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Computer science club for girls and boys – a survey study on gender differences

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ABSTRACT

Background and context: This study investigates differences in views of girl and boy members of a CS club.

Objective:Understanding differences in the views of girls and boys regarding perceived parental attitudes and values, social support, appreciation of CS, and engagement in science and CS. Understanding differences in girls' and boys' view of CS, and future study and work aspirations related to science/CS.M

Method: A survey was distributed to all members of a CS club. 115 boys and 39 girls aged 9–16 completed the survey, yielding a response rate of 16.8%.

Findings: Similar parental support was perceived by both genders, although girls are less likely to appreciate CS and to aspire to work or study CS. Girls tend to primarily talk to family about CS and science. Girls and boys have a similar perception of CS, but their motivation for wanting to work with CS varied.

Implications:Having support, a broad understanding of CS, and a personal interest are critical aspects when it comes to girls' participation in CS, but these are insufficient in making girls aspire to work or study CS. Educators need to reflect on other aspects of CS education that can promote girls' aspiration in CS.

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Computing outreach; gender; children; interest in STEM

1. Introduction

In recent years, an increasing number of children in Sweden and in the Western world are participating in different computing outreach activities such as computer clubs and computing summer camps (McGill et al., 2015). These outreach efforts have a wide-range of motivations for their existence, from securing the future need of more computer engineers to increasing the children's general knowledge of computing. Most outreach efforts also have a social-justice motivation such as combating computing stereotypes and broadening participation through gender or ethnic diversity. In terms of gender representation, the need for outreach programs is evident when looking at the statistical trends provided by the Swedish government. Statistics from the Swedish government show that 89% of graduates with engineering degrees in computing are men (Universitetskanslerämbetet, 2018).

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The lack of gender diversity in computer science (CS) is not unique to Sweden and is consistent with most Western countries. In England, a comparable westernized democracy, the department of education statistics (Department for Education, 2018) shows that girls now comprise less than a tenth of CS students. In Finland, just like in Sweden, fewer than 25% of STEM graduates are women (Stoet & Geary, 2018). In the US, only 27% of the students taking advanced placement CS exams are female (AP College Board, 2018) and only 18% of CS degrees are awarded to women (Code.org, 2017), although this number is slowly growing.

These statistics help us see the need for outreach efforts targeting girls' engagement in CS. Equally important, however, is the need to understand the views of girls and boys who are seemingly interested in CS and are members of a CS club, and there are few studies on differences in children's perceptions related to CS and natural science and technology (henceforth "science" in short) with a focus on gender differences. The context of this study is especially interesting as well since the CS club investigated was the first of its kind in Sweden, and hence, attracted many children who already were interested in CS. Furthermore, the initial advertisement for the summer camp was directed towards the sponsoring companies of the CS club (mainly technology companies), which in turn means that many of the children who participated in the summer camp had a parent who worked with CS. Previous research studies (see e.g., Alshahrani et al., 2018; Jane. & Fisher, 2002) have shown that the career and interests of parents can play an essential role in a child's development of interest in CS. A study by Jane. and Fisher (2002) found that children with parents in technical occupations not only pick up technical language and concepts around the dinner table, but grow up to be more interested in CS, as they have more experience with it. In light of this, we believe that many of the children's parents value science and CS-related skills and knowledge, and the first research question of this study (see below) is to confirm this. With this unique context in mind, where the children's interest and family support are somewhat comparable between the children, it is particularly interesting to investigate whether there are gender differences relating to various aspects. In our study we address the following overarching research question: **What are the views of the girl and boy members of a computing club related to science and computer science?** This overarching research question is further divided into five sub-questions.

What are the girls' and boys' views regarding:

(1) their parents' attitudes and values of science and CS?
(2) their appreciation of CS and their engagement in science and CS?
(3) social support in their interest in science and CS?
(4) the term *computer science*?
(5) their future study and work aspirations related to science and CS?

2. The outreach activity case – the computer science club

In 2016, a Swedish non-profit organization founded the first CS club of its kind in Sweden with the goal of introducing children to CS through digital creation. The club's pilot activity was a computing summer camp for elementary and secondary school children. The computing summer camp was the first of its kind in Sweden and once the summer camp ended the CS club continued their outreach activities through meetups (more detail below). The pilot summer camp lasted for six weeks, and each week the camp hosted 48 new participants. Of the 288 participants, 54% were boys and 46% were girls. The organizers of the summer camp reserved half of the available spots for girls, as they thought it was pertinent that the camp was gender-balanced (Vrieler et al., 2017). Much effort was also put in place to recruit girls, and the efforts bear fruits as can be seen by the percentage of girl and boy participants. The age of the children ranged from 11–16 with the majority of the children being 13–14 years old. Most of the children had tried programming before, although the skills varied widely. According to the instructors, the children signed up for the camp because they were encouraged by their parents (many of whom worked in the CS industry) and/or because they had an interest in digital creation (Vrieler et al., 2017).

The focus of the summer camp was on game programming using both visual and text-based programming languages. The camp was organized into five tracks: 1) Maker-space 2) Scratch-studio 3) Game-studio 4) 3D-studio 5) App-studio. The children had to choose one of the five learning tracks prior to coming to the camp. The first and second learning tracks required no programming skills and had a more versatile learning content. The first and the second tracks also had the least focus on game programming, as compared to the other tracks. According to the instructors, the first and second tracks mainly attracted younger children. The advantage of the diverse learning content in the first and second track is that it displays the diversity of CS, and this can in turn attract a diversity of students (Vrieler et al., 2017). Tracks three, four, and five had a focus on game programming using different text-based programming languages and required that the children had some experience in programming. The focus on using games as a context to learn programming was motivated by the instructors as a medium that the children could relate to, and their previous experience has shown that the use of graphics motivates children.

There were an equal number of male and female camp instructors, and this was a conscious choice made by the organizers in order to fight the stereotype of CS being a male-dominated field. The instructors were responsible for developing the learning content but had no or little formal experiences in teaching. The instructors were either engineering students enrolled at a technical university or were experienced programmers. A day at the summer camp started with a three-hour-long workshop in the morning followed by a three-hour-long lunch break. The second workshop session began after lunch and also lasted for three hours. The evenings were free for different indoor and outdoor activities depending on what the children were interested in and wanted to do. The authors perceive most of the organized evening activities to be non-gendered. At the end of the week the children showcased what they have created to the other children and to their parents.

Besides the summer camp, the CS club also arranged bi-weekly meetups where children (ages 9–16) can continue learning and developing their CS skills with the help of tutors. A majority of the learning content involved programming different types of games and graphics, as well as more hands-on digital creation (such as robotics). According to the organizers, the summer camp, as well as the meet-ups, had been well received by the children, and as a result, the CS club gained many new members. One of the CS club's main aims is to increase the number of girls in CS by sparking their interest in digital creation. It is well documented that early familiarization with computing can determine a young person's future engagement (Banks-hunt et al., 2016; Odun-Ayo & Obafemi-Ajayi, 2017), but is exposure enough to make a similar impact on girls and boys?

3. Related work

3.1. Parental attitudes, values, and support, and their impact on girls' and boys' ability perception and interest in CS

The first context in which children gain computer experiences is often through their family, and the values and expectations that the family exert have shown to affect them in different ways. Parents' expectations for their daughters and sons materialize in the ways they treat their children and the opportunities they provide for them. For example, research studies found that fathers use cognitively harder words with boys, and parents tend to assume that science is easier for their sons than their daughters (Bhanot & Jovanovic, 2009; Tenenbaum & Leaper, 2003). Parents also tend to give their sons more technical toys, and give them access to computers at an early age as part of an assumption that their sons have greater computing interests than their daughters (Jane. & Fisher, 2002). It is not surprising that parents' beliefs about their children's ability and their behaviour towards them shape their children's achievement, aspirations, interests, as well as study and career choice.

Several studies have also noted that families where traditional gender values are strong tend to raise girls and boys according to persisting cultural stereotypes (Chhin et al., 2008; Denner, 2011; Stanko & Zhirosh, 2017). This means, for example, that subjects that are typically male-dominated, such as engineering and computer science, are not actively promoted to girls by their parents. Even though some parents try to move away from gender stereotypes, studies show that it is not always easy for parents to support one's child to go against the norm: "*It is genuinely difficult to make one's child an exception to what seems to be a rule. Even if we as parents wanted to ensure that our daughter, early in her learning process, had exposure to the exciting possibilities computing creates, we were originally hesitant for her to gain these experiences in an all-male environment*" (Topi, 2015). If the traditional stereotypes of what girls can, and suppose to do, are not rejected by the girls later on, the more likely it is that girls will grow up to have lower expectations for success in CS and will fail to see the relevance of CS in their life (Denner, 2011).

Prior studies have noted the importance of parental support in the development of children's interest in CS and in science in general (Alshahrani et al., 2018; Kekelis et al., 2005; Wang et al., 2015). A study by Stanko and Zhirosh (2017, p. 92) showed that students who choose CS as a field of study often have a family that can be characterized by *"[the] ability to notice their child's interests and readiness to support a variety of interests, including interest in STEM, and IT in particular*", and this is true for both girls and boys. Recent studies have also found that parental support does not necessarily have to involve awareness of CS education and careers, nor possessing skills and expertise related to CS, but rather parental support is about encouraging children's emerging interest in CS (Stanko & Zhirosh, 2017; Wang et al., 2015). The role of parents' "emotional support" (where parents have high expectations and encouragement) has also been discussed in Denner (2011) and (Denner, 2009). There is evidence that the role of emotional support from parents is particularly important for girls (Wang et al., 2015), not because it has an immediate effect on girls' interest in CS, but rather, the support mediates the relevance of computing (Denner, 2011).

Several lines of evidence suggest that parents tend to overestimate their son's ability in science and underestimate their daughter's ability in science, which in turn affects boys' and girls' perception of how capable they are in science (Bhanot & Jovanovic, 2009). Children are early aware of their parents' belief and expectations and an underestimation of girls' abilities could explain the low number of women in CS (Chhin et al., 2008). Tenenbaum and Leaper (2003) found that parent's beliefs about how difficult and interesting their children perceived science significantly affected their children's interest and self-efficacy. Self-efficacy and confidence is a key factor for both genders in choosing CS (Wang et al., 2015). Many studies, however, found that female students struggle with lower self-confidence, and this affects their ability to develop a computing identity and a sense of belonging, which in turn discourage them to pursue a career in CS (Dempsey et al., 2015; Wang et al., 2015).

Research has also looked into the socio-economic status of the parents, and here research has found that parents coming from lower socioeconomic groups were more prominent in their gendering of computing (Shashaani, 1994). Specifically, lower levels of parent education predict higher gender-role stereotypes and practices (Eccles, 2005). In addition, maternal occupational level and father's education and involvement have a strong bearing on their children's computing practices and ultimately their choice of computing careers (Adya & Kaiser, 2005; Shashaani, 1994). However, a study by Perera (2014) shows that children from lower socioeconomic groups can benefit equally from parents' positive attitudes towards science as do children from higher socioeconomic groups.

Although many studies found that children's reported interest, confidence, and values are significantly related to their parents' beliefs and encouragement (Adya & Kaiser, 2005; Bhanot & Jovanovic, 2009; Shashaani, 1994), some studies found that children's perceptions of their parents' values in the STEM domain can be inaccurate of the parents' actual values (Gniewosz & Noack, 2012; Šimunović et al., 2018). Gniewosz and Noack (2012) explained that this could be due to children extending their own perceptions of STEM values when interpreting the values of their parents. More specifically, Gniewosz and Noack (2012) found that if both the parents' values are congruent, parent-to-child value transmission will likely also increase. Nevertheless, parents' beliefs, conscious or not, appears to the child both in subtle and overt ways, thus, one can say that parents act as "interpreters of reality" for their children (Šimunović & Babarović, 2020).

Since parental beliefs and attitudes towards CS and education in general have been proven to impact children's beliefs, values, aspirations and interests, the first sub-question of this study assessed whether there are gender differences in how the children perceived parental attitudes and values. Since the children were recruited through parents who mainly worked in tech companies, we assume the children (of both gender) perceive their parents to have a positive attitude towards natural science and CS, and to expect them to attend higher education.

3.2. The role of social support in girls' and boys' participation in CS

Children are influenced by the people in their social surrounding. Social influences from, for example, peers, teachers, parents, media and extended family members can impact children's perception of CS. A study by McLachlan et al. (2010) found no significant difference between genders in terms of personal influences. Although females were slightly more influenced by their parents than males, and males were slightly more influenced by their peers when making decisions on which CS course to study (McLachlan et al., 2010). A study by A. J. Lakanen and Isomöttönen (2018) found that the challenges for the students who wish to maintain their interest in CS include the lack of like-minded peers or mentors, and timely support when faced with technical or practical issues.

Other studies have found that second to family, peer influence and encouragement play a major role in girls' and women's CS participation (Denner, 2011; Tillberg & Cohoon, 2005). Data from several studies identified encouragement from non-family members to be almost as important as family support, and contributed significantly more to women's decision to pursue a CS-related degree than to men (Alshahrani et al., 2018; Wang et al., 2015). Since boys are often assumed to be more interested and skilled in CS (Jane. & Fisher, 2002), they also naturally get more encouragement from people around them. Further, given that more males choose to study CS at university (Universitetskanslerämbetet, 2018), it is reasonable to assume that males', more so than females, see CS as an appropriate and attainable career.

A recent report by Plan International (2019) summarizes the barriers to girls in tech by interviewing subject experts in Scandinavia. The authors of the report found that the low number of girls participating in technology classes left girls feeling lonely and question whether they belong. When girls go against the norm and decide to study CS, they also have to overcome "stereotype threat" (Plan International, 2019). In other words, they have to confront the fear of confirming the negative stereotypes that exist about girls in tech, such as girls not being as technically competent as boys (Tillberg & Cohoon, 2005). Since stereotypes are powerful influencers of behaviours (Beyer, 2014), increasing the number and visibility of women and girls in CS-related activities could lessen the stereotype view of computing being a masculine domain.

Previous research has shown that peer social networks are important for both girls and boys, although boys tend to have larger networks of tech-savvy friends than girls (Goode et al., 2008). Peer support is particularly important for girls for several reasons, including helping girls overcome social isolation in a male-dominated CS classroom, extending their CS-related knowledge, and aiding them in seeing various possibilities within the CS field (Goode et al., 2008). All of this combined will eventually open doors for girls to the world of CS and help them persist in their studies (Barker et al., 2009). Another study by McGrath Cohoon (2008) also found that peer support improves women's (and men's) retention in computer science studies.

A study by DuBow et al. (2016) found that community support, from e.g., home or school, helped girls develop a computing identity. Support from a community can also help young women to overcome and navigate through barriers, as well as connect them with various opportunities (DuBow et al., 2016). Community support through school and teachers is important for girls and boys. There is, however, evidence that personal encouragement from teachers benefits females more than males (Tillberg & Cohoon, 2005). Encouragement from teachers has been found effective in supporting and maintaining girls' interest in CS (Alshahrani et al., 2018; Tillberg & Cohoon, 2005).

Community support can also be accessed through role models who can show girls how CS can fit into their interests, as well as study/career plans (DuBow et al., 2016). In the absence of role models research shows that peer support becomes critical for girls because youth tend to consider their peers as guide (Cozza, 2011). Support in the form of role models has been discussed by several studies (see e.g., Barker & Aspray, 2006;

Beyer, 2014; Cheryan, Drury, et al., 2013; Jane. & Fisher, 2002; McGrath Cohoon & Aspray, 2008). A study by Stout (Stout et al., 2011) found an increase in female students' self-efficacy and subjective identification with STEM when female students had access to female role models (experts). There is also evidence that the impact of same-sex role models might be the greatest in classes where there are few women/men (McGrath Cohoon & Aspray, 2008).

Based on the above research about the importance of social support for girls' and boys' participation in CS, a sub-question related to social support was included.

3.3. Girls' and boys' CS study and career aspirations

It has been demonstrated that children, as early as middle school, decide what school subjects they like and what subjects they are good at (Fouad, 1995; Jane. & Fisher, 2002). A study by Master et al. (2017) showed that girls, as young as 6 years, hold cultural stereotypes of computing as a masculine field. This, in turn, influences their decision about what to study later on. Many research studies suggest early familiarization with computing-related activities in order to increase the number of girls in CS-related disciplines (Alshahrani et al., 2018; Banks-hunt et al., 2016 ; Jane. & Fisher, 2002; Odun-Ayo & Obafemi-Ajayi, 2017; Wang et al., 2015). Since boys usually have more experience with computing upon entering university (Beyer, 2014), teaching CS concepts and ways of thinking to girls earlier could influence their self-efficacy levels (Alshahrani et al., 2018).

According to Farmer (as cited in Tillberg & Cohoon, 2005) students select their field of study that matches with their ability, interest, expectations of success, and the value they place on completing the degree in that major. Unfortunately, young people's interest in technology in Sweden has been declining (Skolverket, 2016), which predicts a persisting lack of future IT competences. According to The Swedish Schools Inspectorate (Skolinspektionen, 2014) fifth-grade girls and boys find technology equally interesting, important, and fun, but by the time they reach ninth-grade girls' interest in technology drops dramatically. In grade nine, 70% of the boys found technology interesting, important, and fun, in contrast to only 37% of the girls (Skolinspektionen, 2014). One can only speculate the complexity of reasons for the decline in technology interest among girls, although there is evidence that girls' disinterest in technology stems from poor pedagogy in technology education, and a disconnect between the technical content being taught and real-word problems (Carter, 2006; Jane. & Fisher, 2002). Research suggest that contextualizing computing education could increase student retention in CS-related studies and was perceived to be more fun by the students irrespective of gender (Guzdial, 2015).

A U.S study by Guzdial et al. (2012) evaluated the impact of a state-wide intervention to improve computing education across a U.S state. The study involved over 1400 students and 19 higher education institutions. The results of the study showed that females are more likely than males to choose computing as their major/minor because of their interest in helping society or people. Male respondents were more likely to choose computing as their major/minor because of their interest in computer games and programming, as well as solving problems with computing. Similar findings were also reported in other studies (Carter, 2006; Tillberg & Cohoon, 2005). Exposing students to CS content through a variety of non-traditional computing subjects can increase student interest and help them to think more positively about CS

(Doerschuk et al., 2010). According to Guzdial et al. (2012) the relationship between computing assignments and prosocial interests and career goals is particularly important and needs to be enhanced in all aspects of CS education in order to improve the outcomes for females.

Considering prior research on the impact of personal values and early exposure to CS on children's choice of future study and career aspirations, questions related to children's future study and career plans were included.

3.4. Girls' and boys' perception of CS

Research has shown that children generally have a gendered view of science and scientists. Studies have revealed that American children have connected masculinity with STEM for at least a decade (Miller et al., 2018). Mercier et al. (2006) performed an analysis of children's drawing of computer users and found that children held stereotypical view of computer users, which was illustrated as a man wearing glasses. The children also described "computer-type" people as people who "love computers, know a lot about computers, or spend a lot go time using computers" (Mercier et al., 2006, p. 343). Another study by Hansen et al. (2017) found that elementary school students perceive a computer scientist to be male, working alone, and only use computers as a tool. The children also selected "working", "coding" and "making" as the most common tasks for a computer scientist. A study by Yardi and Bruckman (2007) explored teenager's perception of computing, and found that teenagers often perceived little practical meaning or purpose with the CS profession. A stereotypical view of CS work was often mentioned by the teenagers, including "boring", "only for smart students", "asocial" and "tedious". When the teenagers were asked to define CS, many described it as a field consisting of people who are good at programming. Similar image of computer scientists and CS as a field was also found in other studies (Cheryan, Plaut, et al., 2013; Kinnunen et al., 2016).

A number of studies have looked at students' perception of CS. A study by Papastergiou (2008) found female high school students perceive CS as more hardware- and programming-oriented than boys do, whereas boys view it more human- and application-oriented than girls. The author suspects that girls' low involvement with computers contributed to their strong image of CS as machine-oriented, and this could, subsequently, discourage them from pursuing a CS-related study. There is evidence that the perception of CS being impersonal and antisocial conflicts more with female gender roles than of males (Markus & Kitayama, as cited in Beyer et al., 2003). Data from several studies suggest students end up not choosing CS education or career because they have an incorrect perception of what computer science entails and what computer scientists do (Carter, 2006). Understanding student perceptions of CS is critical because they are connected to personal values, which function as an internal compass when making academic or career-related decisions. A negative, incorrect, or lack of perception related to CS affects an individual's utility value and this, in turn, makes it harder for the individual to see the usefulness of CS (Wigfield & Eccles, 2000).

Based on previous research related to individuals' (inaccurate or absent of) perceptions of CS, which acts as a significant barrier to participation in the field, a sub-research question regarding the children's understanding of CS was included.

3.5. Girls' and boys' participation in CS outreach activities

CS outreach activities, such as computer summer camps and coding classes, are becoming increasingly popular in Sweden. These activities are often motivated by the need to ensure current and future need of CS-related competence, as well as to attract more girls into computing. There are many studies evaluating the short-term impact of outreach activities but there is a lack of studies that evaluate the long-term impact of these activities (Decker & McGill, 2017). Hence, it is difficult to conclude whether computing outreach activities are equally effective for both genders in terms of how they influence the children's future choices and interests.

Many CS outreach activities suffer from the inability to attract an equal number of girl and boy attendees (Isomöttönen Lakanen & Lappalainen, 2014; Topi, 2015). Participant statistics from CS summer workshops by A. J. Lakanen and Isomöttönen (2018) showed a reducing number of girls attending the workshops while the number of boys increased almost three-fold. A. J. Lakanen and Isomöttönen (2018) workshops started in 2009 with 38 boys and 7 girls, and ended in 2015 with 110 boys and 6 girls. Although the summer workshops were organized without consideration to gender, it is far from the only example of outreach activities that fail to address the gender imbalance (Plan International, 2019). Corneliussen and Prøitz (2016) study of Kids Code (an after-school CS club for kids in Norway) recommends all code clubs to have a targeting strategy to recruit girls.

While many outreach efforts have difficulties in recruiting girls to their events, many studies of outreach activities have reported a positive interest development for the children who participated (Adams, 2007; Craig & Horton, 2009; Giannakos et al., 2013). Although not longitudinal, evaluative studies of outreach efforts showed that positive changes in adolescents' confidence, attitudes, knowledge and perceptions of computing can occur in a short amount of time (Doerschuk et al., 2010; Harriger et al., 2012). When it comes to the kinds of outreach activities enjoyed by girls and boys, there is evidence that girls prefer group work or cooperative assignments rather than individual projects (Lang et al., 2015). Project-based learning with a focus on hands-on, practical, creative activities in combination with playfulness with technology have been found to be preferred by both genders (Corneliussen & Prøitz, 2016; Giannakos et al., 2013; Vrieler et al., 2017). Females seem, however, to have been significantly more inspired by television drama series with scientific elements in their choice of STEM study subject (Henriksen et al., 2015); hence, Henriksen et al. (2015) argued that it might be wise to include activities related to popular science also in outreach activities.

In the study by McGill et al. (2016), the authors designed the Effectiveness of Technology Outreach Survey to investigate whether the impact of outreach activities is similar for male and female participants' choice of college major. The results of this recollective study showed that outreach programs are not successful at engaging females with a limited interest in CS. The data showed that the outreach activities played a larger role in males' choices of major while this is not the case for the females. The results suggest that instead of broadening participation, the outreach programs are reaching those who are already interested in CS. Results from this study also showed that female participants who did not major in CS had a more negative perception of outreach activities than male participants who did not major in CS.

Several lines of evidence suggest that exposure to CS at young age is critical for females in their decision to pursue a CS-related degree (Guzdial et al., 2012; Kekelis et al., 2005; Plan International, 2019; Wang et al., 2015). It is, therefore, fair to believe that well-designed outreach events can provide girls with the necessary exposure. The children participants in this study are members of a CS club and assumed, therefore, to have been exposed to CS early. This makes the context interesting to study from a gender perspective, as it is reasonable to believe that the children have an existing interest in CS. A questionnaire item related to the children's interest in CS was included to confirm this.

4. Methods

A survey study was conducted to investigate the children's views on science and CS with regard to: (1) their parents' attitudes and values, (2) their appreciation of CS and engagement in science and CS, (3) their social support, (4) computer science and, (5) their future study and work aspirations. The survey was distributed to all 923 members of the CS club during December 2016 – April 2017, nine months after the club organized the pilot summer camp and approximately six months after the first meet-up. The number of respondents who completed the survey was 154, yielding a response rate of 16.8%. The questionnaire was distributed by the CS club to the children members' parents/guardian by email. Before the respondents answered the questionnaire they, and their parents, had to give consent by ticking a box at the end of the cover letter. Since this study does not collect any sensitive or personal information, ethical approval by the Ethics Review Authority is not required by Swedish law.

4.1. *The study instrument*

This study drew on items from the science capital questionnaire developed by Archer et al. (2015). It is important to note that this study does not attempt to emulate the study of Archer et al. (2015), which was to calculate students' science capital "score". This study poses very different research questions from those stated in Archer et al.'s study. Therefore, the results of this study cannot be compared to those of Archer et al.'s. Items from Archer et al.'s (2015) questionnaire was chosen because they suited the purpose to explain differential patterns of computer science aspiration, engagement, appreciation and educational participation among young people.

Modifications had to be made to the questionnaire items in order for them to fit the context of the study. The original questionnaire items in English were translated to Swedish and the word science was replaced with computer science in most questions. The word *science* has no Swedish equivalent and has been described as natural science, technology, and computer science. Natural science and technology are Swedish school subjects and can therefore be assumed to be familiar to the children. Computing was not included in the technology curriculum prior to this study and was thus mentioned separately. However, the word has no Swedish equivalent which is why the term computer science was chosen. The children's interpretation of computer science is more uncertain.

The items included in the questionnaire can be seen in Table 1. The items in the categories *view of CS, future CS work aspirations* and *appreciating CS* are connected to the children's personal values and motivation in relation to CS, therefore only the term *computer science* was used (see Table 1). On the other hand, the nature of the items in the categories: *Engagement in CS and science, parental attitudes and values*, and *future study and work aspirations* makes it necessary to use a broader terminology, so the combination of natural science, technology, and computer science was used.

The questionnaire comprised seven categories of questions. The fourth to seventh category emerged after factor analysis was performed (more detail under the section 4.2. Data Analysis). The majority of the questions appeared in the order of the categories outlined below. For an overview of the categories and the questions and response options related to each category, see Table 1.

4.2. Data analysis

The data collected through the single- and multiple-answer questions were analyzed by descriptive statistics (category one and two, see Table 1). Common factor analysis (principal axis factoring) was used to identify the underlying factor structure of the Likert-type questions (category four-seven, see Table 1). Factor analysis (FA) requires a minimum of five cases for each item (Tabachnick & Fidell, 2013), and this condition was met. The number of factors to be retained was guided by Kaiser's criterion (eigenvalues above 1) and inspection of the scree plot. The reliability of the subscales was assessed using Cronbach's alpha coefficients. The alpha coefficient for the subscales ranged from.601-.745 (see Table 2).

The alpha coefficient values in this study are lower than those reported in the study of Archer et al. (2015), and this is most likely due to the dissimilar sample and questionnaire items included in this study. It is well known that the reliability of a scale varies depending on the sample (Pallant, 2016). This study included responses from a wider age range of children (9–16-year old), while the study of Archer et al. (2015) included responses from children ages 11–15. The decision to include responses from a wider age range was justified by the desire to gain the broadest range of voices as possible. We are well aware that the differences in the children's cognitive development is large considering the age range included. In order to increase the response quality from the younger children, a few items from the original questionnaire were excluded to reduce the time and concentration needed to answer the survey. In addition, the translation of the questionnaire items was done carefully in order to reduce potential ambiguity. A shorter questionnaire in combination with clear wording of the questionnaire items have been found to improve the quality of responses from younger children (Borgers et al., 2000). All things considered, we wanted to explore if the alpha coefficient of the subscales could be improved by excluding the responses of the younger children, and thus narrowing the range of cognitive development. Hence, the responses from children ages 9 and 10 were dropped. A new round of reliability tests of the subscales using Cronbach's alpha showed that the alpha coefficient ranged from .517-.761 (see Table 2). The alpha values of parental attitudes and values and engagement in CS and science improved slightly while the alpha values of future CS work aspirations and appreciating CS *decreased*. The recommended alpha coefficient of a scale should be above .7, and considering that the alpha values did not improve for two of the subscales, one of which decreased considerably (appreciating CS) it was decided appropriate to retain the responses from the children ages 9 and 10.

Mann–Whitney U test was used to explore differences between boys and girls on various continuous dependent variables (e.g., appreciating CS, and the median number of options selected for the question "Why do want to work in natural science, technology, or CS in the future?"). Pallant (2016) recommends using Mann–Whitney U test when the sample size is small, when the data measured is of ordinal scale, and/or when the distribution of scores on the dependent variable is non-normal, which is the case of this study.

The data from the open-ended question: "What do you want to be when you grow up?" was grouped by the first author into two categories: 1) mentioning primarily work in computer science and engineering; 2) mentioning primarily work in other fields. The second author reviewed the analysis made by the first author in order to discuss possible ambiguities, and in this manner, consensus was reached. The categorized data were analyzed using a χ^2 test (Pearson's) for independence. The χ^2 -test was used to explore relationships between what the students mentioned they primarily wanted to work with and gender. A χ^2 -test was also performed to compare differences in gender proportion in terms of whom the respondents talked with about natural science, technology, or CS. In order to perform the analysis, the responses "friends" and "family" were combined and a χ^2 -test was performed to check differences in gender proportion. All χ^2 and Mann–Whitney U tests were checked for assumptions before being applied. All analyses were performed using SPSS version 25. The level of statistical significance was set at 0.05.

4.3. Sample

The survey was distributed to all parent members of the CS club in December 2016 and was open for participation during a period of four months. Since the respondents are children the survey request was sent to the parents so they could approve of participation, and if needed, aid the respondents when answering the survey. The sample was 154 members, 115 boys and 39 girls, aged 9–16 [mean (M) = 12.6, standard deviation (SD) = 1.5].

4.4. Reliability and validity

As the respondents were children, the questionnaire items were designed to be as straightforward and as clear as possible in order to avoid confusion. The two first authors translated the questionnaire items with careful consideration to the Swedish context. De Vaus (2014) recommends pretesting of the questionnaire before piloting it, as the questions that worked in the context of Archer et al.'s (2015) study might be inappropriate for this particular sample. Hence, the questionnaire was sent to the third researcher to test the questions for understanding and amendments were made accordingly. In addition, the questionnaire was distributed to two children respondents who answered the questionnaire while "thinking aloud" so the first author could take notes on potential misunderstanding or misinterpretation due to the phrasing of the questions. The items were then improved according to the feedback.

Some of the questions ask the respondents to imagine scenarios far in the future (e.g., question related to study and work aspirations), and this is especially true for the younger respondents. Although the respondents were given the option "don't know" or "other, please specify" the question itself might have caused the respondents to feel the need to satisfy the researchers by giving what is believed to be a correct answer. This could affect the reliability of the results.

Cronbach's alpha on subscales appreciating CS (.601) and engagement in CS and science (.646) was below .7, which is below the level considered acceptable by many authors (DeVellis, 2012; Pallant, 2016). Since the scale reliability is on the low side of acceptable, future work on the scale has to address this issue.

5. Results

5.1. Significant differences in future CS work aspirations, appreciating CS, and engagement in CS and science

The responses to the Likert-type questions belonging to the categories: parental attitudes and values, future CS work aspirations, appreciating CS, and engagement in CS and science were subjected to FA, to examine the underlying structure of the scale. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.745, which exceeded the recommended value of 0.6 (Pallant, 2016), and Bartlett's test of sphericity was statistically significant ($p = <0.001$). Four factors greater than 1 were extracted, explaining 13.5%, 13%, 9.3%, and 8.8% of the variance, respectively. The factors were assumed to not correlate, hence, varimax rotation was performed to aid in the interpretation of these factors. The rotated solution (see Table 3) explained a total of 44.6% of the variance.

In order to analyze the differences in views of the respondents with regards to their parents' attitudes and values, future CS aspiration, appreciating CS, and engagement in CS and science, a median score was calculated for each respondent corresponding to each of the four factors. Afterwards, for each factor, the medians of the scores were compared between gender groups through a Mann–Whitney U test. A Mann–Whitney U test revealed no statistically significant difference in the girls' and boys' view of their parents' attitudes and values, but statistically significant differences were found in the other three categories (future CS work aspirations, appreciating CS, and engagement in CS and science). Boys recorded a higher median score in all three categories. The results are presented in Table 4.

5.2. Significant difference in social support

Regarding engagement in CS and science, the respondents were asked whether they talked or chatted with someone about natural science, technology, or CS, or about things related to computers outside of school. Only eight boys (7%) and three girls (8%) never talked/chatted with anyone about natural science, technology, or CS, or about things related to computers. 76 respondents (53.2%) talked/chatted to friends. Among them, 62 were boys (53.9% of the boys) and 14 were girls (35.9% of the girls). 56 respondents (36.4%) talked to family. Among them, 36 were boys (31.3% of the boys) and 20 were girls (51.3% of the girls). Only three respondents (1.9%) talked to teachers. Among them, two were boys (1.7% of the boys) and one was girl (2.6% of the girls). Eight respondents (5.2%) talked to someone else. Among them, seven were boys (6.1% of the boys) and one was girl (2.6% of the girls). The eight respondents mentioned that they talked to someone online.

To check whether the proportion of boys that talked to friends or family were the same as the proportion of girls, a χ^2-test was performed. A χ^2-test showed a significant difference (1, N = 132) = 5.042, p = .025, phi = .2) in gender proportions in terms of whom the children talked to. As can be seen in Table 5, a majority of the boys talked primarily to friends while a majority of the girls talked primarily to family. Very few of the respondents talked to teachers or someone else about natural science, technology, or CS, or about things related to computers outside of school.

5.3. Similar view of CS

The responses to the multiple-answer question: "When you think of the word 'computer science' what comes into your mind?" provided a way to understand how the children perceived CS. The respondents were given fourteen different options (see Table 6), of which they could select multiple. If they did not associate CS with any of the fourteen options they could select "none" or "other, please specify". The ten "other" responses included computers (2); hacking (1); icons within CS, e.g., Alan Turing (1); machine learning and artificial intelligence (1); hexadecimal numbers (1); 3D-printing (1); YouTube (1); "patience is important" (1). The tenth "other" response was unfortunately unintelligible. The free text responses show that the options could be improved.

As can be seen in Table 6, both genders have a similar association to the word CS. The top three associations with CS for both boys and girls included "programming", "games, robot" and "binary notation". Slightly more girls associate CS with "games and robots". At the fourth place, one can detect the first difference in association. More girls selected "advancement, the future, better world" while more boys selected "ideas, invention, discover, research". Minor differences in association can also be found from place six and onward. Girls associate "vehicles" and "experiment, inquisitive, understanding" more with CS than "engineering", while this is not the case for boys. The median number of options selected was the same for both genders, meaning that girls and boys associate CS with similar number of things.

5.4. Significant difference in future work aspirations

The respondents were asked to give a free text answer to the question: "What do you want to be when you grow up?" Among the 90 children who were decided about what they wanted to do in the future, 70% mentioned a profession within the field of natural science, technology, and CS, and 30% mentioned a profession in other fields. Where the children mentioned several professions, the authors interpreted the profession that was mentioned first as their primary choice, and therefore, was coded accordingly. A χ^2-test showed a statistically significant difference in the proportion of boys and girls and occupational choice (1, N = 90) = 5.546, p = .019, phi = .2). Boys, more frequently than girls, stated an occupation within the field of natural science, technology, and CS as their primary choice.

The next question related to future work plans asked the respondents a similar question to the previous one: "Do you think you might want to work in natural science, technology, or computer science?" although this time the respondents had to select between the options yes/no/I don't know. The data analysis showed that 107 of the respondents (69.5%) want to work in natural science, technology, or CS in the future. Among them, 83 are boys (72.2% of the boys) and 24 are girls (61.5% of the girls). It was not possible to perform a χ^2-test to check for differences in gender proportions, as very few of the respondents (two boys or 1.7% of the boys and four girls or 10.3% of the girls) did not want to work with natural science, technology, or CS in the future. All six girls and boys selected "Just want to do something else" as the reason why they did not want to work with natural science, technology, or CS in the future. 30 boys (26.1% of the boys) and 11 girls (28.2% of the girls) did not yet know if they want to work in natural science, technology, or CS in the future. The similar percentages recorded for the free text question related to future work plans validate the coding process of the open-ended question.

A follow-up question asked the respondents why they want or do not want to work in natural science, technology, or CS in the future. The 107 respondents who were decided about working in natural science, technology, or CS were given twelve different options to answer why they wanted to do so (see Table 7). If the options were not satisfying they were able to select "I don't know" or "other, please specify". The median number of options selected was higher for girls than boys but this difference was not statistically significant.

As can be seen in Table 7, apart from the first option "interesting", boys and girls differ in opinions about why they want to work in natural science, technology, or CS in the future. This confirms our previous assumption that the children in this study have an existing interest in CS. For girls, the advantage of being able to select from many different types of jobs is considered more important than for boys (17.3% vs. 11.1%). A slightly higher percentage of boys selected "opportunities to design new technology", "opportunities to make exciting new discoveries" and "well paid" than girls. Merely 6.1% of the girls selected "personally satisfying" as the reason to work in natural science, technology, or CS, as compared to 13.1% of the boys. A higher percentage of girls included "opportunity to help others" and "good work/life balance" as reasons to work in natural science, technology, or CS. Although few of the boys selected "well respected/high status" or "secure" as reasons to work in natural science, technology, or CS, none of the girls did so. Of the six boys and girls who did not want to work with natural science, technology, or CS in the future, three boys and two girls selected "just want to do something else" as the reason. One boy selected "I don't know". No respondents mentioned other reasons why they do or do not want to work in natural science, technology, or CS, indicating that the options are to the respondents' satisfaction.

5.5. Future study aspirations

Finally, the respondents were asked about their study plans at upper secondary school (See Table 8). Of the 142 respondents who were decided about what they wanted to study, 69 respondents (49%) wanted to study a program that focuses on CS. A higher percentage of boys were sure about studying CS than girls. A similar percentage of girls and boys wanted to study a program that focuses on natural science and technology, or did not want to study a program that focuses on technical or natural science but did not mind taking a few natural- or computer science courses. A higher percentage of girls did not want to study anything related to natural science, technology, or CS, and did not yet know what they wanted to study at upper secondary school. The numbers show that a majority of the respondents (118 or 76.6%) want to study a program that focuses either on natural science and technology, or CS.

6. Discussion

6.1. No difference in perceived parental attitudes and values

No statistically significant difference was found between boys' and girls' perception of their parents' attitudes and values. In other words, the children in this study perceive similar positive parental attitudes and values towards science and CS. Almost all of the respondents selected "5: strongly agree" to the statement "One or both my parents expect me to go to university", confirming our assumption that the children perceive that their parents expect them to attend higher education. This finding can also be viewed as an indication of the parents' education level. The finding was expected, since the survey was administered to a specific group of children where many of the parents worked in technology companies, and hence can be assumed to have studied CS in higher education. The children's interest in science and CS, as found in this study, could be a result of the supportive parents. Prior research has been able to demonstrate that attentive and encouraging parents is a central factor in developing children's interest and participation in CS (Stanko & Zhirosh, 2017). It is now well established from a variety of studies that family influence is especially important in the development of girls' interest, values, and self-perception in CS, which ultimately can lead to girls choosing CS as their field of study and occupation (Adya & Kaiser, 2005; Alshahrani et al., 2018; Bhanot & Jovanovic, 2009; Kekelis et al., 2005; Shashaani, 1994; Wang et al., 2015). The result could also be viewed as parents' exhibiting non-traditional gender-values, where a typically male-dominated subject such as CS is not seen as an obstacle for their daughter's involvement. This, in turn, could indicate that the parents of the children in this study come from a higher socioeconomic group where gendering of computing is less prominent (Shashaani, 1994).

6.2. Difference in future work aspirations

Statistically significant differences were found in girls' and boys' future CS work aspirations. This means that boys see themselves working in the field of CS to a higher extent than girls. Also, boys stated an occupation within the field of science and CS as their primary choice of occupation more frequently than girls. This finding concurs with that of Beyer's (2014) who found that even though women viewed CS positively, women were hesitant towards studying more CS courses. This finding is surprising considering that a higher percentage of girls selected "interesting" when asked why they wanted to work with science and CS. A possible explanation for this might be that girls found other science subjects more interesting than CS, but since the question combined science with CS it was not possible for the respondents to be more specific in their answer.

Even though more girls than boys found natural science, technology, or CS interesting, fewer girls selected "personally satisfying" as the motivation for wanting to work in the field. Perhaps girls find science and CS interesting because they realize the relevance of the subjects and the career opportunities they provide. More girls, however, wanted a job in natural science or CS because it gives them the possibility to select from many different types of jobs in the future. This finding correlates with those of Papastergiou (2008) and Beyer (2014) who noted that girls' motivation to study CS is more extrinsic (enhanced employment opportunities) than intrinsic (personal interest). The finding is, however, inconsistent with those of Tillberg and Cohoon (2005) where both men and women placed a high value on the broad range of occupations a CS degree can offer. In the end, however, being able to select from many different types of jobs will most likely lead to personal satisfaction as well. A critical question, nonetheless, remains on how to develop young girls' intrinsic motivation to study CS. This is an important issue for future research. As educators, we need to make CS relevant for both girls and boys, hence, a good approach to achieving this could be to involve the children in the design of the CS curricula. The types of activities included in the curricula matters greatly when it comes to increasing diversity among the participants (McGill et al., 2016), and previous research has demonstrated that diversity in content also can help with retention problems (Guzdial, 2015).

Slightly more boys selected "opportunities to design new technology", "opportunities to make exciting new discoveries" and "well paid" as reasons why they wanted to work in natural science, technology, or CS in the future. This finding concurs with Papastergiou (2008, p. 601) who found that "boys have more positive perceptions of the IT profession, considering it more interesting, prestigious, creative, competitive, profitable and multifarious than girls do". However, the difference between the girls and boys were very small percentage-wise, and caution must be applied when interpreting this finding. No girls selected "well respected/high status" or "secure" as reasons to work in natural science, technology, or CS. This accords with the observations of Tillberg and Cohoon (2005), where only women in their study expressed discomfort with the perception that financial reward motivated their career choice. The reason why no girls selected "secure" could be due to its similarity with the option "Lots of different types of jobs available". Being able to select from many different types of jobs can lead to a feeling of security, as it makes it easier to find employment.

Previous research has shown that there is a disconnect between girls' prosocial interest and CS studies (Guzdial et al., 2012), and a study by McGill et al. (2016) found that outreach activities play a larger role in males' choices of major than females. McGill et al.'s (2016) data suggest that outreach programs are not successful at encouraging females with limited interest in computing, but benefitted only females who were already interested. It may be that outreach activities are catering more to boys' interests than to girls', and as a result, girls cannot see CS as "their" field, even though they have a positive view of it. Another possible reason for the difference in girls' and boys' future work aspirations could be that they have already decided what they want to do when they grow up. As mentioned in the literature review, children decide what subjects they like and what they are good at as early as middle school. Perhaps CS outreach activities reach the children too late, or are unsuccessful in making a significant impact on girls with limited interest. Whatever the reasons might be, more research is needed in order to understand why there is a difference between boys and girls.

6.3. Difference in appreciating CS and engagement in science and CS

The construct *appreciating CS* has to do with the ways the children perceive the value of CS knowledge in their life. The results of this study indicate that boys, more so than girls, find it important and useful to know a lot about CS, and believe CS knowledge is relevant for other young people as well. The girls in this study do not aspire to work with CS to the same extent as boys, and personal satisfaction was also not selected to the same extent when asked for reasons why they wanted to work in the field of science or CS. It is likely that girls do not appreciate CS to the same extent as boys because they do not aspire to work with CS, and doing CS does not satisfy them personally.

Boys were found to engage in science and CS through popular media to a significantly higher extent than girls. Prior studies have suggested that including popular science in CS learning activities could engage female students (Henriksen et al., 2015). However, the finding of this study speaks of the contrary. Since boys seem to be more familiar with science and CS in popular media, it may be that including these activities in the CS curricula could favour boys more than girls.

6.4. Difference in who girls and boys talk to about science and CS

Social support by key people has been found by several studies to be one of the determining factors for females to persist in CS (Alshahrani et al., 2018; Jane. & Fisher, 2002; Kekelis et al., 2005; Stanko & Zhirosh, 2017). The data in this study showed that boys tend to primarily talk to friends, and girls tend to primarily talk to family about natural science, technology, and CS. This result might be due to fact that there are fewer girls who participate in CS activities. Many studies have reported difficulties in recruiting girls to CS events (Isomöttönen Lakanen & Lappalainen, 2014; Topi, 2015). A study by Denner et al. (2014) found that females report significantly less encouragement from their peers to persist in CS. This might be due to external influences outside of the girls' direct social environment, for example, the media, where CS is being presented and communicated as a domain for men or nerds with little social competence. This finding is concerning considering that having like-minded peers is decisive to maintain interest in CS (A. J. Lakanen & Isomöttönen, 2018). Additionally, peer support and social influences were found to be one of the majoring factors attracting women to the CS major (Tillberg & Cohoon, 2005). Creating social networks for girls who are interested in CS is achievable. For example, collaborative learning environments and same-sex mentor support can lead to the development of peer networks, improved learning, and persistence in computing beyond introductory courses (Barker et al., 2009; Denner et al., 2015).

6.5. Similar perception of CS

The children in this study have a similar perception of CS. This finding is consistent with that of McGill et al. (2016). The girls and boys in this study associate CS with a similar number of things, and this could be the result of their early exposure to CS-related activities. The children also gave other responses beyond the multiple option responses. The finding suggests that both girls and boys have a wide perspective of what constitutes computing. This finding does not support those of Papastergiou (2008) who found that high school girls identify CS with traditional subjects, such as algorithms, more than boys do. Besides the differences in context, the respondents in this study are younger and have prior experience with CS, which makes them different from the respondents in Papastergiou's (2008) study. Another possible explanation for the differing findings is the emphasis of the CS club on digital creation using various tools, which enables the children to see a more diverse side of CS. It is likely that students who have little exposure to CS have a narrower view of what is included in CS, which could explain the dissimilar findings. It is disappointing that although the girls have as broad a view of CS as boys, they still cannot see CS as their field to the same extent as boys.

"Programming" was associated with CS by both genders to an equal extent, following "games, robot" and "binary notation". This finding contradicts the finding of Papastergiou (2008), who found that girls associate CS with programming more than boys do. As mentioned in the study's context description, both the summer camp and the meetup organized by the CS club have a focus on programming. It is possible that these top three associations with CS reflect the kinds of CS activities and knowledge that the children have been most involved with. Other studies of students' and children's perception of CS also found a strong association between CS and programming (Cheryan, Plaut, et al., 2013; Hansen et al., 2017; Kinnunen et al., 2016; Yardi & Bruckman, 2007). A potential problem with the strong focus on programming is that this setup has been found to attract more boys than girls. When male and female students were asked why they wanted to study CS, programming was more frequently mentioned by boys and prosocial reasons (e.g., contribute to society) were more frequently mentioned by girls (Carter, 2006; Guzdial, 2015; Guzdial et al., 2012; Tillberg & Cohoon, 2005).

A slightly higher percentage of girls associate CS with "advancement, the future, better world". Also, more girls selected "opportunity to help others" and "good work/life balance" as reasons to work in natural science, technology, or CS. This is in line with the findings of other studies, which found that females' intention with CS studies often stem from their interest in helping society or people (Guzdial et al., 2012; Jane. & Fisher, 2002). This "female interest" is consistent with how the female workforce is distributed in the Swedish society today, where the three most common occupations among women during the year 2017 are nurse, childcare worker and school teacher (Statiska, 2017). All three occupations can be characterized by its social and caring nature.

6.6. Girls' and boys' aspirations to study science and CS

A majority of the children were interested in studying a program in upper secondary school (gymnasium) that focuses either on natural science and technology or CS, or taking a few natural- or computer science courses. There are, however, more girls than boys who are undecided about what they want to study in upper secondary school. If these girls are given the opportunity to continuously participate in meaningful CS-related activities with a strong support structure in place, it is more likely that they, too, will choose to study a few courses related to CS or a program that focuses on CS. The children who are undecided create a window of opportunity to provide them with incentives to learn more about CS.

Data analysis showed that more boys than girls consider studying CS in upper secondary school. Although the difference between the girls and boys in this study is small, the data shows that outreach activities still have their work cut out for them when it comes to attracting girls to CS education. One way to attract more girls to CS studies is to communicate the value and application of CS in the real-world. Since CS works in the "background" a stronger connection between CS and real-world problems could be made more prominent. Meaningful assignments that immerse students in higher-order thinking tasks and interdisciplinary contexts have been found to help students see the relevance of CS (Goode et al., 2008). This is important because the perceived value of computing is one of the main motivations behind girls' choice of CS as their field of study (Denner, 2011; Jane. & Fisher, 2002). On the bright side, however, almost as many girls and boys consider studying natural science and technology, and a majority of the respondents are interested in studying a program that focuses either on natural science and technology or CS in upper secondary school.

7. Limitations

There are several limitations to this study. The response rate of the survey was low (16.8%). We suspect the low response rate is due in part to the length of the survey and in part to the fact that many members were not active members of the CS club. The questionnaire consisted of 24 different items, which we suspect was too long considering the age of the respondents. Another limitation of this study is the small sample size; particularly the number of girls was on the low side. Future work needs to address this issue.

Even though the survey was distributed to all members of the CS club, there is no guarantee that all of the respondents have participated in one of the activities provided by the club. This is due to the novelty of the activities and the timing of the survey. Nevertheless, the majority of the members became members after they have participated in one of the club's activities.

Because the request to participate in the questionnaire was distributed to the parents of the respondents, it is difficult to evaluate how the involvement of the parents affect the respondents' ability to honestly answer the questionnaire, especially regarding their parents' attitudes. This is especially true for the younger respondents where it might be more difficult to complete the survey without the aid from their parents. This, of course, affects the reliability of the results.

Another limitation of this study is the age range of the respondents. A few of the respondents were as young as nine and ten, and their cognitive ability to answer a questionnaire is different than that of a fifteen or a sixteen-year-old. In addition, it is harder for younger respondents to imagine scenarios far into the future, such as questions related to future study and work aspirations. This, in turn, affects the response quality of the questionnaire negatively.

Finally, the alpha coefficient values for two of the subscales were lower than the recommended alpha value of 0.7. The low alpha values indicate a weakness in terms of the subscales' internal consistency and this, in turn, affects the scale's reliability. Possible reasons why the alpha values were lower than expected could be because of the small sample size in combination with the number of questionnaire items and the way the questionnaire items were formulated. Future iteration of the survey needs to address the reliability issues.

8. Conclusions and recommendations

This study is unique in the sense that it explores gender differences in views among children with similar parental support and early interest in CS. The findings of this study offer valuable insights into the differences that exist between girls and boys with regards to perceived parents' attitudes and values, future CS work aspirations, social support, appreciation of CS, and engagement in science and CS. Also, the findings offer insights into the girls' and boys' view of CS, and future study and work aspirations related to science and CS. The results provide evidence to critically examine our CS outreach, as well as educational activities, to ensure that we are working and not counteracting our goals. Although the questionnaire suffered from some reliability issues, the findings from this study are still important, and offer the authors evidence on how to improve the questionnaire for future iteration.

Our findings suggest some potential implications for those engaged in developing CS education and outreach activities:

Having parental support, a broad understanding of CS, and a personal interest are critical aspects when it comes to girls' participation in CS-related activities, but these seem to be insufficient in making girls aspire to work or focus their study on CS. Educators need to reflect on other aspects of CS education that can promote girls' aspiration in CS – from the social environment in which the learning takes place to the learning content itself. One way to promote student participation is to know the students, understand their desires, and involve them in the development of the learning content.

A majority of children relate technical aspects with CS. Although programming is an important part of CS, a focus on programming and other technical content could translate into a disconnect between what girls expect to experience in a CS classroom and what they actually learn. Educators need to reflect on how to prioritize the problems students find meaningful and make sure to never lose sight of the context. Doing CS should not only be for the sake of programming but also for a higher personal goal.

Although a majority of the children planned to study a program or a few courses related to science or CS in upper secondary school, many boys and girls were still undecided. Educators should try to identify these students and give them the opportunity to gain more experiences in CS to further promote, encourage, and expose them to a broader range of CS related activities.

Lastly, educators need to think about ways to expand girls' peer support networks. Outreach initiatives for girls only are one way to approach the problem but we also need to build peer support networks for girls and provide role models (or mentors). Today's technology offers many digital channels where we can create and sustain communication between girls, as well as between role models and girls. One possible avenue forward for educators is to experiment and take advantage of different such technologies and strategies and evaluate what works in their context.

9. Future work

Although parental support and personal interests have been stated as critical for girls' participation in CS, the results of this study show that these critical factors were not enough. Future work will benefit from using qualitative methods to better understand why girls who are interested in CS and have the support from their parents still cannot see CS as their field of work or study, appreciate CS, or engage in CS and science to the same extent as boys.

The questionnaire used in this study could be improved for future studies, for example, by only including items related to computer science in order to eliminate potential confusion between *natural science and technology* and *computer science*. Doing so might also improve the reliability of the scale and increase the response rate. This study addresses an interesting and complex research area, and further research is needed to explore the differences in views and expectations of boys and girls who participate in outreach activities.

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Appendix

Table 1. Overview of the questionnaire.

Categories	Questions	Response options
Demographics	(1) Gender	Single choice (male, Female).
	(1) Age	Free text.
View of CS	(1) When you think of "computer science" what comes into your mind?	Multiple choice (16 alternatives. See Table 6 for a complete list of alternatives).
Future study and work plans	(1) What do you want to be when you grow up?	Free text.
	(1) Do you think you might want to work in natural science, technology, or computer science?	Single choice (yes; no; I don't know).
	(1) Follow-up question: Why do/don't you want to work in natural science, technology, or computer science?	Multiple choice (12 and 13 alternatives respectively. See Table 7 and Section 5.4 for the alternatives).
	(1) Although it is a long way off, which of the following best describes your study plans?	Single choice (Five alternatives. See Table 8 for a complete list of alternatives).
Parental attitudes and values	One or both my parents: (1) Think it is important for me to learn natural science, technology, and CS (2) Think natural science, technology, and CS is very interesting. (3) Has explained to me that natural science, technology, and CS is useful for me in the future. (4) Expect me to go to university. (5) Knows a lot about natural science, technology, and CS.	Likert scale (1: strongly disagree, 5: strongly agree).
Future CS work aspirations	(1) In the future, I would like to work as a computer scientist. (2) In the future, I would like to work with programming or developing computer systems. (3) People who are like me, work with programming or computer science when they grow up.	Likert scale (1: strongly disagree, 5: strongly agree).
Appreciating CS	(1) I know quite a lot about CS. (2) Getting young people to understand CS is important for our society. (3) It is useful to know about CS in my daily life. (4) Other people think I am interested in CS and that I know a lot about CS.	Likert scale (1: strongly disagree, 5: strongly agree).
Engagement in CS and science	How often do you do the following things outside of school? (1) Read or leaf through books or magazines about natural science, technology, and CS (2) Watch TV and/or Internet programmes/channels related to natural science, technology, and CS (e.g., documentaries, Big Bang Theory etc.) (3) Go online to find out about natural science, technology, and CS (e.g., Youtube, forums, games)	Likert scale (1: strongly disagree, 5: strongly agree).
Social support	(1) When you are not in school, do you talk or chat with someone about natural science, technology, or computer science, or about things related to computers?	Likert scale (1: never 5: almost every day).
	(1) Follow-up question: Who do you primarily talk with about natural science, technology, or computer science, or about things related to computers?	Single choice (friends; family e.g., parents, siblings, grandparents, cousins, aunts; teachers; other please specify).

Table 2. Results of Alpha coefficient in different samples.

	Alpha coefficient for sample age range 9–16	Alpha coefficient for sample age range 11–16
Parental attitudes and values	.745	.761
Future CS work aspirations	.734	.707
Engagement in CS and science	.646	.649
Appreciating CS	.601	.517

Table 3. Results of factor analysis.

Areas	Factor 1	2	3	4
Parental attitudes and values	.749.623.593.560.535			
One or both my parents:				
Think it is important for me to learn natural science, technology, and CS				
Think natural science, technology, and CS is very interesting				
Has explained to me that natural science, technology, and CS is useful for me in the future				
Expect me to go to university				
Knows a lot about natural science, technology, and CS				
Future CS work aspirations		.800.676.554		
In the future, I would like to work as a computer scientist				
In the future, I would like to work with programming or developing computer systems				
People who are like me, work with programming or computer science when they grow up				
Appreciating CS			.538.514.493.350	
I know quite a lot about CS				
Getting young people to understand CS is important for our society				
It is useful to know about CS in my daily life				
Other people think I am interested in CS and that I know a lot about CS.				
Engagement in CS and science				.670.614.429
How often do you do the following things outside of school?				
Read or leaf through books or magazines about natural science, technology, and CS				
Watch TV and/or Internet programmes/channels related to natural science, technology, and CS (e.g., documentaries, Big Bang Theory etc.)				
Go online to find out about natural science, technology, and CS (e.g., Youtube, forums, games)				
% of variance explained	13.5%	13%	9.3%	8.8%

Table 4. Gender differences by factor.

Factor	Boys (*N* = *115*) *Mdn*	Girls (*N* = *39*) *Mdn*	Gender differences *U*	*z*	*p*	*r*
Parental attitudes and values	5	5	2165	−.370	.711	-
Future CS work aspirations	4	3	1451	−3.474	.001	.3
Appreciating CS	4.5	4	1565	−2.952	.003	.2
Engagement in CS and science	5	4	1760	−2.390	.017	.1

Table 5. Who girls and boys talk to about natural science, technology, or CS, or about things related to computers outside of school.

	Boys (*N* = 115)		Girls (*N* = 39)	
	f %		*f* %	
Friends	62	53.9	14	35.9
Family members	36	31.3	20	51.3
Teachers	2	1.7	1	2.6
Other	7	6.1	1	2.6

Table 6. Number of responses and percentage by gender to the question: "When you think of the word 'computer science' what comes into your mind?".

Options	Boys (*N* = *115*)		Girls (*N* = *39)*	
	f	%	*f*	%
(1) Programming	99	25	36	24
(1) Games, robots	77	19	33	22
(1) Binary notation (ones and zeros; 1,0)	58	15	23	15.5
(1) Ideas, invention, discovery, research	43	11	12	8
(1) Advancement, the future, better world	31	8	14	9.5
(1) Engineering	25	6	6	4
(1) Vehicles, e.g., cars, airplanes, rockets	18	5	7	5
(1) Experiment, inquisitive, understanding	15	4	7	5
(1) Economic benefits, jobs within the sciences	11	3	6	4
(1) Health, drugs, healthcare	4	1	2	1
(1) School, exams, lessons, teachers	2	0.5	2	1
(1) Social sciences, economics, psychology	3	1	0	0
(1) Biology, chemistry, physics	1	0.25	0	0
(1) Environment, nature, plants, animals	1	0.25	0	0
(1) None	0	0	0	0
(1) Other, please specify	8	2	2	1
Total	**396**	**100**	**150**	**100**
Median number of options selected	**4**		**4**	

Table 7. Number of responses and percentage by gender to the question: "Why do you want to work in natural science, technology, or CS in the future?".

Options	Boys (*N* = *83*)		Girls (*N* = *24)*	
	f	%	*f*	%
(1) Interesting	58	19.5	21	21.4
(1) Opportunities to design new technology	50	16.8	15	15.3
(1) Personally satisfying	39	13.1	6	6.1
(1) Opportunities to make exciting new discoveries	37	12.5	12	12.2
(1) Lots of different types of jobs available	33	11.1	17	17.3
(1) Well paid	32	10.8	10	10.2
(1) Opportunity to help others	17	5.7	10	10.2
(1) Good work/life balance	17	5.7	7	7.1
(1) Well respected/high status	7	2.4	0	0
(1) Secure	5	1.7	0	0
(1) I don't know	2	0.7	2	1
(1) Other, please specify	0	0	0	0
Total	**297**	**100**	**98**	**100**
Median number of options selected	**4**		**5**	

Table 8. Number of responses and percentage by gender to the question: "Although it is a long way off, which of the following best describes your view?".

Options	Boys (*N* = *115*)		Girls (*N* = *39)*	
	f	%	*f*	%
I want to study a program that focuses on CS in upper secondary school (gymnasium)	55	47.8	14	35.9
I want to study a program that focuses on natural science and technology in upper secondary school (gymnasium)	37	32.2	12	30.8
I do not want to study a program that focuses on technical or natural science but do not mind taking a few natural- or computer science courses in upper secondary school (gymnasium)	11	9.6	4	10.3
I do not want to study anything related to natural science, technology, or CS in upper secondary school (gymnasium)	5	4.3	4	10.3
I do not know yet	7	6.1	5	12.8