Workshop
Women in AI and CS
IJCAI 2015

Workshop Chairs: Veronica Dahl, Santiago Ceria, and Maria Gini

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This workshop at IJCAI 2015 addresses from an interdisciplinary perspective (scientific and sociological) the curious phenomenon that world-wide female participation in AI and CS in general is dwindling instead of increasing (e.g. in Argentina, it has gone from almost 70The workshop will discuss the societal causes of female under-representation in Computing Sciences, and in particular in AI, in order to:

- promote consciousness of this situation among both sexes, so that it ceases to appear as "normal"
- discuss potential actions that could heal these causes and could help the integration of women into the field
- find ways of enlisting men in particular into helping out, given that they are placed in privileged positions and can therefore exert the most influence.

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A Reflection about the Proportion of Women in Information Technology Degrees at the Universidad de Buenos Aires

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Abstract

In the beginning of computer science (CS) history, many programmers were women. The proportion of women CS students has been decreasing since then. We present a brief survey about the gender proportion of computer scientists in different parts of the world, elaborate some hypothesis of the reason for this situation, and present some preliminary proposals to change it.

1 Introduction

There appears to be very little participation of women in Computer Science (CS) and in Artificial Intelligence (AI). Nevertheless women are present in other AI aspects, for instance ACM Technews comments that "A disproportionate percentage of artificial intelligence (AI) systems have female personas" and asks why this could be[1].

Many of the first programmers of the history were women. What led to the situation seen today, where men proportion is much higher than female proportion? This appear to be a trend that not only happens in Argentina [Zukerfeld *et al.*, 2015], but also in other parts of the world [Dean, 2007; Fisher and Margolis, 2000]. Why is world-wide female participation in AI and CS in general dwindling instead of increasing?

In order to think about this question, we present some studies that have been done about this issue, and some hypothesis and possible solutions that have been found.

2 Background

In 1946 six brilliant young women programmed the first all-electronic, programmable computer, the ENIAC, a project run by the U.S. Army in Philadelphia as part of a secret World War II project [ENI, 2015b; 2015a]. See [Borensztejn, 2014] for a recount of the job performed and the recognition given to the programmers.

Nowadays, only 15-20% of undergraduate computer science majors at leading U.S. departments are female [Fisher and Margolis, 2000]. Why did this happen? In the beginnings there might have been more women than men because men where fighting in second world war. Nowadays the "nerd factor" might be a problem. Dean mentions that "According to a 2005 report by the National Center for Women and Information Technology, an academic-industry collaborative formed to address the issue, when high school girls think of computer scientists they think of geeks, pocket protectors, isolated cubicles and a lifetime of staring into a screen writing computer code" [Dean, 2007].

Lin; Fischer and Margolis [Lin, 2013; Fisher and Margolis, 2000; Fischer and Margolis, 2003] explain how Fisher, the Associate Dean of Computer Science at Carnegie Mellon University and Margolis, a social scientist, tried to figure out what they could do to increase the ratio of women in CS career. They increased it from 7% to 42% in five years. Two of the main activities performed were 1) teaching computer science high school teachers how to provide gender equity instruction and 2) changing the admission process in a way that it doesn't only give preference to people with previous programming experience, but also to people with other academic or non-academic strengths (like leadership).

Barr [2014] does an analysis of the report *Women, Minorities, and Persons with Disabilities in Science and Engineering* [National Science Foundation and Statistics, 2013] and the 2013 *Digest of Education Statistics* of the US National Center for Education Statistics [for Education Statistics, 2013] and states that the gender disparity ratio in CS went from 3 in 1966 to 6 in 2012. That is: in 2012 men earned CS degrees at 6 times women's rate. It is interesting to notice that gender disparity ratio of Engineering decreased 30 times, the one of Physics and Biology about 2 times and Earth Sciences 3.5 times. The only other discipline with a growing disparity of gender ratio was Math, with a 1,2 increase. Barr also states that women had consistently between 19% and 23% of computer science PhD degrees between 2002 and 2012.

There exist some organizations such as ACM Women (ACM-W[2]) and Anita Borg Institute for Women and Technology[3] that promote the engagement of women in all aspects of the computing field. Some of the goals of ACM-W are to educate women about the opportunities in the computing field, to engage women students in exciting computing activities, to connect students with women leaders in the field, to en-

[1]http://cacm.acm.org/news/183789-rise-of-the-fembots-why-artificial-intelligence-is-often-female/fulltext

[2]http://women.acm.org/

[3]http://anitaborg.org/

courage students to promote the field of computing to young girls and extend the conversation about why its important to increase the number of women in computing [4]. ACM-W provides scholarships for women, among others.

3 Situation in Argentina

In Argentina women represent 18% of the information technology students -11 % of CS students-, but they where more than 50% until the 80's and even 75% in the 70's [Zukerfeld *et al.*, 2015]. Fundación Sadosky is working in bringing students to Computer Science careers. Among others, it has focused on the low quantity of women and did a study guided by sociologists in order to understand this situation [Zukerfeld *et al.*, 2015]. The study states that among women it is more relevant that they really like their career than the salary they will get. They also say that stereotypes should be changed.

Table 1 shows the amount of male and female students in the different careers related with Information Technology taught at the University of Buenos Aires (UBA), the largest university of Argentina with currently more than 260000 students and the second best university of Latin America according to a Ranking of World Universities done in 2014[5],[6]. The Data is taken from a student census performed by the university in year 2004 [Secretaria de Asuntos Academicos, 2004].

UBA had at that time four careers related with Information Technology (IT): Computer Science, teached at the *Facultad de Ciencias Exactas y Naturales* (FCEyN), Organization Information Systems (*Facultad de Ciencias Económicas*, FCE) and Systems Analysis and Computer Engineering (*Facultad de Ingeniería* , FI). At that time they had 23%, 24%, 20% and 33% of the IT students respectively. Systems Engineering (FI) had the lower proportion of women (12%) followed by Computer Science (FCEyN) with 17%. Information Systems (FCE) is the one with the greater proportion of female students (32%) and it is followed by Systems Analysis. Proportions of students that are entering the careers (not shown) is similar to the male/female proportion of the careers.

Degree	Male	Female	Total
Computer Science	971 (83%)	199 (17%)	1170
Computer Engineering	1485 (88%)	201 (12%)	1686
Systems Analysis	736 (71%)	306 (29%)	1042
Information Systems	852 (68%)	393 (32%)	1245

Table 1: Students of IT degrees at Universidad de Buenos Aires in year 2004 [Secretaria de Asuntos Academicos, 2004].

Table 2 shows the proportion of female/male students of the CS degree at UBA.

In Argentina a local chapter of *Girls in Tech*, a non-profit organization based in Silicon Valley, that works on the empowerment of women in technology and entrepreneurship and that has more than 40 chapters worldwide, has been created this year[7,8].

Year	Male	Female	Total
1988	1158 (58%)	837 (42%)	1995
1992	953 (61%)	600 (39%)	1553
1996	821 (67%)	404 (33%)	1225
2000	880 (77%)	270 (23%)	1150
2004	971 (83%)	199 (17%)	1170

Table 2: Students of the Computer Science degree at Universidad de Buenos Aires [de Buenos Aires, 2015].

4 Discussion

In its origins, computers were primarily used for complex numerical computations. Therefore, the computer science degree was linked in its origins with mathematics (particularly at the UBA the Computer Science Degree of the University of Buenos Aires (UBA) was a detachment of the career of mathematics). The proportion of female students of mathematics has been decreasing but is higher than the one of CS students (61 % in 1988 and 48% -223 female students- in 2004). In our opinion, this might explain the great proportion of female students in computer science at the early decades of the existence of the degree. When computers evolved the computer science degree got more independence from mathematics degree, including subjects of study different than just numerical computation and inclined mathematics students might have not been that attracted for this field of study. In our theory this could explain, at least in part, the dwindling of computer science female students.

We also have the hypothesis that the fact that math has nowadays a greater proportion and amount of female students than computer science, might obey to the fact that math is associated with a more relaxed and less payed work and that still today many women think that they won't be the one's in charge of taking money home.

Computer science seems indistinguishable from many other scientific and technical careers in the fact that knowledge is largely abstract part and research work often occurs in isolation. Physics, Chemistry, Mathematics and other sciences could be described in similar ways. However, Computer Science seems to be marked by a stigma of coldness and isolation. Current low proportions of female students in computer science, could be explained by the misconception of programming as an isolated activity with a computer, the lack of knowledge of programming, and the lack of women socially recognized associated with computer activities.

We believe that the proportion of female students could be increased, taking into account some of following actions: the creation of a humanistic orientation in the computer science degree,the creation of programming courses at schools and of female prototypes in computer games, the availability of films

[4] http://women.acm.org/chapter

[5] http://www.shanghairanking.com/

[6] http://www.uba.ar/comunicacion/detalle_nota.php?id=16699

[7] http://www.girlsintech.org/about/

[8] http://www.startupbuenosaires.com/evento/lanzamiento-girls-in-tech-argentina

and commercials with women (as ”beautiful” and as ”smart” as others and with the same social skills) that work in CS or AI, and the availability for girls of toys that traditionally are thought for boys[9] and that could enhance girls interest in CS and Engineering.

We also believe that CS could be presented as an opportunity for the female gender, since there are opportunities for flexible working (eg. part-time or from home), where the development or role can be based on the skills or interests of each one (for example more communication and less isolation, theoretical or practical work).

As women computer scientist we can say that we have not experienced many gender-discrimination episodes during our studies or our professional careers. There have been some issues of lower salaries. We also have heard of some other discrimination case because of motherhood. But none of these problems are exclusively of this area.

Computer Scientist and Information Science jobs, as many others, are not mechanical and have constant challenges. We think that some characteristics that are usually present in women, can present advantages in Information Technology jobs. One of this characteristics consists in the multitasking ability. This probably explains why, in the industry, many functional analysis, project management and information system design tasks, where multiple aspects and variables have to be taken into account, are usually taken by women. On the contrary, programming is mostly done by men.

These ideas come from our analysis of the situation and the studies performed by the referenced material. In order to deepen the understanding of the situation and further courses of action we think a survey should be elaborated.

5 Conclusions and Future Work

In this reflection, we review briefly the decrease of women studying Computer Science in Argentina and in some other countries. We explain some actions that have been taken (not in Argentina) in order to revert this situation. We draw some non-proven hypothesis about the decreasing female participation, proposed some lines to revert this situation and we commented some experiences and opinions as women computer scientists.

As future work, we plan to interview women that are involved at computer science and AI, at different levels (students, professors, researchers), in order to make a sociological analysis from the female perspective of the participation in the field and write stories of life. We also plan to do a survey of men and women that are entering the CS career.

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[9] http://www.goldieblox.com/

Women in AI and CS: Pipelines, Pathways, and Patterns

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Abstract

We briefly survey the state of gender underrepresentation in computer science and some of its potential causes. We describe efforts at UMBC to increase gender parity, speculate about some potential causes for the low numbers of women in AI specifically, and propose studies that could be done to explore and address these issues.

1 Background and Insights

Women are highly underrepresented in computer science: in the U.S. in 2014, they earned only 18% of Ph.D.s, 22% of master's degrees, and 14% of bachelor's degrees [Zweben and Bizot, 2015]. These numbers represent a dramatic decline from the peak of 1984, when women earned 37% of bachelor's degrees. Margolis and Fisher [2003], Abbate [2012], and Misa [2010] explore the history of women in computing, the factors causing this disparity, the negative impact of gender underrepresentation on the discipline and on society, and recommendations for change. Despite years of study, many concerned community members, and localized successes, the percentage of women studying and pursuing careers in computing has remained low.

Studies show that female students tend to be more motivated than male students by a desire to help people and make a difference in the world, and AI is certainly a field that has the potential to do great good and to affect people's lives positively. However, although no statistics for the percentage of women in AI specifically seem to be available, many women in the field have the sense that their proportions have been declining. Why are women not more represented in AI?

In this position paper, we describe some of our efforts at UMBC to increase gender parity and support for women in computing fields. We then speculate about several potential causes for the low numbers of women in AI specifically, and propose some studies that could be done to learn more about these factors and potentially address them through culture change.

2 UMBC Initiatives to Increase Gender Parity

At UMBC, a group of committed faculty and administrators have invested significant resources in increasing the pipeline of incoming students, improving the campus climate for women in computing, and increasing retention rates. While the number of female CS majors has not increased dramatically, there is evidence that the climate has improved for female students, and we are hopeful that a continued focus in our broad range of initiatives will pay off in increased enrollments.

2.1 Starting Early to Broaden Girls' Interest in Computing

In order to increase the number of women majoring in computing in college, it is critical to reach them before their arrival at college to start to build an interest in the field. Our efforts in this area include outreach programs and NSF-funded programs targeting high school curriculum and teacher preparation.

The undergraduate-led Artemis[1] summer camp for rising 9th graders was started by AI professor Amy Greenwald at Brown University. UMBC offered a one-year pilot version of Artemis in 2013, with support from NSF and the Silicon Valley Community Foundation. In 2014, the student leaders of the UMBC Artemis camp organized a one-day event called The Athena Conference that brought 40 high school girls to campus for a day of hands-on learning about computing and IT. UMBC's Center for Women in Technology (which co-author Rheingans directs) also offers an annual overnight event for 11th grade girls called "Bits & Bytes"[2] that teaches girls about engineering and computing, and engages them in a confidence- and experience-building design challenge.

Through a series of NSF- and industry-funded activities, we have built a strong community of teachers and supporters who are interested in and committed to CS education at the high school level in Maryland. Our Google-sponsored CS4HS workshops in 2011, 2012, and 2013 led to the creation of a Maryland chapter of the Computer Science Teachers Association, and formed the core group of university faculty and high school teachers that worked together to obtain continuing NSF funding in this area. Our CE21-Maryland planning grant led to a mini-summit in August 2012, a statewide summit in May 2013, and the creation of a contact database that has now grown to over 800 individuals across the state

[1] http://cs.brown.edu/people/orgs/artemis/
[2] http://cwit.umbc.edu/hs/hsprograms/

(teachers, administrators, university/college faculty, and industry partners) [desJardins and Martin, 2013].

The new AP Computer Science Principles (CSP) class was designed to offer a broad introduction to computational thinking for a diverse audience of high school students, including those with no programming experience who may not even be sure whether they are interested in computing. CS Matters in Maryland[3] is an NSF-funded CS10K project to collaboratively develop a complete curriculum for CSP with one key goal: to provide all students with the opportunity to learn computer science within a rigorous and engaging framework. To attract, retain, and teach traditionally underrepresented groups, the curriculum is designed to foster welcoming learning environments that are respectful of the diverse strengths of all students. The theme of the CS Matters course is data – where it comes from, how it is collected and made available, how it can be analyzed and visualized, and the impact of "big data" on society. The CS Matters in Maryland grant engaged 13 master teachers in collaboratively writing a complete curriculum for CSP, supported those teachers in piloting the course, and will train 30 additional teachers in Summer 2015 to teach the course in the 2015-16 academic year.

2.2 Diversifying the Freshman Experience

As part of an NSF-funded research project under the Transforming Undergraduate Education in STEM (TUES) program, an interdisciplinary team at UMBC developed and delivered a new first-year course for freshman computing majors, which has been offered for the past three years.[4] The new course, COMP 101, is designed to increase student retention, learning, and success, especially for women and other underrepresented groups. COMP 101 provides an overview of the computing disciplines, builds foundational technical skills, includes a group design experience, and strengthens skills needed for academic and professional success. The course has had a positive impact on student persistence in their majors (students are less likely to switch majors, and those who do switch do so earlier in their college careers). Data from focus groups and individual interviews suggest that the team-based learning, design project, and professional development elements of the course are having a positive impact on student learning outcomes.

2.3 Building an Undergraduate Community

The UMBC Center for Women in Technology (CWIT)[5] aims to increase the representation of women among those who create technology. Four broad initiatives address this goal: three Scholars Programs for highly qualified students, an Affiliates program available to all women (and supportive men), surveys and training to improve the gender climate in the College of Engineering and Information Technology (COEIT), and outreach efforts to broaden the pipeline of women interested in computing and engineering.

The CWIT Scholars program lies at the heart of all of these efforts. Since the founding of the program in 2002, there have been 145 CWIT Scholars (most of them female) across five engineering and computing majors. Over the life of the program, over 90% have been retained and graduated in technology majors, with that figure rising to over 95% in recent years. This compares well with a national rate of 39% persistence in STEM majors. Apart from financial support, the key elements of the CWIT Scholars program are the supportive community and intentionally designed experiences. Community-building elements of the program include a three-day New Scholar Retreat in the summer before the freshmen year; a Living Learning Community (LLC) in the residence hall that is mandatory for freshmen Scholars and optional for sophomores; monthly community or cohort meetings; three mentoring programs (with near peers, faculty, and industry professionals as mentors); networking-oriented Women in Technology (WIT) Events involving students, faculty and industry professionals; and social events throughout the year. This supportive community helps protect students from being derailed by the almost inevitable bumps and obstacles of pursuing a difficult major.

The community activities are supplemented by formal advising and seminars. The First Year Experience seminar in the fall of the freshman year addresses issues with the transition to college; a Leadership Practicum in the spring of the sophomore year builds the confidence as skills to help Scholars become change agents; and the Industry Mentoring Practicum in the junior year helps Scholars get the most out of the relationship with their industry mentor. These meetings and seminars serve to ensure that Scholars have access to knowledge and connections more typically available through the informal networks of majority group students.

In 2007, the CWIT model was adapted to create the T-SITE Scholars program,[6] funded by a series of NSF S-STEM grants. The T-SITE program provides scholarships and support programming to highly qualified community college transfer students with financial need. T-SITE scholars tend to be older than first-time freshmen, are more likely to be the first in their family to attend college, are more likely to have been born in another country, and frequently have greater family responsibilities than a traditional student. We also intentionally broadened our target group to explicitly include other groups underrepresented in technology. Most program elements are shared with CWIT, but the First Year Experience seminar is adapted to directly address the distinct challenges of transitioning from community college to the university. In 2013, the Cyber Scholars Program was modeled after the CWIT and T-SITE programs. The Cyber Scholars program is open to new freshmen, new transfer students, and continuing UMBC students in computing majors with an interest in cybersecurity.

In order to support a larger number of women, the CWIT Affiliates program was created in 2010. Affiliates are invited to participate in many aspects of the CWIT program: living on the LLC, their own FYE transition seminar, peer mentoring, WIT events, and other social events for women in COEIT majors. There are currently about 150 active Affiliates (about 25% of the women in COEIT) and many other women who

[3] http://csmatters.org/

[4] http://tues.umbc.edu/

[5] http://cwit.umbc.edu/

[6] http://www.cwit.umbc.edu/tsite/

attend CWIT events that are open to the whole College.

UMBC is also part of the Building, Recruiting, and Inclusion for Diversity (BRAID) Project,[7] which is a partnership between 15 U.S. universities and corporate sponsors to increase diversity within CS majors through internal initiatives and by sending groups of female students to the Grace Hopper Celebration of Women in Computing (GHC). Support from BRAID allowed UMBC to send 14 students and a faculty sponsor to the 2014 GHC. Ongoing UMBC efforts in support of BRAID include examinating gender and confidence effects in introductory computing and engineering courses, and a letter writing campaign to reach out to admitted women.

2.4 Increasing Pedagogical Inclusivity

A number of initiatives at UMBC focus on increasing classroom engagement, active learning, and team-based learning, all of which have been shown to increase the likelihood of positive outcomes for female students.

With support from UMBC's Hrabowski Fund for Innovation and additional funding donated by BAE Systems and Northrup Grumman, the co-authors created a new classroom, the ACTIVE Center,[8] which was designed to provide a dynamic physical and virtual learning environment. The ACTIVE Center supports active, collaborative learning, skill mastery through in-class problem solving, and laptop-based in-class laboratory activities. The flexible, modular furniture and portable whiteboards facilitate group problem solving. In Spring 2014, co-author desJardins redesigned her introductory AI course to take advantage of the new space through a "partial flipped classroom" model that combines structured pre-class reading assignments, short lectures, and in-class exercises to test and extend students' conceptual understanding and problem solving ability [desJardins, 2014].

Co-author desJardins also redesigned a junior-level course on computing ethics that is required for all CS majors, with a goal to increase student engagement, especially for members of underrepresented groups. The redesigned course uses a team-based, student-centered approach that encourages students to identify ethical issues in areas of personal interest. The course is writing-intensive and emphasizes an analytical approach to understanding the ethical, social, and legal issues related to computing innovations. A key goal of the redesign was for the students to become active learners and to be more invested in the course content. Student evaluations indicate that despite an increased workload, students in the pilot class benefitted greatly from the group-based approach, enjoyed having the opportunity to contribute to the design of the course, and felt they learned more than students in the earlier version of the class. A particularly valuable session of the course offering was on gender underrepresentation in computing.

Both the redesigned AI course and the redesigned ethics course have continued to be offered in the ACTIVE Center using the more interactive, student-directed learning model, which anecdotally appears to be especially appealing to female students in the courses.

[7] http://anitaborg.org/braid-building-recruiting-and-inclusion-for-diversity/

[8] http://active.umbc.edu/

3 Trends in AI and Possible Research Directions

As mentioned earlier, many female students are more motivated than male students by a desire to make an impact in the world, and less motivated by competition and games. Our perception—and that of many female AI practitioners we have spoken with—is that over the past 10-15 years, there has been an increasing emphasis in the AI community on theoretical mathematical contributions, a decreasing acceptance of interdisciplinary problems and empirical work, and an increasing emphasis on competitions. These factors could be contributing to a gradual decline in the representation of women in the field.

Computer science is often known for its "hypercritical culture": NSF data shows that reviewers in NSF's Computer & Information Science & Engineering (CISE) Directorate rank proposals on average 0.34 points lower on a scale of 1–5 than reviewers in other directorates (average rating 2.96 cf. 3.30) [Wing, 2011]. AI is no exception to this rule, and the hypercritical culture can also play out in harsh reviewer feedback and "attack-style" questioning during talks. Some colleagues have speculated that the "hypercriticality" also tends to overrate research that is "correct but unexciting," compared to research that is "flawed but novel." While there have been some efforts to counter this tendency through new reviewing standards (e.g., a completely redesigned reviewing rating process, in AAAI-13, for which co-author desJardins was program cochair), there is also often resistance to rethinking standards, and an implicit or explicit belief that doing so means lowering overall quality.

The above suggestions are anecdotal, based on personal observations and conversations. If they are true, however, it would behoove us as a discipline to rethink how we are presenting and evaluating ourselves. Even if they are not true, it would be worthwhile to understand why these perceptions exist. I hope that the AI community, perhaps with leadership from AAAI and ACM SIGART, will place some effort into collecting and analyzing the available data to understand the effects of gender within AI. Some of the questions that would be valuable to answer include:

- What is the percentage of women in different subfields of AI, and at different levels (graduate student, junior faculty, senior faculty, industry/government)?
- What subfields of AI are most well funded? What subareas are most frequently advertised and/or hired in academia?
- What is the gender distribution of submitting authors, accepted authors, and attendees at major conferences in AI?
- How do the keywords/topics selected by male and female authors differ, both of submitted and accepted papers? Conversely, what are the acceptance rates associated with different keywords/topics, and is there any correlation with gender preferences?

- How do ratings and review quality, tone, and oversight in AI conferences and journals compare with those in other areas of CS that attract a higher percentage of women (such as HCI, cognitive science, and CS education)?

There have been a number of efforts to build a sense of community among women in the field of AI. A series of informal "women's lunches" at ICML conferences in the early 2000s eventually led to the creation of the very successful Women in Machine Learning (WiML) organization, which has continued to run a WiML workshop and to offer a community mailing list that connects women in the field. The AAAI/SIGART Doctoral Consortium has actively targeted underrepresented groups, including women, and has often successfully paired female Ph.D. students with senior wome in the field. Co-author desJardins co-organized "Breakfast with Champions," a women's mentoring event at AAAI-15. While these efforts can reduce the sense of isolation and keep women more engaged in the community (especially junior women), answering the research questions listed above may also provide more insight into initiatives that may have a broader impact on the representation of women in AI.

4 Thoughts for the Future

Many of the successful initiatives that we list here and have observed at other institutions and across computer science are designed to increase the sense of community and improve the climate for women who are already in these fields. However, such initiatives do not seem to have had a significant effect on the number of women entering the fields. The AI community needs to look seriously at the patterns of gender representation within the field, and to consider ways to actively increase diversity, if we are ever to "move the needle" on the underrepesentation of women.

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Using Robots to Engage Middle School Students in Computer Science

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Abstract

There is a general consensus that an early start can get students interested in the fields of science, technology, engineering, and mathematics (STEM), but simple exposure often isn't enough to keep them interested through the years and into their career planning. Programs such as FIRST LEGO League and the following FIRST challenges offer a means to engage students, starting as early as kindergarten, and keep them engaged in the program through high school. We present an overview and brief analysis of two programs in which we have been mentors and instructors for 7+ years, and discuss how the differences in the programs affect their impact on the students, and in particular how it affects female students.

1 Introduction

Even as there has been a reduction in funding and the subsequent removal of elective and non-core classes in the US education system, there has also been a push to increase the number of science, technology, engineering, and mathematics (STEM) classes that are taught in US schools [CoSTEM, 2014]. With projections showing that these areas have sharply rising employment openings, but a dearth of qualified job candidates graduating from college [Department of Education, 2014] there is interest in both engaging students in the fields early and finding ways to keep them interested, so that we will have the workforce with the skills needed when these students reach the job-seeking age.

A primary concern is that students turn away from STEM fields early in education, seeing them as too difficult, or "not for them" and choosing to pursue other activities. This is particularly prevalent amongst female students, often due to societal pressure that math and science are for boys and that girls should choose other fields of interest, such as art or literature. However, there are programs that encourage all students to consider STEM as a possible career avenue, and give them opportunities to see what STEM careers might be like, even as early as kindergarten. Creating more of these programs, particularly on-going programs that can grow with the students, is imperative to keeping students engaged in the STEM fields and fueling future innovations.

2 Outreach Programs: Impacts and Observations

One of the most well known programs is "For Inspiration and Recognition of Science and Technology" (FIRST), which started with the FIRST Robotics Challenge for high school students in 1992 [FIRST, 2015] and has since added programs for grades K-3 (Jr. FIRST LEGO League), 4-8 (FIRST LEGO League), and 8-10 (FIRST Tech Challenge). These programs bring thousands of students in grades K-12 together to work on various challenges, not just in the robot game, but also from a societal and scientific standpoint, on the research project side of the competition. These programs provide an arena for teaching students about many aspects of the STEM fields, while also instilling a sense of teamwork and cooperation, and keeping the students engaged and excited in the process. These programs generally run from the start of the school year in late August through the first sets of regional competitions in November, and, if teams continue to the next level of competitions, may continue until the worldwide competitions held in April. For many teams, the end of the competition season is not the end of the activity, and the teams continue to meet until the end of the school year, or even over the summer, to cover additional material and even to prepare for the next year's competition. We have been involved as mentors/coaches for FIRST LEGO League (FLL) teams for the past eight years, and have seen the impact it has had on our students.

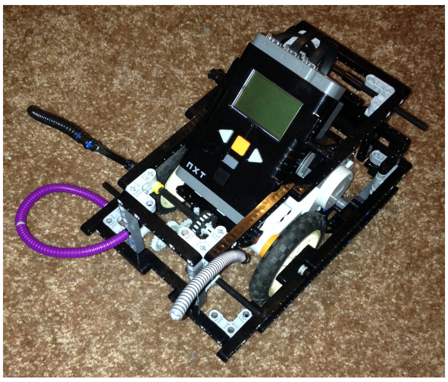

Figure 1: A LEGO NXT robot with arms and bumpers.

Students on the FLL team arrive with a wide variety of abilities in engineering and computer science, but all have left with the ability to program a LEGO robot (see Figure 1) to accomplish tasks like seeking out and picking up an object, avoiding obstacles, and line following. They also have an understanding of basic robot design, from building a sturdy chassis to incorporating flexibility by using attachments for different jobs, and from using different sized gears to gain more torque to finding the right angle at which to apply pressure to push a swinging lever. These students have also come up with projects on the yearly topic, ranging from how to better teach middle school students about electronic circuits, to improving the lives of senior citizens by starting a game night at a local retirement home. In particular, we have seen that the female students on the team come away with a broader understanding of what computer science is as a whole field and with an interest in making a career in computer science.

On a smaller scale, the University of Minnesota offers a Technology Day Camp for middle schools students between the ages of 10 and 13. This camp brings in 32 students per session, with 2-6 sessions each summer. The camp is offered free of charge, and draws students from the local school districts, which is comprised of many minority and under-served populations, so the camps provide an opportunity to see a college campus and consider careers in the STEM fields that might not otherwise be presented to these students. We have taught at the Technology Day Camp for seven years, and have seen the changes in students over the course of the week.

We spend the first day talking about what makes something a robot, and what it means to write programs, and we take the students on a tour of the campus and to visit various robotics and computer science labs. The second day, the students learn to solder together a robot (Figure 2) and we teach them the basics of programming using Scratch. On the third and fourth days, we move on to more complicated programming, this time for the Scribbler robots, and the students learn about using cameras to make the robot follow certain colors, or play music while dancing. Many students arrive on the first day with no experience in programming or robotics whatsoever, but they all leave having learned to write basic programs in two different languages, and with a robot toy that they put together themselves. The students are often surprised by the variety of things that can be done with computer science, and they are drawn in by the robots, excited when the program works, and curious when the robots do something unintended.

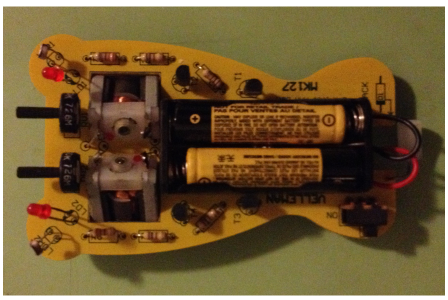

Figure 2: Robot soldering project at the Tech. Day Camp.

In FLL, the students meet at the beginning of the year, though most have been going to school together for multiple years already. Because they are in the same school, they see each other most days, and can form friendships outside of FLL, which meets only once a week, though FLL may provide the introduction that they needed. In contrast, at the camps, the students may be meeting 31 other students for the first time, and they only have 4 days to get to know each other. We have observed that, in FLL, separating the boys and girls doesn't make much difference in how the students act, or what they prefer to work on, but in the camps, separating the groups by gender makes a significant difference in how the female students interact and behave during the activities. If there are only girls in the group, they tend to be more focused and get more work done, and they ask more questions about the projects. If the groups are mixed gender, it is usually the boys who ask questions, and the girls are less interested in the project overall. These are just observations, not part of a study or done with concrete measures, but still leads us to they hypothesis that the difference we are seeing is due to the familiarity the FLL students have built with each other, but which is not present between the camp students.

3 Conclusions

From our experience in these two outreach programs, both groups are very excited about using and programming robots and the use of robots is effective in engaging the students on a wide variety of STEM topics. However, we have observed that the FLL students show better understanding of computer science fundamentals, and are more likely to continue to study STEM topics in high school, than the students in the Technology Day Camps. We believe this is due to the duration of the activities–the FLL students have the entire academic year to learn about robotics and other STEM topics, while the camps are only 4 days long. We do see some students coming back to the camps multiple years in a row, and they retain some of what they learned the previous year, but without the opportunity to pursue these topics in the interim, they have not progressed further.

We have also found that familiarity between the students lends itself to more equal roles between the genders, with the female students more willing to speak up or take charge if they already know the other students. In contrast, when the students don't know each other, the female students are more likely to be quiet, or ignore the activity in favor of watching what the other students are doing. Thus, we suggest separating students by gender for short programs, to engage all students more completely in the activities.

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"Women Are Just Not Interested in Computer Science": a Convenient Falsehood, a Convenient Truth

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Abstract

"Women are just not interested" is a convenient justification for the absence of women in computer science. This paper questions this simplification; it admits that women have not shown considerable interest toward computer science by referring to the relevant statistics and common observations by experts in the field. Second, it analyses several diverse factors that may have led to this lack of interest. This paper also points out the importance of women's involvement in this field, and discusses some possible solutions.

1 Introduction

At the university's restaurant, where my colleagues and I were eating lunch, Štefan broke the silence and asked me about the progress of my paper about the lack of female presence in computer science. While I was explaining the historical roots and background of this phenomena for a table consisting of only male researchers (with the exception of myself), a colleague said: "isn't it because women are just not interested!?"

"Women are just not interested in computer science", or STEM (Science, Technology, Engineering, and Mathematics) fields in general, is a quote that you encounter again and again. This claim aims to establish the easiest possible endpoint for a complex process that has formed over time due to various and multiple reasons. However, a quick search on the internet on the topic of "why women leave computer science" or "under-representation of women in computing" or other similar questions, demonstrates evidence that is contrary to common belief: an increasing amount of research and efforts are put into discovering the secret of the mysterious absence of women in STEM-related professions and college programs. Why mysterious? In the early days of computing, there were a majority of women doing the job. In the mid 80's, the situation began to change.

While reviewing literature and interviews on the subject dating back to the 90's and and the first few years of the new millennium, I was astonished to discover that nothing has changed. Generations from the 80s onward all faced barriers, concerns and problems similar to today's. Why has there been no significant change? Technology has changed, there have been many movements struggling to achieve gender equality in different aspects of social life. Then why are we still in a position that women find themselves deserting computer science faculties, at both graduate and under-graduate levels?

The answer to this question is rooted in a very broad aspect of gender inequality which itself originates from economical, political and geographical realities. For practical reasons, this paper only highlights some of the factors playing significant roles in issues related to the female presence in computer science. The main purpose is not to give an overview, rather, to point to some similarities between my own experience and the existing literature and statistics on this topic. Moreover, in this article, computer science, information technology and artificial intelligence are used interchangeably, because they share the similar educational curricula.

2 In Fact, Women Are not Interested In Computer Science

"Women are not interested in computer science" becomes a common belief simply because our collective experiences and observations say so. It does not surprise me anymore (but it still annoys me) when I find myself the only woman in a conference room or in a work meeting. Collective observations are also confirmed in the literature: several researchers ranging from social scientists to biologists support this observation through their studies. Examples include biological difference between women and men such as size of and organization of the brain [Deary *et al.*, 2007], difference in hormones, or other biological reasons indicating cognitive differences among genders [Ceci and Williams, 2010]. Not only cognitive abilities, but life styles and preferences are also influenced by biological differences. More specifically, the overall difference (caused by physical and sexual and ultimately gender differences) in life style and preferences is the main reason for womens under-representation in high-intensity STEM careers [k. Ferriman *et al.*, 2009]. It is believed that women's views toward life are more people-/society-oriented and that is one of the reasons why there are more women in health related jobs rather than computer science [Eccles *et al.*, 1999]. Even if women chose to become computer scientists, they are mostly active in medical-related branches of computer science[1].

Let's assume the inherent difference in life style and preferences between genders, as the studies above suggest. The question is: why is computer science considered an anti-social field in the first place? Does the "all nighter geek" represent the broad field of creativeness? Figure 2 shows the percentage of women who have graduated in STEM-related degrees in the U.S [NECS, 2013] between 1970 and 2012. This data shows that there is no STEM gender gap in the U.S. The gender gap only exists in Engineering and Technology (ET). But even in ET, things were not always this way. Women were early pioneers of computer science and worked in the field for decades [MISA, 2010]. But women's interest in computing started declining in the 1980s in the U.S. Many believe that this decline is a direct result of the fact that early personal computers were marketed to boys as toys for gaming[2], as well as the prevalence of male "geek" character in popular movies in the same decade [MISA, 2010]. Therefore, it is very important to see how this lack of interest was formed, through features of popular culture such as advertisements for example, and which factors consistently contribute to the continuation of the existing situation.

Figure 1: Two Nintendo commercials from the 80s and 90s. Most commercials from those decades showed only boys playing games.

3 Computer Science Culture, Media and Norms

The general atmosphere of computer science has not been very welcoming to women. "Male behavior becomes the standard for the right fit and success", "[the emergence] of the male nerd in popular culture as well as the rise of computer gaming are barriers for women's entry" are very common issues discussed by those who believe that the interest of women towards computer science is engineered by a harmonic symphony against women.

One of the prominent studies addressing this particular issue, is 'anatomy of interest' by Margolis *et al.* [2000],

[1]It should be mentioned that such 'essentialist' theories which view differences between men and women as eternal, and usually apply biological methods to support their ideas, are not so popular any more, and are widely opposed by the pioneers of sociology and gender studies in particular. Gender is no longer viewed as a result of biological difference between men and women but as 'constructed' by society, hence gender roles have little to do with the actual 'capacity' of men or women, rather are a result of how society, for example through popular culture, idealizes and enforces these roles.

[2]see https://www.youtube.com/watch?v=P9oDkQyzqkU

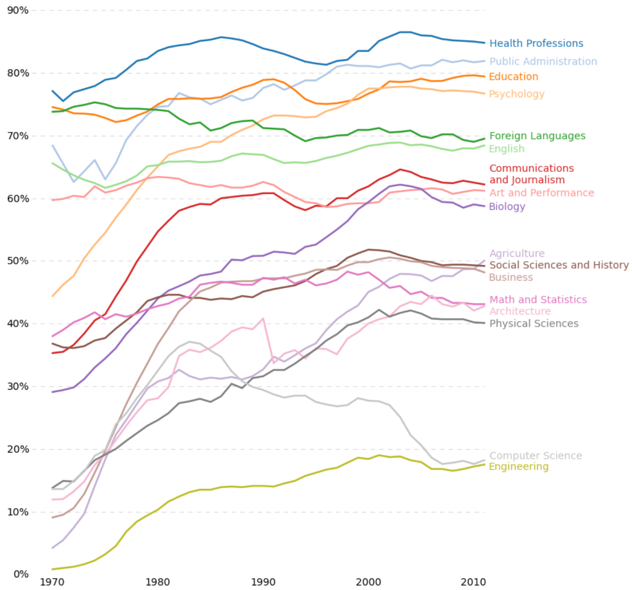

Figure 2: Percentage of Bachelor's degrees conferred to women in the USA(1970-2012) [NECS, 2013]

who interviewed computer science under-graduate students at Carnegie Mellon University. The study is comprehensive in the sense that it involves students from both genders, different years and backgrounds. The result of the study showed how women's confidence, as well as their early enthusiasm, faded when they were eventually confronted with the masculinized standard. They felt that they did not fit the program because they did not code in their free time. This gives credit to this feeling, which in fact is shared in my work/study experience, and raises the following question: the ability of thinking "out of the box" comes with broad knowledge and distinct backgrounds; is computer science the only exception in which only programming matters?

It is rigorously believed that geek stereotypes are an integral part of computer science culture. A team of researchers at University of Washington (UW) decided to find out how media representations of geeks affect women's interest in the field of computer science [Cheryan *et al.*, 2013]. In the first part of the UW study, Sapna Cheryan and her team set out to survey the common image of computer scientists among students at UW and Stanford. The results were predictable. They found a high percentage of both male and female students believing that computer scientists are male, obsessed with computers, antisocial or isolated, and that computer scientists "play WoW all day long.". More interestingly, women who had taken even just one computer science class were much less likely to believe in these stereotypes. So, does the stereotypical image of the field represent reality? My experience admits that the stereotypical image often represents reality; at the same time it is difficult to see any correlation between the stereotypical icons and successful computer scientist role models. Does being obsessive with computer games really contribute to enhancing the ability of problem solving and thinking in an algorithmic way? There is no research that supports a positive answer to this question.

Media contribute negatively to create the gender biased computer science culture. In fact, media intensifies the wrong and biased image against women, and does so consistently all over the world. Even in a high gender-egalitarian country such as Norway, Hilde [2007] studied one of the largest national newspapers in Norway, Aftenposten, to obtain the following significant findings. From 1980 to 2007, newspaper reports were most likely about men's high skills in using computers, while reports about women and computing often focused on womens incompetence in mastering computers. One example of TV series propagating the typical stereotypes include "The IT Crowd". In this series, the IT poeple are portrayed as boring, solitary, poorly dressed, and socially inept. Garcia-Crespo *et al.* [2008] conduct a study with 40 people as subjects from both professional IT sectors and last-year high school students (22 men and 18 women). Some of the results unfold as follows: 60% of IT professionals felt zero identification with the TV characters; women showed on average a lower level of identification than the men; and 80 percent of students, including both men and women, show a very low level of interest in the profession based on the show. The study is interesting because the stereotypical characteristic is not attractive for either of genders. This image of the field/profession, whether right or wrong, affects negatively both genders.

It is not just, TV series, gaming companies and newspapers (i.e., popular culture in general) that reproduce this culture. Governmental laws and regulations have also played their part. For example, in 1970, during the British technological revolution, the British government created a new Automatic Data Processing work grade for programmers, but explicitly excluded females form applying to the programmer position. Systematic prevention of women from learning new technology led to a gradual downgrading of their skills with respect to the state-of-the-art of the time, thus literally a dead end. This happened while British women were very progressive in working as technologists [MISA, 2010].

Note that none of the factors above is the culprit on its own, and it is hard to believe that someone changes his or her career path only based on a TV series, or a few newspaper articles, or having a group of geeky classmates. All of these factors combined cause the problem over time, and they strengthen each other by providing complementary negative biases towards the profession.

Overall, the world of computer science is not separated from the rest of the world in which women are discriminated against on daily basis. However, many women overcame all these obstacles, passed all the difficulties, pursued their interest, graduated in a computing-related field, and followed a related career.

4 Why do we care?

Computer science related jobs are not the only ones that suffer from unbalanced gender composition in the workplace. For example, nursing is a female dominant profession around the world. Does the lack of male workforce in the nursing concerns us? Certainly yes. Diversity matters.

A very recent research done at MIT [Woolley *et al.*, 2010] posits the question of why some groups are smarter than others. This research emphasizes that nowadays, regardless of how smart each individual is, the important decisions are taken by groups. They grouped 697 volunteer participants into teams which were asked to perform different ranges of tasks, and also designed a scoring mechanism to evaluate the performance of the group and measure each individual's IQ. The result showed that teams with higher average IQs didn't score much higher than the teams with lower average IQs. In fact, the results had nothing to do with average IQ. Smarter teams (the teams with higer score) were the ones where members contributed more equally to the team's discussions, rather than letting one or two people dominate the group. Teams with more women outperformed teams with more men. This is an interesting study because it highlights the importance of having both genders in a group. This can lead the group to make better decisions. There is other ongoing researches which suggests that diversity in gender, ethnic and background benefit the workplace. Baumgartner *et al.* [2007] studied teams comprising diverse members, finding that these consistently outperform teams comprising "highest-ability" members. More specifically, in computer science related workplaces, teams with equal numbers of women and men are more likely (than teams of any other composition) to be creative, share knowledge, and fulfil tasks [BusinessSchool, 2007]. All of the above studies become important if we actually care about high quality and creating useful technologies which can benefit human beings. In other words, if the quality of the product matters, then diversity in the group which makes this product matters.

In addition to the importance of a balanced workplace, living standards also matter. Computer science related jobs are on average well paid, and job opportunities are rapidly increasing. Tech leaders in companies like Google, Facebook, Amazon, and Apple will need to fill more than 650,000 new jobs by 2018 to meet their growth projections, and two-thirds of those new hires will be for STEM roles [Craig *et al.*]. The situation in Brazil, China and India where technology industries play an important role in the economy, is similar. In such conditions, the absence of half of the population can be harmful in two ways: first, women are deprived from very broad innovative and well-paid jobs, and second, technology will continue to consists of male-customized products.

More importantly, no-one shall be forced to choose or not choose a job as a result of imposed stereotypes and wrong images. In fact, there is absolutely nothing wrong in not being interested in any STEM majors, for a female or a male person, as long as we can make sure that the lack of interest is the result of free, unbiased will, and not a consequence of false, misleading images.

5 Toward Solutions

The problem is recognized among different groups of people with decisional power, including CEOs, academics, job recruiters, politicians and several others. Each of these groups take minor steps toward balancing the situation. For example,

Figure 3: School kids often visit the Center for Applied Autonomous Sensor Systems (AASS) at Örebro university in Sweden.

in academia, remedies for the problem range widely: courses on ‘Gender issues in information technology education and computer science’ (e.g., the WINIT project[3]), holding women days in a CS/IT/AI related conferences (e.g., IJCAI, RSS), dedicating special issues to this topic (e.g., ‘Special Issue on Women and IT in Information and Communication technology: Research on Intervention Programs of the Information Systems Journal’). In addition to academic communities, there are private and governmental organizations which specifically address the issue of under-representation, and perform different activities to encourage women’s involvement in computer science programs and professions (e.g., she++, CodeEd, Geek Girl). In this paper, I only point out two possible solutions which in my opinion, are more prominent than other remedies.

5.1 See Inequality as a Problem!

To many people, gender-segregated playgrounds, gender-segregated parties, gender-segregated classrooms, gender-segregated pedestrian ways, seem extremely awkward and even offensive. I believe that working/studying in a gender-segregated location is also awkward and abnormal. Research shows that in many countries subject to the dilemma of female under-representation, there is no formal discrimination, nor are there overt barriers [Welle and Heilman, 2007]. However, is informal discrimination that is unlikely to be noticed by people. But is it always about the law?

“She is always moaning about inequality stuff”, “oh come on, this is too much, you are just cynical”, “stupid feminists are still alive” and in the best case “I am not sexist” and “ I cannot understand what all the fuss is about”. These quotes are not unfamiliar to most females, or equality-sensitive males, in the field of CS. I do not want to list what I often hear, but in a nutshell: if you want to be an instant target for disapproval, or if you enjoy being referred as tiresome, all you need to do is to speak out about sexism in your workplace.

Sexism is not only about active and explicit discrimination. Being ignorant on discrimination or hidden sexism, as well as unbalances situations toward one gender, do assist the development of a sexist environment (e.g., I am not sexist, therefore sexism does not exist). Briskin [1990] defines a non-sexist versus anti-sexist category. Non-sexists are those who see anti-sexist people as prejudiced. They also believe that questioning gender issues is irrelevant to any scientific development and it is only a matter of individual choice in deciding to do or not to do something. This, in turn, means that there are no differences between men’s and women’s conditions in society. With such an attitude, there is no need for further effort to empower women and endeavor towards gender equality, i.e., taking no responsibility for the existing problem, which leads to neutrality, inadvertently and effectively results in supporting the existing situation.

5.2 Target Kids

I started coding when I was twelve. I had my personal computer and a family which did not limit my ambitions and abilities. I was not aware of any computer science culture and stereotype, and lucky enough to not have a geeky brother. However, this is not often the case. Gender roles are shaped in the mind of children not only by family, but also by cartoons, toys, school and many other aspects. If we aim to separate science and gender as an ultimate solution, the toy industry, educational system, the cartoon/movie industry, and many other institutions should share the same concern, thus, contribute to solve the problem. There are efforts to ameliorate current gender biased situations, such as supervisory institutions that assure the absence of discrimination and sexism. More specifically related to the topic of this article, in several countries like Sweden and Germany, there is a girl day where school girls come to tour engineering departments. The purpose of the visits is to see some female role models, as well as what sorts of things can be done as an engineer. Showing technology-related labs which stimulates people’s creativity is one of the common practices these days. A school in Stockholm took part in a research program where high school students were asked how many of them wanted to be an engineer. Less than 5% of the students who wanted to be an engineer were females. The percentage was drastically changed when the meaning and tasks of an engineer was elaborated for them, thus their minds were cleared of the stereotypes they were fed over the years.

[3]See `http://www.winitproject.com/`

6 Conclusion

This paper has discussed issues related to the lack of representation of women in compute science. The problem is pervasive in this field, and I have briefly discussed some of the related studies on the topic. It has been observed that popular culture (which is engineered by TV series, gaming companies, governmental laws, newspaper, and many other factors) related to computer science is strongly male-dominated, and projects the image of geeks – which are invariably male – as smart and intelligent people. I have reflected on the consequence of gender bias in our societies, which I believe precludes women from being involved in interesting, creative and well-paid career paths today. Some of the efforts toward balancing the situation have been mentioned. Also, I stress the importance of early impact on how gender roles are defined in children's minds. An important steps toward solving this problem is to speak about the problem and to actively try to convince people (of both genders) that an unbalanced gender workplace is not normal. I hope that fostering the gender debate in computer science will lead more women to choose this wonderful line of research and profession.

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Institutional Support for Promoting Women in AI and CS: Athena Swan

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Abstract

Equality Challenge Unit (ECU) is a charity that works to further and support equality and diversity for staff and students in higher education institutions across the UK and in colleges in Scotland. Athena Swan Charter is a scheme introduced by ECU to promote women in higher education. In this paper I briefly introduce Athena Swan Charter, followed by the activities around it in the Department of Computer Science of University of Bath, UK, where I am a PhD student. I am a member of Athena Swan Committee in our department and was recently involved in putting forward an application for a Bronze Athena Swan Award. I discuss the findings of our application, in terms of identified areas of improvements and actions to fulfil them.

1 About Athena Swan Charter

Athena Swan is a scheme established in 2005 in the UK that promotes the career progression of women in science, technology, engineering, math and medicine (STEMM) [1]. By being part of Athena SWAN, institutions are committing to ten principles that ensure their policies, practices, action plans and culture facilitates a progressive charter for women:

1. Acknowledging that underrepresentation of women in STEMM results in academia losing half of the talent.
2. Committing to advance gender equality in academia in all levels from senior positions to supporting roles.
3. Committing to promote the equal gender participation with respect to disciplinary differences. In particular the underrepresentation of women in senior roles and the high loss of women in STEMM.
4. Committing to tackle the gender pay gap.
5. Committing to address the negative consequences of using short-term contracts for the retention and progression of staff in academia, particularly women.
6. Committing to tackle the discrimination against trans people.
7. Acknowledging that advancing gender equality requires commitment and action from the institution and its leadership.
8. Committing to make sustainable structural and cultural changes to advance gender equality
9. Committing to recognise and consider the intersection of gender and other factors in all individuals wherever possible.

2 Athena Swan Award

In total 129 institutions have joined this scheme since 2005. The Athena SWAN members can apply for an Athena Swan award. Depending on the strength of the application, the award is granted as Gold, Silver or Bronze Athena Swan Award. The award is a representation of the advancement of equality and diversity in the institution, hence the large number of the institution that joined the scheme. Applications for awards need to provide (i) a self-assessment description of members of Athena Swan committee in the institution applying for awards; (ii) a pen-picture of the institution to set the context for the application including the number of male and female members, their roles, and etc. (iii) a detailed account of the support available for the career progression of women in the institution; and (iv) an action plan for the next three years that addresses the priorities identified by the analysis of relevant data presented in the application, success/outcome measures, the post holder responsible for each action and a timeline for completion.

3 Computer Science Department Award Application Process

This process involved gathering both quantitative and qualitative data. Figures 1, 2 and 3 display the number and percentages of male and female students in all levels. The data for academic staff is represented in Figure 4. Apart from quantitative data, Athena Swan team conducted a number of formal and informal meetings with research students and academic stuff to discuss and identify gender-specific issues. The result of analysis of questionnaires and focus groups were particularly useful in figuring out the positive and negative practices in the department. More importantly, they guided us to devise an action plan that is discussed in the next section.

UNDERGRADUATE STUDENTS	2011/12				2012/13				2013/14			
	Female	Male	% Female	% Male	Female	Male	% Female	% Male	Female	Male	% Female	% Male
Total	**43**	**237**	**15%**	**85%**	**47**	**247**	**16%**	**84%**	**43**	**288**	**13%**	**87%**
Full time	43	236	15%	85%	47	247	16%	84%	43	288	13%	87%
Part time	0	1	0%	100%	0	0	-	-	0	0	-	-

Figure 1: Undergraduate Students Data

POSTGRADUATE TAUGHT STUDENTS	2011/12				2012/13				2013/14			
	Female	Male	% Female	% Male	Female	Male	% Female	% Male	Female	Male	% Female	% Male
Total	**4**	**14**	**22%**	**78%**	**4**	**12**	**25%**	**75%**	**10**	**2**	**83%**	**17%**
Full time	4	14	22%	78%	4	12	25%	75%	10	2	83%	17%
Part time	0	0	-	-	0	0	-	-	0	0	-	-

Figure 2: Postgraduate Taught Students Data

POSTGRADUATE RESEARCH STUDENTS	2011/12				2012/13				2013/14			
	Female	Male	% Female	% Male	Female	Male	% Female	% Male	Female	Male	% Female	% Male
Total	**9**	**40**	**18%**	**82%**	**11**	**42**	**21%**	**79%**	**10**	**41**	**20%**	**80%**
Full time	7	31	18%	82%	9	35	20%	80%	9	34	21%	79%
Part time	2	9	18%	82%	2	7	22%	78%	1	7	13%	88%

Figure 3: Postgraduate Researach Students Data

ACADEMIC AND RESEARCH STAFF	2011/12				2012/13				2013/14			
	Female	Male	% Female	% Male	Female	Male	% Female	% Male	Female	Male	% Female	% Male
Total	**8**	**25**	**24%**	**76%**	**10**	**25**	**29%**	**71%**	**10**	**33**	**23%**	**77%**
Research	4	9	31%	69%	5	6	45%	55%	6	15	29%	71%
Teaching	0	0	-	-	0	0	-	-	0	1	0%	100%
Lecturer	0	3	0%	100%	0	4	0%	100%	0	2	0%	100%
Senior Lecturer	2	2	50%	50%	2	2	50%	50%	1	3	25%	75%
Reader	2	4	33%	67%	2	3	40%	60%	2	4	33%	67%
Professor	0	6	0%	100%	0	8	0%	100%	0	7	0%	100%
Other	0	1	0%	100%	1	2	33%	67%	1	1	50%	50%

Figure 4: Academic Staff Data

4 Athena SWAN Bronze Computer Science Department Award Application Findings

In this section I briefly point out the most important observations and issues we found regarding underrepresentation of female students and staff in our department.

Underrepresentation of female students and staff: In order to ensure the representation of women in higher education and senior roles, we first need to ensure sufficient female student recruitment in the undergraduate level followed by providing enough support and resources that paves the way to higher levels. We have planned some outreach activities such as school visits to emphasis the role of female participation in CS and AI. The activities also include guidelines on ways of getting involved in CS and AI as a future career. Regarding postgraduate recruitment, we ran few focus groups to identify bad and good practices that the students found encouraging and discouraging in the department. Issues identified are all taken into account in the action plans. Increasing the number of female specific bursaries for both home and overseas students is also one of the actions we have in our plan to attract more female students. Recruitment of female academic staff, on the other hand, needs more proactive search since the target audience is not as easily accessible as school students. The aim is to increase the female academic staff, which is currently 14%, to at least the national level of 21% in the next three years.

The role of support at the key transition points: One of the reoccurring themes that emerged during the surveys and interviews conducted with PhD students and staff was the importance of support and mentoring. Mentoring services found to be very helpful in career progression and transition, and in decreasing the staff turn over rate.

Promotion: Closely related to the previous point, is the subject of promotion. Although the university is obliged to support the career progression of all member of staff, a lack of a structured promotion stream is evident. The department intends to monitor the promotion of, especially female staff, more closely, encourage applications for promotion when appropriate.

Maternity and paternity leave: Most of female members of department expressed their fear of work life balance, especially during and right after maternity and paternity leave. We are planning to introduce a departmental policy that facilitates transition back into work after maternity and paternity leave. The department also plans to have a more proactive role in offering leave and flexible working around leave.

Lack of sociability and research mobility: Organising a suitable space for female postgraduate students and staff to meet informally is on the agenda as a way to enhance the community and culture of the department. As for research mobility, the department plans to increase support, including financial and childcare, for female PhD students to participate in conferences, workshops and seminars.

5 Conclusion

Athena Swan and similar schemes all around the world are institutional forces that play a key role in investigating the curious phenomenon of female underrepresentation in science. Beyond submitting an application for an award, the process of preparing the application involved an in depth analyses of the department, which is a great step toward identifying the reasons behind unbalanced percentages between genders in CS and AI. More importantly is finding ways of overcoming obstacles, which would not have been possible without identifying them in the first place.

We believe that real change in womens position within our discipline cannot be achieved by working only within a single university. Girls are under-represented in computing related study at school. Women are under-represented in computing related undergraduate courses. Hence, we are planning early interventions to enthuse young women about pursuing computer science. Our Action Plan therefore, combines departmental activities and outreach activities in schools. However, significant progress in including and promoting women in computing requires action on a national scale, since those leaving school to pursue higher education in computer science will not necessarily apply to our university even if our outreach activities provided their inspiration. For our part, if a girl leaves school inspired by our activities to become a computer scientist at any university, we will have achieved something. Our outreach work in schools includes developing the new national curriculum for Computer Science through the Computing at Schools network, working with the International Baccalaureate Organisation, and organising workshops in local schools, all with an emphasis on engaging the potential female computer scientists of the future.

The department is also committed to improve the staff gender ratio and support the career progression of the female staff. In the past three years we have seen two promotions of women Lecturers, and expect to maintain this positive movement. We will actively encourage women applicants for positions at all levels. In the department we know well the challenges of maintaining an appropriate work/life balance. The department is responsive to requests for flexible working, schedules meetings and events within sociable hours and provides a supportive introduction to new staff and maternity leave returners.

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Girls and Robots in the Performing Arts

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Abstract

The percentage of women graduating with IT degrees has been on the decline for decades, which is impacted by the fact that girls' interest in STEM fields drops before middle school, well before undergraduate education. We seek to address the problem in elementary school, getting girls interested in technology by using robots to teach computational thinking in interdisciplinary, project-based classes and summer camps. We use storytelling and performance with programmable humanoid robots as performers to integrate the arts and sciences and introduce core computational concepts to students who may not have an interest in traditional STEM fields. We provide an opportunity for students to obtain first-hand experience programming robots to perform theatrical skits and dance recitals. In the process, we will help students understand the role that creativity plays in technology and learn computer science in the context of performing arts.

1 Introduction

Women continue to be under-represented in technology-related fields. According to the National Center for Education Statistics, the percentage of women among bachelor's graduates in computer and information sciences in 2012-2013 was 18%. Studies show the drop in interest in STEM fields occurs around middle school, but that a supportive high school environment for women in math and science can reduce that gender gap [Legewie and DiPrete, 2012].

One way to address the low number of women in computing may be to increase positive experiences in computing fields to girls before their reported interest in STEM-related subject matter drops. There is evidence that project based learning enhances quality of learning and is effective for teaching complex processes and procedures like communicating, problem-solving, and decision-making [Helle *et al.*, 2006; Thomas, 2000]. Thus, introducing computer science projects to young girls before the usual drop in interest may help pique or enhance their interest in future STEM studies. We discuss several projects designed to increase interest in computer science using interdisciplinary undergraduate courses, after-school activities, and girls-only summer camps.

2 Projects and Observations

This paper describes three programs developed to increase students' exposure to computer science, one of which is aimed exclusively at girls. The first involves designing interdisciplinary classes to explore algorithmic thinking in the performing arts by using humanoid robots as performers. The second is a weekly, informal, after-school activity where three 5th/6th grade girls have the opportunity to program humanoid robots to perform theatrical skits. The third, scheduled for July 2015, is a summer camp for girls which integrates programming concepts in a theater and robotics setting. In each of these programs, NAO humanoid robots, developed by Aldebaran Robotics, are used. NAO comes with proprietary software, *Choregraphe*, which is used to program the robots. All the projects discussed herein use this relatively simple drag and drop interface for programming the robot.

2.1 Undergraduate Classes

The first project consisted of a series of two undergraduate classes offered in 2014: "Dancing Robots" and "Robot Theater." These experimental, hands-on, project-based courses pulled students from dance, theater and computer science backgrounds. The goal was to allow students with diverse backgrounds to collaborate to create choreographed dances and skits using several NAOs. In each class, students had to work together when programming, and each student was responsible for choreographing a performance piece for a final presentation held at the end of the semester.

"Dancing Robots" had eight students – three dance students and five students with technical majors, including computer science, informatics, and engineering. Two of the three dance students were women, and all students with a technical background were men. Performing Arts students learned about computation, CS/informatics/engineering students learned about creative work, and all students learned about interdisciplinary collaboration. "Robot Theater" had six students, one theater/playwright student and five students with technical majors which included computer science, informatics, and engineering. The only engineering student was a woman, and the other students were men.

In both classes, students learned about the logistics involved in putting together a show, including staging, lighting and working with performers. Every student in the class learned how to program the robots, and every student wrote original content which was performed by a combination of robot and human performers. Students had to think about ways to have the robots convey emotion and connect with an audience. While each student was responsible for an individual project, all performances were collaborative efforts. As the projects evolved, the entire class was involved in giving constructive feedback and helping program the robots to move and deliver their lines correctly.

2.2 Weekly Workshops

As a result of the experiences in designing the interdisciplinary classes involving performing robots, a strategy was developed to teach elementary school students to program the robots. The development process involved working with three 5th/6th grade girls for one hour each week for the 2014-2015 academic year. After a very brief demonstration of the software, the girls were able to get a robot to speak and move, after which they imagined a variety activities for the robots to perform: cheer-leading, telling a story, conversing with other robots, and conversing with a human. The girls worked together to animate the Dr. Seuss book *Green Eggs and Ham*; the skit involved a human and robot interacting.

After working with the robots for the academic year, the girls were eager to share what they had learned with their peers. We were invited to give a demonstration and workshop to a mixed-gender after-school STEM club of 4th grade students. The girls took turns reading one character's lines, and the robot delivered its lines as programmed. The girls then showed the 4th graders how to program the robots, including how to make the robot speak, perform simultaneous motion and speech, and pose the robot to create new movements. The girls were very confident in their ability to work with the robots and demonstrate their technical knowledge.

In this STEM club meeting, there were six girls and three boys. Both boys and girls seemed interested in the robots. When they were first given the opportunity to control the robot, both boys and girls took a little time to think about what they wanted the robot to say. When the boys took time to think, the other club members waited patiently without rushing them. When the girls were thinking, however, the boys who had already had a turn were eager to take control of the robot during what was perceived as down-time. During this time, the 4th grade girls started to drift to the side to watch the boys try to control the robot. Fortunately, the older girls made sure everyone had a turn, which helped to keep the entire group engaged. The older girls were able to answer questions and had no problem taking control of the robot when they wanted to demonstrate a particular concept.

2.3 Summer Camp

The last project is a two-week summer camp for girls in 5th/6th grade. The "Robot Theater Summer Camp" will be composed of 12 elementary-school students, three instructors, and two student assistants. Unlike the previously described projects, this camp is aimed exclusively at girls. Scholarships will be provided to reduce the cost for students in financial need, opening the door to students of low socioeconomic backgrounds. The students will work in small groups, with the goal that each group creates a robot skit to be demonstrated in a final show that is open to the community.

The camp will run for three hours each weekday for two weeks in July, 2015. No programming or robotics experience will be required. The first week's lessons include making the robot speak, e.g. delivering a monologue with appropriate gestures, creating a dialogue between robot and person, creating a dialogue between two or more robots, designing postures and gestures for the robots, and finally creating skits that put all of these components together. Through these lessons, the girls will learn concepts including sequential and parallel programming, logic, and conditional statements. Each girl will be responsible for leading her small group one day during the second week while developing the final skit of the group's design. They will have the option to perform alongside the robots in the final performance. Participants will be encouraged to learn more about the capabilities of the robots and the additional technology that enables the robots to communicate with each other. We will introduce interested students to Python code that can be used to create custom programs.

If the first camp is a success, we plan to offer the "Robot Theater Summer Camp" every summer as a set of tiered camps. The introductory camp will be as described above and serve 5th to 6th grade girls. Successive years will build on the programming skills learned in previous camps, and alumnae of previous camps can work as tutors and assistants to the introductory camps. We intend to collect data on the participants' interest in computer science and robotics before and after the camp, as well as in future years. Future advanced camps will make use of some of the more sophisticated capabilities of the robots, and explore other technologies that can interface with the robots.

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