ABSTRACT

Women are severely underrepresented in the field of computer science. Already in school gender differences in CS, especially in programming, are observable. To face this, we surveyed 63 computer science teachers on their experiences regarding these differences between female and male students. The results of the survey were matched with findings from recent literature. We identified that teachers have only a limited perspective on the influences of gender on programming. Based on this result we are planning an intervention for computer science teachers.

CCS Concepts

• Social and professional topics → Gender; • Applied computing → Education;

Keywords

Gender, Motivation, Computer Science Education

1. INTRODUCTION

In almost all western countries women are severely underrepresented in computer science [4]. Only 20% of the persons at the most CS departments are female [6].

The reasons for the lack of female students are various. Amongst others, computer science is stereotyped as male-dominated [5]. Clearly, if we want to change this situation, we need to act at an early stage in the students’ lives. This means that CS teachers have to be aware of the situation and the recent findings of research concerning gender differences.

The focus of our research are the gender differences in programming. Specifically, what we can learn from prior research and how the differences arise in the first place. As a first step, we focused on a literature review of gender differences inside and outside of CS. The research question is:

How do CS teachers perceive gender differences in their classes concerning programming and how does this correspond to literature findings?

To face this question we studied relevant literature about gender differences in computer science and especially in programming. Findings are outlined in section 2. We found out that there are several key differences between girls and boys. Afterwards we conducted a study with computer science teachers. We asked them about their perception of the gender differences and the potential reasons for these differences. In this paper we want to present our findings from the survey.

2. GENDER DIFFERENCES IN CS

Several researches in the field of gender differences in CS have been published over the last years. Clearly, in Europe and the United States there are gender differences in computer science [4]. The number of boys choosing CS is much higher and in school they have often better results than their female counterparts. One of the reasons for this are the stereotypes that are connected to this subject.

Furthermore there still exists the role model of the typical male computer scientist, which steadily persists over time. While there are many male computer scientists and male computer science teachers, there are almost no role models for girls in this area [5].

When students have to decide what they want to choose as major, boys select CS often due to their interest whereas girls choose computer science due to the future prospects. Apart from the fact that boys are usually more interested in CS, they also have more prior knowledge. In contrast, girls are less self-confident in this area. They moreover tend to attribute their successes in computer science to luck and their failures to the lack of ability [5].

The learning process is influenced by different aspects. For example emotions affect the students during this process. In [7] Um et al. showed that positive emotions during the learning process with digital media affects the performance of learning. Additionally, Giannakos et al. found in [3] that happiness has a positive and anxiety a negative influence on the learning process and the motivation of girls.

Furthermore girls are inherently more emphatic than boys. The communication with others is a very important part of their lives [1], so it stands to reason that the communication with others also affects learning processes for girls.

In [2] Denner et al. show that girls benefit from collaboration. In particular, girls who worked together in a pair programming team as driver and navigator performed much better in the tests than a control group. They learned that computer science needs effective communication and collaboration, in spite of their previous stereotype of CS.
3. STUDY

3.1 Methodology

The observations of gender differences perceived by teachers were gathered in the form of interviews as well as a questionnaire. We invited 185 Bavarian CS teachers (49 women and 136 men) to participate in a teachers’ advanced training at our university. Six of the respondents (one woman) have been invited to do short interviews with us, the others received a questionnaire. The main question was:

What are the differences between girls and boys concerning programming?

In the end, 63 responses were handed in from which 57 contained an answer to our question (14 from women). In the interviews, the same question was used as in the questionnaire. For the analysis, the interviews were recorded and transcribed. Then, the transcripts were analyzed together with the surveys.

In a first step, the interviews and the responses of the survey were divided into sentences. These sentences were rewritten in an abstract way and assigned to appropriate categories. This was done independently by two researchers. The resulting category system was then merged by a third person. Afterwards the final categories were used by the first two persons who both coded the entire data set again. This was the basis for the investigation of an intercoder agreement, where no significant differences were found.

3.2 Results

The analysis of the responses led to a category system with the following 14 categories: structuredness, self-confidence, scientific curiosity, no differences, results, interests, learning receptivity, accuracy, previous knowledge, perseverance, creativity, frustration, teamwork and evolution.

<table>
<thead>
<tr>
<th>category</th>
<th>sample</th>
<th>abs. freq.</th>
</tr>
</thead>
<tbody>
<tr>
<td>structuredness</td>
<td>“Boys just start working, girls think about it first”</td>
<td>28</td>
</tr>
<tr>
<td>self-confidence</td>
<td>“and because there are some times a few girls who do not dare to”</td>
<td>19</td>
</tr>
<tr>
<td>scientific curiosity</td>
<td>“Boys want to try more, test, find things out”</td>
<td>18</td>
</tr>
</tbody>
</table>

Almost one fifth (19%) of all investigated teachers are not aware of any gender differences in programming. Additionally, differences in results, interests, and learning receptivity were mentioned in more than 14%. Since we were interested in a category system of the perceived gender differences, we had to find some measure of “commonness”.

We looked for a reasonable “cutoff-point” based on the frequencies. The first obvious gap occurs between scientific curiosity and no differences. So the three categories above this point can serve as the categories of perceived differences (see Table 1). The second column of the table shows an exemplary quote that clarifies the meaning of the category. Furthermore, the absolute frequencies of the appearance of the category in the documents are shown in column three.

4. CONCLUSION AND FUTURE WORK

Concerning the teachers’ perception, it is interesting that a high number of participants do not perceive any differences at all. The three resulting categories that we take as “common enough” are all related to the personality and the working methods of the students: According to the teachers, girls show a more structured approach, lack of curiosity in programming, and are less self-confident about their abilities. All other categories except for no differences and evolution also fit this major distinction.

Some of the statements from the teachers are similar to those from the literature, for example that girls have less self-confidence in computer science, especially in programming. From the literature we know that girls benefit from conversation, collaboration and positive emotions. The surveyed teachers, however, placed their emphasis on different aspects. Some of them even did not recognize any difference between girls and boys.

Our next step will be a categorization of the literature to get a better understanding of the problems and reasons of gender differences in programming. Furthermore we are planning follow-up studies. On the one hand, we want to survey computer science teachers with specific questions that we derive from this categorization of literature. On the other hand, we want to know how the female and male students experience their own CS classes and aspects of gender.

Based on the category system and the results of the studies we want to create an intervention for computer science teachers. It will explicitly focus on the aspects of emotions as well as collaboration and communication which are missing or are not prominent in the teachers’ perception so far.

5. REFERENCES