on projects outside of class, either by yourself or with	1.00	5.00	3.96	1.08	1.16	146

others, builds your confidence in your CS abilities.						

Q32 - Do you have any male mentors who are in computer science or in a CS related field? Check all that apply.



Q33 - Do you have any female mentors who are in computer science or in a CS related field? Check all that apply.



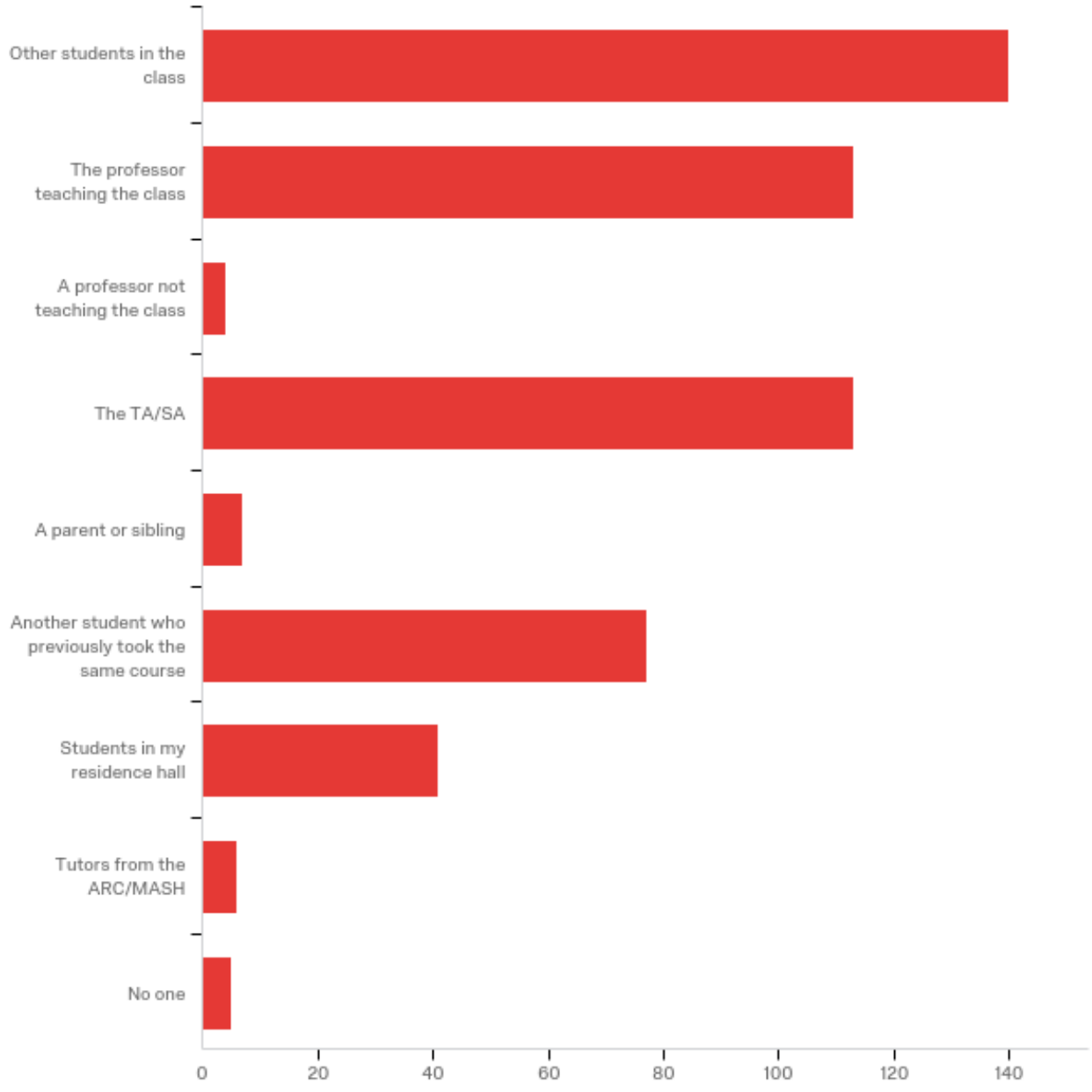
Q34 - Please rate the following statements, with 1 being you strongly disagree with the statement and 5 being you strongly agree with the statement.

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
Office hours are a good way to find help.	1.00	5.00	3.95	0.99	0.97	150
Office hours are held in appropriate locations.	1.00	5.00	3.91	1.02	1.04	144
It is easy to get timely help during office hours.	1.00	5.00	3.17	1.13	1.28	142
Office hours are held at accessible times.	1.00	5.00	3.55	0.94	0.89	141
It is easy to get helpful information in office hours.	1.00	5.00	3.62	1.01	1.01	141
You feel more confident after attending office hours.	1.00	5.00	3.79	0.96	0.91	136
You feel comfortable raising your hand during introductory CS courses.	1.00	5.00	3.15	1.38	1.92	149
You feel comfortable raising your hand during upper level CS courses.	1.00	5.00	3.30	1.31	1.72	139
Rate this statement 4 if you are paying attention.	1.00	4.00	3.97	0.26	0.07	158
You feel comfortable contacting professors outside of class and office hours.	1.00	5.00	3.76	1.10	1.21	148

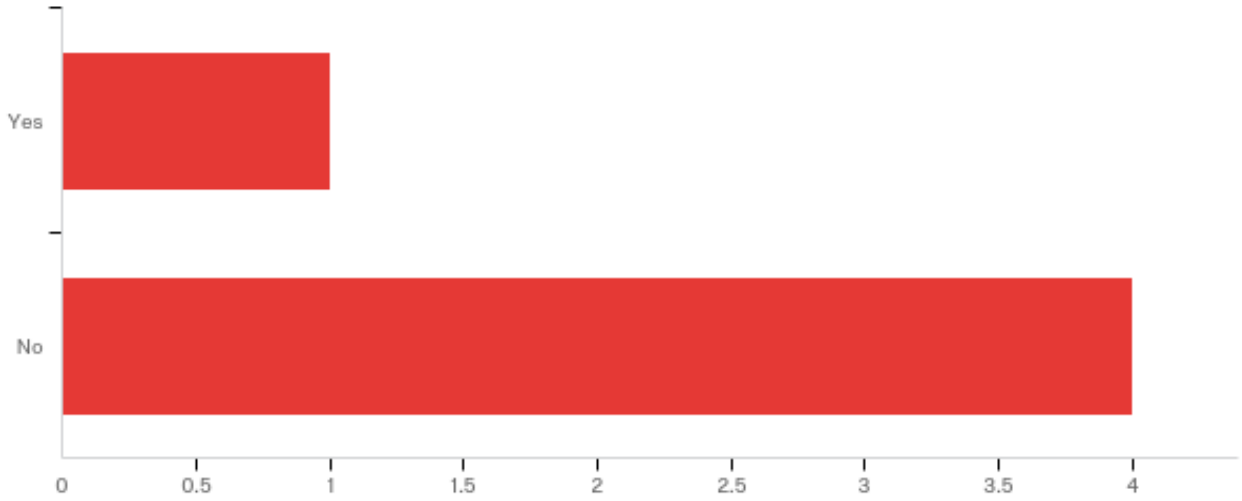
Q35 - Please rate the following statements by how often you attend, with 1 being very rarely and 5 being very often.

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
TA/SA Office Hours	1.00	5.00	2.27	1.30	1.70	152
Professor Office Hours	1.00	5.00	2.16	1.18	1.39	153
Review Sessions	1.00	5.00	2.61	1.47	2.17	150

Q36 - When you have a question about an assignment or project in one of your CS classes or labs, you ask (Check all that apply):



Q37 - Was it because you felt too embarrassed to ask for help and/or waited too long to seek help?



Q38 - Did you like this survey?