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Exploring Gender Imbalance in Computing Science

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Science, technology, engineering, and mathematics are often perceived as male-dominated fields. Gender gaps in some science, technology, engineering, and mathematical fields have decreased, but not in computing science (CS). Based on previous literature, 6 overarching themes that may contribute to gender disparity in CS were investigated: stereotypes, attitudes and beliefs, environmental and institutional factors, nature of CS as a career, societal factors, and course-related factors. This study counted 343 responses from female and male undergraduate students who participated in the study by completing an online survey. The results suggest a shift in traditional assumptions surrounding the lack of diversity in computing science and indicate that males are unaware of the barriers females face, which may prevent the diversification of undergraduate university CS courses and programs.

Keywords: computing science, gender, stereotypes, imbalance, diversity

La science, la technologie, l’ingénierie et les mathématiques sont souvent perçues comme des domaines à prédominance masculine. Il est possible de remarquer une baisse de l’écart entre les sexes dans certains domaines associés aux sciences, à la technologie, à l’ingénierie et aux mathématiques, mais pas en sciences informatiques. Les études antérieures ont permis d’observer 6 thèmes généraux pouvant expliquer la disparité entre les sexes en sciences informatiques : les stéréotypes, les mentalités et les croyances, les facteurs environnementaux et institutionnels, la nature des sciences informatiques comme profession, les facteurs sociétaux et les facteurs rattachés au programme. Un questionnaire en ligne a été rempli par 343 étudiants et étudiantes de premier cycle. L’analyse des résultats démontre une transformation des idées préconçues par rapport au manque de diversité en sciences informatiques et indique que les hommes n’ont pas conscience des difficultés que rencontrent les femmes, créant un obstacle à la diversité des cours et des programmes universitaires en sciences informatiques au premier cycle.

Mots-clés : sciences informatiques, sexe, stéréotypes, déséquilibre, diversité

Careers and academia should be free from gender imbalance, yet science, technology, engineering, and mathematics (STEM) fields such as physics, engineering, and computing science continue to have a male bias. In recent years, the number of females and males in some STEM fields have become more imbalanced. However, some STEM fields have been more successful at closing the gender gap than others for unknown reasons. Computing science (CS) is a STEM field that continues to be gender biased in favour of males. Gender imbalance can be harmful because women do not have the same opportunities as men to share their input, essentially leaving entire sectors of industry and academics dominated by male perspectives.

Previous research has found that aspects such as stereotypes, academic experiences, biases, and identity issues are some of the many barriers that women face when entering, and remaining in, STEM programs (cf. Blackburn, 2017). Further, Cheryan, Ziegler, Montoya, and Jiang (2017) reviewed micro and macro-level factors that may be dissuading women from entering CS in particular. Micro-level factors are internal to the individual, whereas macro-level factors are external to the individual. Studies on this topic tend to be either experimental, whilst focusing on one particular aspect of the phenomenon, or a review of all the factors together with minimal empirical data looking at the entire scope of gender imbalance. The current study explored multiple factors thought to contribute to gender disparity in CS programs. Since there has been evidence for a variety of contributing factors, the study investigated stereotypes, attitudes, and beliefs as micro-level factors, and work environments, the nature of CS work, and societal factors as macro-level factors together in a single framework, while also considering coursework and scheduling as extraneous factors. Extraneous factors are other reasons why students might not enter CS classes or fields.

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Stereotypes are thought to be significant contributors to gender imbalance, influencing individual and group-level processes. Computing science is often seen as a masculine field encouraging male characteristics while discouraging female characteristics. Masculinity is incompatible with feminine identity and may lead women to think that CS is not for them. When undergraduate women read descriptions of a stereotypical computer scientist, they were less interested in CS than when they read descriptions of a non-stereotypical computer scientist (Cheryan, Plaut, Handron, & Hudson, 2013). The stereotypical computer scientist was described as being technology-oriented, rather than people-oriented, and being talented at programming and working with computers. If women feel that they are incompatible with the stereotypes of CS, they may also believe that they would not succeed in this field.

Stereotype threat occurs when an individual is afraid of confirming a negative stereotype. Stereotype threat is prominent when women know that they are the minority in a group setting (Aronson, Wilson, Fehr, & Akert, 2016). When masculine stereotypes are reinforced in the environment and by social structures, it can negatively impact a woman's self-efficacy, which is how an individual perceives their ability to perform tasks. This was investigated as an attitude and belief that may be related to existing gender bias (Good, Aronson, & Harder, 2008; Jones, 2011; Master, Cheryan, & Meltzoff, 2016; Master, Cheryan, Moscatelli, & Meltzoff, 2017). In the current study, questions regarding attitudes and beliefs were designed to target potential affective or cognitive ideas that individuals may hold about their own abilities and the ones required to work in the CS field. It is unclear to what extent stereotypes and attitudes/beliefs contribute to gender imbalance and whether they vary with other factors.

Work and educational environments, in addition to the nature of work that computer scientists do, may be unintentionally disincentivizing women to enroll in CS courses at post-secondary institutions. Environmental and institutional factors were defined as how individuals perceive and interpret interactions and situations around them, whereas nature of the work factors were defined as aspects such as tools used to perform day-to-day tasks, or characteristics acquired or inherently present while active in a CS career. Women in STEM fields typically have inferior statuses, lower salaries, and fewer chances of promotion compared to their male counterparts, which may be salient to women and discourage them from pursing in CS (Cheryan et al., 2017). Societal factors have major influences on one's lifestyle, personality, attitudes, and beliefs. Women are also less likely to complete STEM-related post-secondary programs because of social structures including feeling out of place, lack of female mentorship and opportunity, and not being taken seriously professionally (Acker & Oatley, 1993). Some studies have explored how peers and sense of belonging influence career aspirations in the future (Blaney & Stout, 2017; Gauthier, Hill, McQuillan, Spiegel, & Diamond, 2017; Kim, Sinatra, & Seyranian, 2018); females who feel that they are a part of a group or have friends with similar mindsets tend to enter STEM fields when they are older. However, current research does not provide a full understanding of how previously existing perceptions of the social structures within the industry relate to why women are not in CS now. By understanding female perceptions surrounding CS, the present study may find strategies to incentivize female entry into these programs and fields.

Besides micro and macro-level variables, other extraneous factors could impede women from entering STEM fields. First of all, there may be conflicts with university schedules for a variety of reasons: two classes may occur at the same time, other courses may be more interesting or important, or the time of day that the course is offered may be inconvenient. Furthermore, students may not consider choosing a CS course in the first place if it is not a degree requirement. Post-secondary CS courses may have mandatory laboratory components. The extra time and effort needed to go to laboratories and complete assignments separate from the lecture component, may in itself be a deterring factor from enrolling in CS. In addition to the perceived time and effort required, students may avoid CS due to its perceived difficulty and the potential negative impact it could have on their grade point average (GPA). Believing that one would have difficulty learning the skills required to master CS material could be intimidating enough to dissuade students from this field.

Although there is an abundance of existing literature on the topic of gender imbalance in STEM fields, there is still a need for research that integrates the different components of the phenomenon and includes opinions from a diverse background of people. The current study included students from thirteen faculties and explored micro and macro-level factors collectively. On a macro-level, identifying existing barriers could pave way for policy and recruitment changes in academia and industry. An important step for implementing these changes is understanding how factors work together to create gender imbalance. On an individual micro-level, being aware of stereotypes and implicit attitudes/beliefs can benefit and empower women to realize that they are as capable as men and that success in CS is not contingent on their gender identity.

Hypotheses

The current study assesses to what extent micro-level factors (stereotypes, attitudes, and beliefs) and macro-level factors (work environments, the nature of CS work, and societal influences) impact the current gender imbalance in CS. For micro-level factors, it was first hypothesized that females would be more perceptive of CS stereotypes that are incompatible with their personal identity. Attitudes and beliefs can be influenced by stereotypes, shaping how an individual may evaluate themselves and their capabilities. Thus, it was predicted that women would have lower self-efficacy and would expect to have more difficulty learning CS skills. With regards to the first macro-level factor, it was hypothesized that woman will perceive the CS academic and work environment as unwelcoming and discouraging. When presented statements about the nature of an occupation, it was hypothesized that men and women would differ in terms of what characteristics of a career would appeal to them and which they would value more. Questions about social structures, such as mentorship and relationships, were expected to be rated differently by males and females. Significant gender differences were not expected for questions relating to the extenuous factors (e.g., coursework).

Method

Participants

Participants were undergraduate students at the University of Alberta (Edmonton, Canada). Participants were recruited electronically by the University of Alberta's Undergraduate Student's Digest email service, as well as through Facebook advertisements posted by the researchers. The survey was completely anonymous. There were 86 participants that were excluded for one of the following reasons: 1) they did not give consent; 2) they did not specify binary gender; 3) they took a CS course before; 4) they were not undergraduate students at the University of Alberta. After the exclusion criteria, there were 268 females and 75 males for a total of 343 participants. Majority of participants (78%) were between the ages of 18 and 21. Our sample was drawn from all faculties and departments, excluding the department of CS. Over half of respondents were either from the Faculty of Science (31%) or the Faculty of Arts (26%). The remaining 43% of participants were from the Faculties of Medicine and Dentistry, Education, Native Studies, Agricultural Life and Environmental Sciences, Alberta School of Business, Physical Education and Recreation, Engineering, Nursing, and Extension. Some participants were also from University of Alberta affiliate Campuses Saint-Jean and Augustana Campus. Due to the anonymous nature of the data collection, there were no opportunities to meet and compensate participants.

Materials and Procedure

We investigated six overarching factors: stereotypes, attitudes and beliefs, environmental the nature of the environment and job, the nature of CS work, societal factors, and extraneous course-related factors. Questions were created by the authors to specifically target these themes; therefore, the questions have not been formally tested for reliability and validity. Explanations for individual items used in the survey can be found in the Appendix (cf. Table 2).

Google Forms were used to distribute our survey which included consent and debriefing pages, questions targeting themes of interest, previous exposure to CS, and basic demographic questions such as age, gender, and faculty (see Appendix for items of the survey). In total, our survey had 40 questions that were automatically randomized to avoid order effects. To control for fence-sitting, we used a 4-point Likert scale: 1) *strongly disagree;* 2) *disagree;* 3) *agree;* 4) *strongly agree*. Completion of the survey required approximately 10 minutes. The data was analyzed using SPSS (IBM Statistical Package for the Social Sciences 25.0).

Results

Reliability: Cronbach's Alpha and Effect Size

Cronbach's Alpha was calculated to determine the individual internal reliability for each of the six constructs. The attitudes and beliefs subscale had the highest reliability (α = .66), followed by societal factors (α = .48), nature of work (α = .46), environmental and institutional factors (α = .44), and coursework (α = .35). The stereotypes subscale had the lowest internal reliability, (α = .25). Overall, individual constructs demonstrated poor to moderate reliability. The questionnaire displayed moderate reliability (α = .67). Effect size was computed using the Phi coefficient. All calculated effect sizes were between .005 and .25.

Chi-square Tests of Independence

Questions were analyzed using a chi-square test for independence to examine the relationship between gender and *agree* or *disagree* responses. Because alphas were too low, questions combined within a factor could not be investigated in the chi-square test. Therefore, it was necessary to perform the analyses on each question individually. We compared females and males by combining *agree* and *strongly agree* responses and *disagree* and *strongly disagree* responses. The test statistics and *p* values were corrected using Yate's correction for continuity to reduce the likelihood of overestimating statistical significance for a small 2 x 2 model.

For the stereotype factor, items 1 and 3 revealed significant response differences between males and females, but not for item 2; item 1 (“I am good at math”), $\chi 2$ (1, N = 340) = 4.65, p = .03, Φ = .12; item 3 (“People in computing science are often depicted as male”), $\chi 2$ (1, N = 333) = 15.29, p < .001, Φ = .22. Within the attitudes and beliefs factor, items 4 and 6 were significant and item 5 was not; item 4 (“I would not be successful in computing science”), $\chi 2$ (1, N = 332) = 7.51, p < .001, Φ = .16; item 6 (“I would have trouble learning computing science skills”), $\chi 2$ (1, N = 336) = 18.58, p < .001, Φ = .24. Items 7 to 10 investigated the environmental and institutional factors, all four items were significant; item 7 (“I would not have many opportunities in computing science”), $\chi 2$ (1, N = 333) = 3.84, p = .05, Φ = .12; item 8 (“I would not be respected in a computing science job”), $\chi 2$ (1, N = 331) = 4.70, p = .03, Φ = .13; item 9 (“There is sexism in computing science”), $\chi 2$ (1, N = 333) = 18.61, p = .001, Φ = .25; item 10 (“I have been encouraged to pursue computing science in the past”), $\chi 2$ (1, N = 335) = 8.38, p < .001, Φ = .17. For the nature of CS work factor, responses for items 14 and 15 were significant, but items 11, 12, and 13 were not; item 14 (“I do not want a job that involves sitting in front of a computer”), $\chi 2$ (1, N = 338) = 4.85, p = .03, Φ = .13; item 15 (“I want a job with high status”), $\chi 2$ (1, N = 333) = 4.71, p = .03, Φ = .12. Within the societal factor, items 16 and 17 were significant and items 18 and 19 were not; item 16 (“It would be hard for me to find a relatable mentor in computing science”), $\chi 2$ (1, N = 325) = 14.33, p < .001, Φ = .22; item 17 (“It would be hard for me to make friends in computing science”), $\chi 2$ (1, N = 334) = 5.20, p = .02, Φ = .13. Lastly, in regards to the coursework factor, items 20, 23, and 25 reached significance, but items 21, 22, and 24 did not; item 20 (“Computing science is not one of my degree requirements”), $\chi 2$ (1, N = 340) = 7.47, p < .001, Φ = .16; item 23 (“I am worried that a computing science course would lower my GPA”), $\chi 2$ (1, N = 334) = 14.06, p < .001, Φ = .21; item 25 (“I would have trouble learning computing science skills”), $\chi 2$ (1, N = 336) = 18.58, p < .001, Φ = .24.

Pearson Correlations

The chi-square test for independence analyses identified differences in how males and females responded to questions, but it does not provide sufficient evidence to suggest an association. Thus, we performed Pearson correlations between participant interest in taking a future computing science courses (rated on a scale from 1 to 10) and all our variables (see Table 1).

Analysis of Covariance

We then conducted a one-way analysis of covariance (ANCOVA) as the final step of our statistical analyses to determine whether differences between males and females would exist even when controlling for our defined factors. To do this, we entered gender as our independent variable and the participants' interest in taking a CS course as the dependent variable. Our co-variables were the responses with significant correlations in the previous step of our analyses. Each covariate was entered individually due to inter-correlation between items.

Using a significance level of .05, we found that there were no differences between the genders regarding future interest when certain variables were entered as covariates (“I would have trouble learning computing science skills”, F(1, 332) = 2.41, p = .12, η^2 = .01; “Do you have any experiences with computing science outside of school?”, F(1, 339) = 3.63, p = .06, η^2 = .01; “I have been encouraged to pursue computing science in the past.”, F(1, 331) = 3.48, p = .06, η^2 = .01). However, significant differences in interest between the genders were remained when controlling for the remaining items.

Table 1
Correlations between interest in CS courses per gender

	Gender			
	Men n = 75		Women n = 268	
Factors	r	p	r	p
Stereotypes	.12	.300	.05	.380
Attitudes & Beliefs	-.47	< .001	-.33	< .001
Environment & Institution	-.30	.010	-.05	.430
Nature of Work	-.41	< .001	-.11	.070
Societal	-.26	.020	.00	.960
Coursework	-.49	< .001	-.08	.170

Discussion

The purpose of this study was to provide a unified framework for evaluating gender imbalance in computing science. Data was collected from 343 undergraduate students and results suggest multiple underlying factors for why women are not entering CS. Generally, the results not only revealed differences in how males and females perceive the problem, but also in how they perceive themselves and the type of environment found within CS.

Stereotypes

Current stereotypes about CS may be dissuading women from entering the field. Computing science is a stereotypically masculine field, seemingly dominated by individuals that are technologically-inclined; thus, it was hypothesized that women would be more perceptive of these stereotypes. Results from the chi-square analysis revealed gender differences between some of the items measuring these stereotypes held within CS. Men did not believe that CS is a stereotypically male field. When asked if they thought people in CS were “nerdy”, there were no gender differences. As previously mentioned, males did not perceive sexism in CS either. Although women and men share an environment, the results show that they do not interpret it the same way. If women feel that they do not fit CS stereotypes, then they may not enter the field in the first place (Cheryan et al., 2017).

When asked about perceived mathematical ability, women reported having poor mathematical skills, whereas men believed the opposite. Women were also significantly more likely to think that they would have trouble learning CS skills than men. This difference may arise from socialization differences; however, it is important to mention that this is a perceived difference and is not indicative of actual differences in math ability. A previous experiment conducted by Spencer, Steel, and Quinn (1999) found that when women were primed with gender, they performed more poorly than men on a mathematics test. When gender was not primed, there was no difference in performance. Since participants in the current study were asked about their gender before answering the survey questions, there is a chance that participants were primed to make gender salient while they judged their capabilities.

Attitudes and Beliefs

Just as stereotypes influence performance, attitudes, and beliefs can also shape cognitions, behaviours, and decisions. It was hypothesized that women would display low self-efficacy for skills required in CS and that this contributes to the overall existing gender disparity. The chi-square analysis supported this notion and revealed that women were significantly more likely to believe that they would be unsuccessful in CS. Further analyses indicated that interest in taking CS courses was related to perceived ability to learn required skills. This is indicative of low self-efficacy rather than actual capabilities; women perceived themselves as less able to learn CS skills regardless of whether or not these differences exist in reality. Importantly, when controlling for attitudes and beliefs, men and women did not differ in baseline interest in CS. This suggests that the attitudes and beliefs that one holds of themselves can significantly influence their interest in pursuing CS.

Environmental and Institutional Factors

The environment and type of work that a career entails is an important factor to consider when choosing an undergraduate program. The current study hypothesized that women perceive CS environments as unwelcoming and discouraging. Indeed, women significantly agreed that there would be fewer opportunities, more sexism, and a lack of respect towards them in CS. These opinions might not reflect the true nature of CS but are held by women nonetheless. Therefore, the threat of inequality may deter women from enrolling in CS programs. Further, there was a higher proportion of men who were encouraged to pursue CS and ANCOVA analyses showed that this was associated with individual’s interest in taking CS courses in the future. In other words, when controlling for whether participants have been encouraged to take CS, there were no gender differences in interest for CS. Therefore, encouraging women could motivate them to enter CS by modifying their beliefs of self-efficacy. Previous research on early interventions has also found this result (Master, Cheryan, & Meltzoff, 2017; Master et al., 2017) thus confirming that environmental and institutional factors have an influence on gender imbalance in CS.

The Nature of CS Work

In relation to the nature of the work, it was expected that there would be gender differences in the characteristics men and women want in their careers. Despite previous research that emphasizes the implications of gender roles while choosing an occupation (Cheryan et al., 2013), the results found no significant gender differences regarding job security, income potential, and desire for interpersonal interaction at work. However, a significantly higher proportion of women were less likely to want a job sitting in front of a computer and did not want high status. A large meta-analysis conducted by Su, Rounds, and Armstrong (2009) found that men preferred working with things and women preferred working with people. The current results found that men and women wanted careers that involved people, but men were more content with a career that involved sitting in front of a computer. Gender imbalance could exist due to gender differences in vocational interests, as Su et al. (2009) suggest. However, the current study only partially supports previous findings. In summary, we can infer that people may not be pursuing CS because of their perceptions of the nature of the work, given the absence of significant differences between male and female responses for many of these questions.

Societal Factors

In terms of societal factors, females were hypothesized to score higher than males on dimensions including obtaining relatable mentors in CS and level of difficulty making friends in CS programs/fields, which can be important factors in determining whether women will remain in CS programs once enrolled (Cheryan et al., 2017; Gauthier et al., 2017). Higher retention rates for women have been observed when the faculty and graduate staff are female; however, the mentor and mentee must also relate on a personal level (Blackburn, 2017; Cheryan et al., 2017). Female participants in our study reported concerns that they would not be able to find a suitable mentor nor make friends in CS. These results may indicate that women have a perception that they would not be supported in CS programs or fields.

The present study also explored other societal factors including family life and anxiety related to doing something contrary to what is expected of one's gender role; results were not significant for either questions. Overall, the lack of mentorship and low possibility of forming desired relationships is related to lower interest of woman in enrolling in CS.

Course-Related Factors

The present study included course-related factors (including class times, study time required, and presence of a laboratory component) as additional extraneous factors that had not been previously examined, since these determinants play into many students' course selection decisions. Significant gender differences were not expected for this section; however, the analyses revealed two significant results. Men were more likely than women to have CS as a degree-requirement, and they were more confident that a CS course would not lower their GPA. There were no gender differences between questions that asked about scheduling conflicts, taking classes with laboratories, and study time. Initially, it was believed that there should not be any differences between genders when asked about CS lowering their GPA; however we can infer that since the results revealed that females have a lower self-efficacy and lower self-reported skills that are necessary for CS courses, it is reasonable that they would also be more afraid of a CS class lowering their GPA.

Limitations

Although efforts were made to minimize confounds in the study, there are still some limitations that should be noted. First, since the survey was designed by the authors, the individual questions have not been formally validated. Therefore, we cannot be certain that the survey questions completely operationalize the constructs we were trying to measure. We conducted statistical analyses to examine the reliability of the survey and the six constructs. The reliability varied from low to moderate; the stereotype constructs had the lowest reliability, therefore results in this section might be difficult to replicate if these questions were used in future studies. Because of the low reliability, we did not analyze or pool the questions into a single variable (i.e. we analyzed each factor independently). Our questions had good face validity, so it was inferred that participants understood which constructs we were measuring.

Another potential limitation is that participation in this study was self-initiated and data was only collected from University of Alberta undergraduate students. Therefore, there could be volunteer bias and low generalizability. As for the nature of our survey and delivery method, there are extraneous aspects such as response bias, introspective abilities, self-image, etc. that are inherent in any self-report measure and may have influenced our results.

Finally, it should be acknowledged that gender imbalance in CS is a multi-faceted and complex phenomenon and the current study serves to support the current literature by confirming that all these constructs vary and relate to one another. These relationships may be best analyzed using a multivariate statistical approach to fine-tune our results and their implications.

Implications

Gender inequality is a complex and multifaceted problem, but there are small steps that institutions and leaders in CS can make to alleviate some of the imbalance that currently exists. Potential benefits of having a greater female representation in CS could include a greater number of individuals enrolling in CS programs, along with a greater variety of perspectives. This could present new insights and advancements within the field. Furthermore, greater awareness of gender imbalances could reduce the presence of sexism and lower social barriers that are affecting entry into or advancement within the CS field. It is important to note that even though the current study focuses on the lack of women in CS, implications from the results can be expanded to professions that are female-dominated, such as in nursing and dental hygiene.

On a micro-level, the personal awareness of the existence of stereotypes and biases and the power of attitudes and beliefs can either strongly motivate a woman to join the CS field, or deter her from considering the path of CS. This constitutes a double benefit; if individuals change their attitudes about CS fields, they change their attitudes about their ability to do well and whether they want to enter the field, and vice versa. Generally, this will promote better academic and work outcomes for both men and woman by promoting the right attitudes.

Conclusion

As the CS field continues to emerge and rapidly grow, the need for novel perspectives and innovation is becoming increasingly imperative. Gender diversity could be a solution. The goal of this research is to bring awareness of the barriers that prevent women from entering and remaining in CS. Our hope is that promoting diversity will allow for equal opportunity and treatment of individuals within the field. In the future, qualitative research should not only focus on identifying and explaining the mechanisms, but also on the larger unified picture of multiple factors working together to further evaluate which factors interact in meaningful ways. Conducting individual interviews of students who did not enter CS (but who considered it as an option), as well as students who did enter the field could be beneficial in order to examine barriers these students may have faced, and how they overcame them.

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Appendix

Table 2

Face Validity for Items in the Questionnaire by Factor

Items	Justification of Questions
Nature of the Work [1, 2]	
1. I consider job security when planning my career.	1. We want to know if an underlying reason for women not choosing a CS field is the idea that a CS-related job does not guarantee job security.
2. I value large salaries over enjoyment when considering jobs.	2. We want to know if individuals hold the idea that having a CS-related job inadvertently means lower salaries.
3. I want to work with people.	3. With this question, we cover the notion that working in a CS-related field means not getting to work with people as much. This question also touches on the notion that women are better suited for jobs that involve working extensively with people.
4. I do not want a job that involves sitting in front of a computer.	4. This question is similar to the previous question, except that it is in the form of a negation.
5. I want a job with high status.	5. This question is based on a study that showed how a women's choice of career is influenced by factors such as status and influence over others. It touches on the idea that being in a CS-related field may mean having a lower status, what more with being a woman.
Stereotypes [1, 3, 4]	
1. I am good at math.	1. Based on the study done by Cheryan et al. (2017) we expect to find that females, having been primed with their gender in the earlier part of the survey, will be more likely to respond with "disagree" or "strongly disagree" if they read the statement "I am good at math". Being in CS may not involve a lot of math skills, but we want to see if the stereotype of women being bad at math holds to this day.
2. People in computing science are often depicted as "nerdy".	2. This question measures individual's stereotypes about what they think people in CS are like. More than that though, it attempts to see if there is a negative perception towards joining CS, which could lead to women being less likely to want to join the field if it brings their "image" down.
3. People in computing science are often depicted as male.	3. As the foundation of this study, this question measures if the overarching reason for the gender imbalance in CS is first a general impression based on a stereotype that people in CS are often depicted as male. If this question has significant results, what more about smaller reasons?
Attitudes and Beliefs [1, 5]	
1. I would not be successful in computing science.	1. Considering how our attitudes and beliefs are fundamental to influencing our day-to-day thoughts, feelings and behaviors, we asked this question, knowing that a disbelief in one's possibility of succeeding in the field is a large predictor in determining if the person succeeds in the first place.
2. If I wanted to pursue a career in computing science I could make it happen.	2. This question is like the opposite of the previous question, but we use the same underlying reason for asking this question. We believe that an intrinsic motivation and belief in one's ability to succeed in a CS career is fundamental to doing well in the field.
3. I would have trouble learning computing science skills.	3. Aside from the big picture of perceiving one's ability to do well in the field, having the belief in oneself to succeed in smaller aspects like certain skills to doing well are little milestones that build up to one's overall success in the field.
Environmental and Institutional Factors [1,5]	
1. I would not have many opportunities in computing science.	1. We asked this question with the idea that women may not choose a CS field in the first place if they already do not expect, via foresight, to have opportunities to develop their personal selves and career.
2. I would not be respected in a computing science job.	2. If a person's sense of worth and self-esteem is dependent on the amount of respect they get, it would be difficult to choose a field to be in if one is aware of possibilities of being disrespected in a field due to one's gender.

Items	Justification of Questions
3. There is sexism in computing science.	3. This question explores the overall atmosphere of what it is like being in CS. Perceptions of the atmosphere applies to both work and educational environments, and influences women's decisions as to whether they want to spend a significant amount of time working and studying in such atmospheres.
4. I have been encouraged to pursue computing science in the past.	4. This question relates more to one's experience before university/ college age. According to previous research, we believe that having encouragements from others is a key factor in influencing one's decision on what field to join. In our study, we look specifically at whether individuals were encouraged at a young age to join CS, and if that influenced their decisions.
Societal Factors [1,5]	
1. It would be hard for me to find a relatable mentor in computing science.	1. A mentor guides a student during their journey through their degree. For some, they follow their mentor throughout their career for many years to come. As such, we aimed to explore if individuals desire a relatable mentor and use that as a determining factor as to whether they should join the field.
2. It would be hard for me to make friends in computing science.	2. This question relates to studies on how having people to study with and share problems with can be a huge factor in making one's experience in a field a good one. Thus, we sought to find out if individuals would be less likely to join the field because of their concerns about having friends to help them go through this process of learning.
3. I would be judged negatively for choosing a field that goes against what is typically expected of my gender.	3. Tied together with stereotypes, attitudes, beliefs, and society's perspectives, this question merges all these factors together to explore if they motivate or do not motivate someone from staying or avoiding fields of work that they perceive to be gender-specific in some way.
4. Computing science would not be ideal for family life.	4. This question relates to beliefs that women should choose a field where they will have sufficient leeway to raise a family, yet perform well in their job. Being an idea that is prevalent in society, we used this question to determine if individuals, especially women, avoid CS because their family is one factor to be taken into consideration.
Coursework	In general, these questions were not explicitly based on questions directly posed in previous literature. As such, we endeavored to seek answers for these questions. Specifically, we also realized a need to find out if there are other factors that are not sociological-based in affecting women's decisions for joining CS. These questions give us a more balanced view on the factors deterring women from joining CS.
1. Computing science is not one of my degree requirements.	1. If an individual has already chosen another field to be in, and that field does not ask for them to take CS courses, naturally, we would not find them in such courses.
2. Computing science courses never seem to fit my class schedules.	2. Aside from CS courses, any courses that do not fit into a student's schedule would generally be avoided as well.
3. In general, I try to avoid classes with labs.	3. This question gives us a little more insight regarding women's perceptions on whether they are good at math-related and computing -related skills. Such beliefs could be the reason for women avoiding classes with lab components. On the other hand, students could simply be avoiding labs because of how time-consuming they are, and studying the difference in responses in gender helps us to find that difference.
4. I am worried that a computing science course would lower my GPA.	4. Most students seek to do well in their degree, and we were looking to see if individuals avoid CS because of the stereotypes, or if it was also because they were afraid that the lack of CS-related skills may lower their GPA.
5. Computing science would take too much time to study for.	5. For students who have a regular or large course load, there would certainly be a concern regarding the amount of time each course takes to study for and do well.

Items	Justification of Questions
Opinion	These questions helped us to gain insight on what people thought was happening in the area of CS, and their general opinions aside from the Likert scale questions.
1. Do you think there is an gender imbalance in computing science courses?	1. This was an open-ended question that gave participants the platform to express what they truly felt, and if they perceived a gender imbalance in CS in the first place.
2. Which gender do you think is underrepresented in computing science courses?	2. This question measures an overall view / snap judgment that individuals make about a field in general.
3. What percentage of students in an average CS class are female?	3. Asking participants for a percentage helps us to understand what individuals think is happening in the field at this moment.
4. On a scale of 0 to 10, rate your interest level for taking a computing science course in the future.	4. After answering multiple questions about the ups and downs of being in CS, we looked to see if people still did or did not express an interest in joining CS.