ICT & SOCIETY

How Papua can help Computing Science

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Introduction

When having dinner with friends all different topics come to the table, but last week, it was time for the topic to turn to women in Computing Science (CS), our joined field of study. One of my friends said he has two nieces, who are great at math, but somehow, never seriously consider studying computing science. He asked me for advice on how to convince them to at least consider computing science, as he thinks they would do well and would enjoy it. The good friend I am, I started looking into the subject of women (not) studying computing science, and found a vast amount of literature giving all kinds of explanations, recommendations and suggestions. It turns out my friend was not the only one struggling with this question.

In this essay, I will try to answer the question *"why are women that are good at math often not considering CS and how can we convince them to do so?"*, and the underlying question *"How can my friend convince his nieces to consider studying CS?"*

As we will see, it turns out that women not studying computing science is not a thing of lack of skill or that women might be unfit for the field or lack some innate capability that men have. It will turn out to have mostly to do with the image that CS has and whether women think if they can reconcile with this image.

In this essay, I will lay out the research that has shown that it has nothing to do with skill. Then I will discuss the research that has shown what it does have to do with. In the end, I will try to formulate an advice based on this research; an advice to both my friend and anyone else that might want to convince a woman that CS is worth considering. But first, let's just quickly walk through why you would want to convince them in the first place.

Why (more) women in CS?

Often, the question is asked why you would want to put in extra effort in convincing women to join CS. If they do not want to join, is it not their choice? Why put in the extra effort when they already chose? Well, the answer is that even though it is the case that it is their own choice, the choice is often based on misconceptions about the field as we shall see in the rest of this essay. Besides, getting more women in the field can be both beneficial for the women themselves and for our society as a whole. The latter because there is a huge shortage in computer scientists, so training women can help reduce the gap. The former because jobs in the field pay well and are often flexible, which are often perceived desirable properties in a job. Another major issue is that is has often become clear that groups that make things for the whole of society should consist of a diverse group in order to make the products suitable for everyone. Some of the earliest versions of voice recognition systems were

only calibrated to recognize male voices. The first generation of airbags was designed for adult male bodies, resulting in avoidable deaths for women and children. These perhaps somewhat extreme examples [1] show why it is important to have women, or a diverse group of people in general, on a team.

Skills

When talking about skills that are necessary for CS, one often takes a look at the mathematical skill. It turns out to be a good predictor of how someone is going to do in a course [2]. While the idea that math is a boys' subject and not a girls' one has been challenged in the last couple of years, I find it necessary to address it a bit. There is a lot of research finding that there is no significant difference in the scores women and men get on math tests (see for example [3]). However, it is often the case that while women do get the same scores as men, they perceive their ability as less than the men do [3] [4]. This perception is also found when measuring confidence in computer skills. When quantitative ability was controlled, a woman's confidence was much lower than a man's in [5]. In [6] more women than men found lack of knowledge and experience a factor in deciding against CS.

Culture

Another thing that needs to be noted is that the idea that CS is a man's field is not universal. It seems to be greatly linked to culture. For example, in Malaysia, CS is viewed as a gender neutral, or even a feminine subject. In [7], the women interviewed found their choice for CS as 'being consistent with being women'. Especially software engineering was considered to be a more feminine field, because of it being an indoors, desk job, whereas here in the west, it is considered a man's job. Professions or fields of CS for which you had to go outside, for example to construction sides, were considered to be more masculine. It is therefore good to keep in mind that it is not innate to men or women to be interested in or have a preference for a job in CS. Whether or not a job or a field is perceived feminine or masculine is very much dependent on culture. It is important to keep this in mind when looking at why women do not want to join. Women might miss out on a great professional path, simply because they could not see themselves do such a masculine job, while the concept of masculinity is greatly cultural.

Perception

As research after research has suggested; perception of the field of CS is what actually keeps women (but also men) from joining. In [6], the most important reason high school students gave for not wanting to study CS was that they did not want to sit behind a computer all day. The perception that Computer scientists sit behind a computer all day is apparently wide spread, but also influential in keeping people from choosing the field. What was also found to play an important part was that students wanted to have a more people-orientated major. Even though it was in [6] the third most important factor for not choosing CS for both men and women, the proportion of women that felt this way was significantly larger than the proportion of men. Therefore, if we want to attain more women (and men) in computing science, it seems we have to do something about the image of CS. After all, computer scientists do not sit behind a computer all day, and there is a lot of people interaction.

Stereotypes

In [8], researchers found four stereotypes students in introductory CS courses at two universities ascribed to computer scientists: singularly focused, asocial, competitive and male. Some of these show overlap with the aforementioned stereotypes, but there are also new ones.

When describing singularly focused, students often state they see or hear that people barely sleep and sit behind the computer all day. It is found unappealing by some of the interviewed students, as they think CS entails doing the same thing the whole day. For asocial, the students state that they see people working alone mostly. Or they find that the people in their CS class are not very social or chatty. They are also be described as introverts by the students. This is also perceived as off-putting by students that do not identify as an introvert. One girl gives this as the reason that she chose another major. One of the girls states: "I don't know how much I would love working with computers exclusively or computers and a small group of people for a job. I would rather be working with more people rather than computers." However, the asocial stereotype is not universally discouraging. There were also girls stating that they preferred to work alone from time to time.

The competitive stereotype consists of two parts. One is where the field is perceived competitive as admission rates to a lot of American universities are low. This part of competitive, however, is less relevant in The Netherlands as our university system is different and competition at admission is often non-existent. The other part can be interpreted as 'lack of collaboration'. Sadly, the research only gives examples on how the first part of competitive stereotype discouraged students, and not the second.

The male stereotype is founded by there being more men than women in the courses the students followed. Also, the perception is that guys get better grades, and about 80% of the teaching assistants was male as well. It is definitely considered off putting by some of the interviewed girls. However, for some girls it is not that they find it problematic on its own, but more how other people view CS and the stereotype: "I'm not a fan of the stereotypes that people make about women in CS [...] I mean every single person I have told that I am trying to major in CS has made some kind of comment about the way that they see me, and it kind of puts me off a little bit. (laughs)".

Drawing computer scientists

Research has also focused on locating when ideas about what is masculine or feminine come to existence. This turns out to be at a really young age. Researchers in [9] looked at what image American fourth-graders (age 8, 9) have of computer scientists. In order to do this, they told the children to draw an image of a computer scientist working and to give a small description. The children had to so twice; once before a couple of computer science classes, and once after. What the researchers then did, was look at the differences in perception the students had before and after the course. As it turns out, most of the children drew male (71%) computer scientists, even though the pool of children consisted of roughly equal amount of girls and boys. What I find hopeful about this particular research is that after the courses, 7% of the students changed from drawing a male to a female (all of which were

female students). The researchers hypothesize that this may have to do with the teacher being female and thus functioning as a role model. This copying of who is in front of the class is also seen in an increase in drawings of bald computer scientists or computer scientists with glasses. The teacher showed some videos during class of bald computer scientists or computer scientists wearing glasses. This research shows how important it is for children to have both male and female (and people of other minorities) in front of the class. Children are really susceptible to these things, which makes it a great opportunity to change the way the field is viewed. However, it is not going to help my friend's nephews, of course.

Experience

Another important factor in women not choosing CS is the idea that they do not know enough about computers. At least in my high school, you had the kid who hacked the school system (and got detention for it), and the kid who made their own website. And you also had me, the girl who never programmed a line in her life before and for which Python was just a type of snake. It was discouraging for me to study computing science.

This anecdote of mine is similar to stories that researchers have found in a lot of women considering to study or studying CS. [1] has a lot of similar stories. But also [8] mentions one, when a girl explains how a seminar helped her reject the stereotype that it is important to know a lot of programming already and do it all day, the whole day: "This is where the seminar came in, at first I thought that wow. CS really isn't for me because all the kids that are in my [CS1] they have been programming since they were 7, they have programmed all of their lives. And like, they even do it as a hobby. And I mean I find CS fun, but I don't do it on the weekends you know. And that is o.k. And when I hit the seminar that was what I was afraid of going into CS, that I was competing against all of these people who programmed as a hobby you know. But the seminar, [the leader] showed us that there are a lot of people who like CS, but they don't do it 24 hours, you know. And they do other things and they are successful at it. It is o.k. to have other interests, and that is often a bonus to have other interests, because it opens your eyes to different things."

Societal benefit

In [1], another important aspect of CS (or rather, an aspect that CS is perceived to be lacking) is mentioned. Women seem to find it more important than men that there is societal benefit from the study they do. In [6] it was found that women mostly consider CS to use it in another field. Therefore, it is good to make clear to prospective students that CS can be used for a lot of different things, also to make the world a better place.

Media

Last but not least, there is one more piece of research I want to discuss, that shows how important the perception of the field is to women, compared to men. In [10], the researchers let undergraduate students read fabricated news paper articles where computer scientists were either described as fitting with the current stereotype or

not fitting with the stereotype. Women that read the articles where computer scientists do not fit the stereotype expressed more interest in studying computing science than the women that read that computer scientists fit the stereotype. However, no such difference was found among men. This gives hope that if the image changes, women will become more interested in the field.

Conclusion

In the end, it seems like the lack of women in CS is mostly due to the perception of the field. There is at least no evidence that women are not as good in CS as men, and it is also not an innate thing to like CS more (as is shown by the Malaysia case). It seems women are more sensitive to the perception that people have of the field than men are. However, it is hopeful to see that when confronted with that the stereotypes might not be true, women seem to adept and show more interest.

To return to the question at hand, it seems there are several things that one should make clear to a woman that might be a good computer scientist, but does not know it yet:

- CS is not sitting behind your computer all day
- It is okay if you have no previous programming experience
- CS is often done in groups and in collaboration
- CS can help in a lot of other fields, and even make the world a better place

In the end, my friend will go tell his nieces about the Papua project some of our mutual friends did. They made an app for a group project which will now be used to teach children in Papua Indonesian in the hopes to give them access to higher education. This example of a project shows both collaboration and the chance to make the world a slightly better place. Also, on the team were people that had not programmed before starting with the study. Now let's hope it actually works.

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