

Computer Science Identity and Sense of Belonging: A Case study in Ireland

Extended Abstract

Dr Catherine Mooney
Assistant Professor
School of Computer Science
University College Dublin
Ireland
catherine.mooney@ucd.ie

Dr Brett A. Becker
Assistant Professor
School of Computer Science
University College Dublin
Ireland
brett.becker@ucd.ie

Lana Salmon
IRC Scholar
School of Physics
University College Dublin
Ireland
lana.salmon@ucdconnect.ie

Assoc. Prof. Eleni Mangina
School of Computer Science
University College Dublin
Ireland
eleni.mangina@ucd.ie

ABSTRACT

The study¹ described in this paper investigates the role that gender plays in making the decision to study Computer Science in University College Dublin in Ireland (background influences) and investigates whether there is a difference in the perceived sense of belonging between the genders. The aim is to improve diversity and sense of belonging amongst Computer Science students, in order to ensure that our school is an inclusive space, where anyone can feel a sense of belonging regardless their gender.

CCS CONCEPTS

• **Social and Professional Topics** → **Computing Education** → Computer Science Education; • **Social and Professional Topics** → **User Characteristics** → Gender → Men and Women.

KEYWORDS

Gender equality, Gender issues in Computer Science

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1 INTRODUCTION

Diversity, including gender equality, is highlighted as one of the core values in our institution. Women are underrepresented in Computer Science across Ireland and globally. Data from the HEA Equality Report 2016² show that only 20% of Irish Computer Science graduates were women. Within academia, these proportions tend to deteriorate even further at later career stages, with women leaving Computer Science (and other STEM subjects) to pursue alternative careers. While emphasis has been placed in assessing the students' problem domain knowledge, less has been done in investigating the aspects that affect the students in learning Computer Science [1, 2, 3]. Self-efficacy has been applied in the career area to examine why women are underrepresented in male dominated STEM fields [4, 5, 6]. In this paper we present the results of an anonymous survey taken in April 2017 from 90 undergraduate students (Stage 1 to Stage 4) at the School of Computer Science in our institution based in Ireland, exploring the factors that encouraged female students to choose the BSc in Computer Science, and exploring the sense of belonging within our School. 25.5% of these respondents identified themselves as female, 73.3% identified themselves as male and 1.11% opting to not specify their gender. This case study has focus on general Computer Science students, while our degree has strong emphasis on Software Engineering modules. Results revealed significantly lower levels of sense of belonging reported by female students, providing a cause for concern considering the link of sense of belonging with progression in higher education and general well-being.

²Report of the expert group: HEA National Review of Gender Equality in Irish Higher Education Institutions, http://hea.ie/assets/uploads/2017/04/hea_review_of_gender_equality_in_irish_higher_education.pdf

2 BACKGROUND AND INFLUENCES

Computer Science has the highest gender disparities in STEM subjects [2]. A reason for this could be that boys are influenced by their friends and family environment or that girls are less likely to enroll in “pipeline courses”, such as open days, open evenings and summer schools. We gathered in this study both qualitative and quantitative data.

2.1 Qualitative Data

The female respondents are more likely to know a family member or friend who works in computer science and overall less than 50% of the respondents know a family member or friend who works in Computer Science, as shown in Table 1.

Table 1: Do you have a friend of family member who works in Computer Science?

	Female	Male
Yes	56.52%	36.36%
No	43.48%	63.64%

The event most attended by the respondents is the Institution’s Open day, with just under half of all respondents attending this event, with more of the male respondents than the female respondents as shown in Table 2.

Table 2: Which of the following events did you attend before you became a CS student in our institution?

Event	Female	Male	Overall
Open Day	47.82%	50.00%	49.40%
Open Evening	26%	19.60%	21.30%
None	39%	34.84%	36%
Summer School	8.70%	4.50%	5.60%
Other event	8.70%	4.54%	5.60%
Personal tour	0	1.51%	1.12%
Lecturer visit	0	1.51%	1.12%
Shadowing Day	0	1.51%	1.12%
HEAR Orientation	0	1.51%	1.12%
Access course	4.34%	0.00%	1.12%

The number of female respondents who felt they are a minority is almost the same as the male respondents who do not feel like a minority. 100% of the female respondents who answered that they are a minority felt due to the fact that they are female as shown in Table 3. Compared to similar research at Stanford University in 2013 [7], 84% of female respondents felt like a minority. We would like to find out the barriers and key issues that keep women

feeling as a minority when they join our course. A barrier that keeps women from pursuing the computer science degree is that female students have less prior experience with computers than men do upon entering the computer science degree [8, 9, 10].

Table 3: Do you consider yourself a part of minority in School of Computer Science? If yes, what minority group(s) are you part of?

Male	No. students	Female	No. students
LGBT	2	Female	19
Sporty	2	Mature Student	3
Mature	1	International	2
Politics	1	LGBT	1
Shy	2	Religious	1
Regrets CS	1		
Feels CS is a minority	1		

Further responses revealed that the male respondents played more computer games, taught themselves to program more often, and attended CoderDojo more than the female respondents. The female respondents have more family members involved in computer science. Moreover, female respondents had no experience in CS before entering the course. However, female respondents took part in more CS courses compared to the male respondents as shown in Table 4.

Table 4: How much experience in Computer Science did you have before joining our degree?

Question:	Female	Male
I played computer games	34.78%	83.33%
I taught myself to program computers	13.04%	39.39%
A family member worked in Computer Science	39.13%	27.27%
I had no experience	26.09%	21.21%
I took at least one CS course	17.39%	16.67%
I took part in CoderDojo or similar	8.70%	16.67%
I had a CS related job	0.00%	6.06%

This study revealed higher rates of CS experience amongst males. International benchmarks report 75% (male) and 45% (female) prior computer science experience [7]. The results obtained in this study are much closer, within the range of 79% (male) and 74% (female).

2.2 Quantitative Data

The quantitative questions from the online survey have been analyzed using a Shapiro-Wilk test for normality carried out in Python on each data set. This is appropriate for small sample sizes ($n < 5000$) [11]. It was found that all data sets are not normal. A Mann-Whitney U test was completed in Python and the p-value obtained was used to determine if the two populations in each question are significantly different. The more encouraging factors are (in descending order): job availability; salaries; job security; teachers; impact on society; and flexible work conditions. The least encouraging factors are (in descending order): stereotype of CS students; university student advisors; career guidance not attached to school; fitting in; other; and career guidance teacher in school, as shown in Table 5.

Table 5: List of People/Factors that might have influenced your decision to study Computer Science.

People/Factors that might have influenced your decision to study Computer Science	♀	♂	Statistically Significant
[Job availability]	1.77	1.39	Yes
[Salaries]	1.61	1.30	Yes
[Job security]	1.57	1.06	Yes
[Teachers]	0.29	0.27	No
[Impact on society]	0.91	0.65	No
[Flexible work conditions]	1.13	0.56	Yes
[Father]	0.83	0.44	No
[Other family]	0.82	0.37	Yes
[Mother]	0.61	0.37	No
[CS Open Day/Evening at University or Summer School]	0.50	0.36	No
[High-profile models/Media] role	0.39	0.33	No
[Work experience]	0.30	0.33	No
[Friends]	0.39	0.30	No
[Social media]	0.30	0.25	No
[Chance to invent new products/services]	0.96	1.00	No
[Professors at university]	0.41	0.17	No
[Career guidance teacher at school]	0.17	0.27	No
[Other]	0.35	0.11	No
[Fitting in]	0.13	0.16	No
[Stereotype of CS students]	-0.48	-0.55	No

Female respondents felt that their parents are less supportive of their choice of computer science compared to the male

respondents. The female respondents also felt less confident in their math abilities compared to the male respondents. Female respondents enjoy problem solving more and are more confident asking a professor/lecturer a question although most of them believe that computer science depends on inherent ability. This study found that men rated their confidence in mathematics higher than females at a statistically significant level and a significant gender discrepancy with respect to confidence asking questions to their lecturers.

3 SENSE OF BELONGING

Belonging in an academic environment refers to students' feeling that they would fit in with the people, materials, and activities within that environment [12]. Research has focused on why do women opt-out from STEM subjects [13]. In this study, the categories for which males and females are significantly different are "I consider myself a part of the CS world"; "I feel comfortable"; "I feel like I fit in". Overall, female respondents feel less in agreement with all statements except for: They feel less respected.; They try to say as little as possible; They feel more nervous; They feel more inadequate; They feel more tense; They feel more like an outsider; They feel more insignificant; They feel more excluded; They feel more they could fade into the background and not to be noticed. Of the positive questions (e.g. I feel comfortable) females feel less positive than the males for all questions apart from "I feel respected". Of the negative questions (e.g. I feel tense) females feel more negative with the exception of "I feel disregarded", "I feel neglected", "I wish I were invisible" as shown in detail in Table 6.

Table 6: Sense of belonging

Question	♀	♂	Statistically Significant
I enjoy being an active participant.	4.78	5.41	No
I consider myself a member of the computer science world.	4.65	5.40	Yes
I feel accepted.	4.59	5.33	No
I feel comfortable.	4.43	5.26	Yes
I feel content.	4.43	5.18	No
I feel that I belong to the computer science community.	4.43	5.11	No
I feel like I am part of the computer science community.	4.48	4.94	No
I feel like I fit in.	3.91	5.08	Yes
I trust the testing materials to be unbiased.	4.26	4.80	No
I feel respected.	4.77	4.58	No
I feel at ease.	4.17	4.82	No
I feel a connection with the computer science community.	4.13	4.58	No

I feel appreciated.	3.96	4.55	No
I try to say as little as possible.	3.91	3.89	No
I have trust that I do not have to constantly prove myself.	3.70	3.83	No
Even when I do poorly, my instructors have faith in my potential.	3.48	3.77	No
I feel anxious.	3.30	3.58	No
I feel nervous.	3.78	3.33	No
I feel inadequate.	3.87	3.28	No
I feel tense.	3.36	3.39	No
I feel insignificant.	3.35	3.08	No
I feel neglected.	2.57	2.80	No
I feel excluded.	2.78	2.65	No
I wish I were invisible.	2.13	2.23	No

4 CONCLUSIONS - FUTURE WORK

Our school is fully aware that course-taking patterns in secondary school indicate that the gender imbalance in Computer Science has already established itself prior to university. With the inclusion of Computer Science as a Leaving Certificate subject in September 2018 and the government's five-year digital strategy, it is of crucial importance for our school to actively promote Computer Science and increase awareness among prospective female students and staff members. Our school has identified the gaps and the opportunities to increase the female:male ratio in our school across all levels. Within the future action plan of our school we have made the following commitments, which will be presented in our application for the Athena SWAN bronze award:

- Review of the recruitment and admission processes for students to ensure that there is a transparent process in place to attract students from all genders;
- Work proactively through widening participation and outreach programmes to promote our school as a subject of choice for female students;
- Carry out annual survey across our school to obtain information in terms of perceptions and experiences for inclusion, gender balance, equal opportunities, cultural expectations and hostility (students and staff);
- Women@CompSci³ (launched on the 8th of March 2018) will engage with Equality Diversity and Inclusion (EDI) unit in UCD to raise awareness of mentoring, sense of belonging and outreach activities (CSSPARKS⁴)

The school is committed to UCD's strategy on equality, diversity and inclusion and specifically under strategic objective 5, we commit to proactively address the gender gap through the "attraction and retention of an excellent and diverse cohort of students, faculty and staff". Computer Science will be included

as a Leaving Certificate (high school) subject from September 2018 and we aim to be the frontier in Ireland to address and influence the gender gap in CS undergraduate student intake. Addressing this gender gap will be a cornerstone and a starting point for our school. We have already launched a postgraduate program for training secondary school teachers supported by scholarships from Microsoft that are targeted at girls' schools and schools in disadvantaged areas.

Our School recognizes that equality of opportunity, the promotion of diversity, and the elimination of discrimination is fundamental to the achievement of its overall goal and ethos. We are at an ideal point in time to address the gender balance in our discipline, impact the job growth in ICT in terms of equality and inclusion, and set the example to the rest of the CS schools in Ireland.

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³ <http://women.cs.ucd.ie/>

⁴ <https://www.cs.ucd.ie/cs-sparks/>