Engaging girls in Computer Science

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Abstract

Girls still decide that Computer Science (CS) is not for them, even though they often do not know what the subject really is. The masculine stereotypes, from both the environment and the general view of what a computer scientist is and does are preventing girls from engaging in CS. Previous work has shown that specialised interventions can boost interest for the subject, but they failed to do this in a way that can be reproduced on a larger scale. This article describes the design and implementation of an intervention that combines several gender-inclusive aspects and masculine stereotype reducing methods to engage more girls in CS during their introduction to the specialist subject CS at secondary school. Results indicate that the intervention did influence the choice for CS as a subject for girls, there are however more factors that weigh in on this decision that need to be taken into account. This calls for further research into earlier and more extensive interventions to engaging girls in CS by using gender-inclusive aspects. Furthermore, research into other factors that might be holding girls back, like profile restrictions and the more technical approach most curricula employ, is needed.

Keywords*: Girls, Computer Science, Gender-inclusive, Stereotypes, Self-efficacy*

Introduction

In a time where there is high demand for Information Communications and Technology (ICT) personnel the number of girls signing up for CS subjects and studies is at an alarming low (Babin, Grant, & Sawal, 2010). Girls have always been underrepresented when it comes to Science subjects. However, the percentage of females in CS studies is lower than in other science areas. This trend is the same all over the world, as can be seen in studies from the US with just 14% of CS bachelor students being female (Goode, 2008) and Spain where only 17% of the CS students is female (Sainz, 2011). More recent numbers from the Universiteit van Amsterdam show that the trend continues, only 5% of the 2016 first year CS bachelor students are female.

The problem does not seem to lie in the perceived importance of computer science to society. Girls and boys rate technology equally important to society, but when it comes to a possible career choice in technology, girls have shown a lot less interest than boys (Schreiner & Sjøberg, 2005). This indicates that girls are being held back from choosing the sciences as a subject or career path, an effect that is even stronger for CS.

The role of CS in everyday life has increased over the past decades. CS is now part of the scientific agenda, creating new kinds of research opportunities (Bundy, 2007). This makes a basic understanding of CS important to everyone who wants to keep up with the constantly changing work and research methods.

There are several studies that have shown that small and focused interventions, often in an out-of-school setting, can give good results in engaging girls for CS (Carbonaro, Szafron, Cutumisu, & Schaeffer, 2010; Fadigan & Hammrich, 2004; Rodger & Walker, 1996). Amongst other factors these interventions put focus on more personal student attention, more gender appropriate assignments and female role models. These interventions increased the engagement in girls for CS by working on the self-efficacy of the students and by giving them access to a side of the subject most had not experienced before.

These interventions show that something can be done to attract more girls to computer science. However, there is still a long way to go before these opportunities can become mainstream. The out of school setting and the well-tailored nature of these interventions might be hard to reproduce. What is needed is an intervention that can increase the number of girls choosing CS in a more manageable setup. In this study, an intervention will be designed and tested that will introduce the CS topic to students with a focus on providing more female role models, expanding the view of the students about what CS is and increasing engagement and self-efficacy in girls when it comes to CS. To be able to reach as many girls as possible this intervention will be held as additional sessions during the phase in which students choose the subjects they will graduate in.

Engagement is a person's or group's involvement in a particular context (Renninger & Hidi, 2016). Since engagement is still a burgeoning construct there is not yet a clear and agreed upon definition on what it entails. There are different models ranging from two to four dimensions. The different dimensions and the subtypes that most models include are listed in table 1.

Table 1 Engagement dimensions (Appleton et al., 2008)

Component	Subtypes
Behavioural	Positive conduct, participation, effort
Emotional	Interest, identification, belonging, positive attitude to learning
Cognitive	Self-regulation, learning goals, investment in learning
Academic	Time-on task, homework completion, credits earned

In this study, the focus will be on engaging girls to choose CS as a subject and how they can stay engaged with the subject. How can girls gain a positive attitude about the field so they can become and stay interested in CS? The first step will be to ensure that girls can identify with CS as a subject. When students do not identify with and value the goals of schooling they tend to opt out (Audas & Willms, 2001).

Identity or identification with CS includes parts of the emotional, behavioural, and cognitive components of engagement. According to Wenger (2000) there are three dimensions to a person’s identity when it comes to engagement. First there is connectedness; can you connect to the subject and a group of people involved in the subject? The second dimension is expansiveness. Is there enough variety of contexts and are there enough identity forming experiences? The third dimension is effectiveness. Are there opportunities to develop socially recognized competences by participating in well-established practises? Can the student feel competent and gain self-efficacy on the subject?

The first step in changing the way girls think about CS is to make them feel more connected to CS. Several issues need to be addressed before female students will find it easier to connect to CS. Cheryan, Plat, Davies, and Steele (2009) show that by changing stereotypical CS objects in a classroom, such as technical and nerdy objects, to more neutral objects, was sufficient to boost female interest in CS to the level of their male peers. This can be the first step to making the CS environment more welcoming to girls.

Another factor in connecting to the subject are the teachers and other role-models for the field. Goode (2008) shows that teachers that are aware of the stereotypes and changed their approach accordingly got great results in regaining balance in the CS student population. They did this by actively recruiting possible future students by showing them the benefits of CS knowledge and by emphasizing non-stereotypical sides and applications of CS. By using female role-models and making teachers aware of their role in removing the cultural stereotypes the choice for CS can be made easier for girls.

The second step in engaging girls in CS is to make them feel more comfortable with CS. The self-variables are an important factor in how people behave, think, feel and self-motivate (Caraway et al., 2003). They state that self-efficacy impacts many aspects of an individual's life, including their goals, the decisions they make and the effort they put into accomplishing tasks. Beyer (2014) states that the CS stereotypes are a powerful influencer on behaviour and that the stereotypes and the low confidence when it comes to computers are part of the reason for the small numbers of women in CS. Fedorowicz, Vilvovsky, and Golibersuch (2010) give a good outline of the basic problem with girls and CS and where the lack of self-efficacy might come from. They state that even though access is equal and both boys and girls sign up for CS courses for the same reasons, boys are more confident about their abilities when it comes to CS. One problem with girls and self-efficacy regarding CS stems from the different ways in which the genders approach working with computers. Boys enjoy computers mainly for leisure and playing games, where girls mostly use the computer for more goal-oriented purposes like schoolwork (Carbonaro et al., 2010). This means that while boys create an enjoyable and comfortable approach to computer use, the girls' approach makes their view of computers a more practical one. The result is that even though girls have the same access to computers and CS courses, boys start out with a clear advantage towards using and learning with computers. This calls for earlier interventions to prevent girls from falling behind even before they get the chance to start their CS education.

Babin et al. (2010) state that working on girls' self-efficacy when it comes to CS education can be achieved by putting less emphasis on the technological nature and the importance of math. Instead focus should be put on the need for people that know how CS works and are able to combine these skills with other fields like business and communication, adding roles and aspects that girls might find more attractive when it comes to their career.

To summarize, the lack of identity that girls have when choosing to enter computer science subject stems from gender stereotypes and the lack of self-efficacy when it comes to CS (Wilson, 2002).

Curriculum and pedagogy

Getting more girls to enrol into CS is only the first part of creating gender balance in the field of CS. The curriculum and pedagogy currently used in most CS environments needs to become more appealing and interesting to girls. The standard CS curriculum often starts with very traditional theory and tasks. These topics, although still very relevant to CS education, are not necessary as a starting point into CS. However, using these topics as a start into CS makes the field come across as a 'technical and difficult domain' (Anderson, 2008). This unintentionally makes CS appear as a field that many students, especially girls, might dislike or avoid. Carbonaro et al. (2010) give a very striking summary of CS introduction courses;

> ‘Most introductions to Computing Science focus on perplexing/irrelevant topics and use languages such as C. Introductory assignments often involve sorting and merging lists of numbers or text, testing algorithms, and creating files. For example, the Computer Science Teachers Association Model Curriculum for K-12 Computer Science (CSTA, 2006) suggests the following lab assignments for the high school Computing Science programming component: methods (functions) and parameters, recursion, objects and classes (arrays, vectors, stacks, queues), graphics, and event-driven interactive programming. They also suggest introducing hardware and systems: logic, gates and circuits, binary arithmetic, assembly language, operating systems, user interface, and compliers.’

First students will learn the terminology and basics, before they head into the more practical side of CS. In their study Carbonaro et al. (2010) give a good alternative to this approach; the creation of a game. This intervention, which they prove to be gender neutral, has a lot of higher order CS components hidden in an enjoyable task. This is an example of an assignment that takes advantage of a pedagogy that creates meaningful engagement that is appropriate for girls.

According to Schlechty (2011), meaningful engagement can be achieved when experiences are; novel and authentic, provide affirmation and choice, include opportunities for collaboration/consultation with others, involve substantial content, are organized to enable the student to engage in making a product and have clear standards for task completion. Adding these suggestions to the CS curriculum will improve engagement for all students.

To make science curricula more gender-inclusive suggestions have been made. Adding real-life and meaningful contexts, social interaction and collaboration, making the assignments more open-ended and more autonomous are factors that several frameworks and interventions incorporate (Brotman & Moore, 2008; Schlechty, 2011; Dare et al., 2017).

Implementation

In this study, an intervention was designed to introduce students to computer science prior to making the decision whether they wanted CS as a specialist subject during their secondary school career. The intervention aimed to engage girls in computer science by adding gender-inclusive approaches to the introduction of CS as a subject. The different factors used to create a more gender-inclusive introduction to CS included; a gender-neutral environment, gender-appropriate assignments, female role-models, active participation, real-life contexts, non-technical examples to improve self-efficacy, showing the more social and communicative parts of CS, emphasizing the autonomy and collaboration required to succeed in the subject and awareness of the role of the teacher.

Research questions

- RQ1: Does a gender-inclusive introduction into Computer science increase the number of girls that choose CS as a subject?
- RQ2: Does a gender-inclusive introduction into Computer science increase the self-efficacy of girls when it comes to CS?

Method

Participants

The participants in this study are the 2016-2017 third-year students HAVO and VWO at the Kalsbeek College in Woerden the Netherlands. In total 229 students answered one or more questionnaires about the specialist subjects they would choose for their upper years of secondary school and about CS. Table 2 shows the number of students and girls for each dataset and how many of them chose CS as a specialist subject.

Table 2 Participants in each dataset

	Participants		CS as a subject	
	Total	Girls	Total	Girls
Pre-test general subject choice	190	100	58 (30,5%)	16 (16%)
Pre-test CS	194	102	48 (24,7%)	11 (10.8%)
Post-test	125	66	28 (22,4%)	8 (12,1%)
Specialist subject choice	229	115	59 (25,8%)	14 (12,2%)

Procedure

The study was conducted from January to May in 2017. Table 3 shows the timeline of the intervention.

Table 3 Timeline for the intervention

January			February	April	April – May
Pre-test	Session 1	Session 2	Post-test	Specialist choice	Interviews

Instruments and Data Collection

Pre-test

At the time of the pre-test the students had completed a general subject choice guidance class about subject choices and future careers. They had not yet received any subject introductions or other subject specific information. The pre-test was done in a classroom setting with the researcher and the career counsellor present to answer questions considering the questionnaires. In the first part of the pre-test the students had to answer a general subject choice questionnaire. This questionnaire measured study and career interest, specialist subject choices and per subject whether the student finds it; fascinating, appealing, exciting, meaningful and boring. The questionnaire started out with some general questions about whether the students knew what kind of career or study they wanted to pursue after secondary school. Then it went on to 7-point Likert scales regarding the different subjects they could choose. These questions were adapted from the STEM Semantics Survey (Tyler-Wood, Knezek, & Christensen, 2010). The final part of this questionnaire was a complete subject matrix were the students had to pick the specialist subjects they intended to choose for the rest of their secondary school career.

When the students finished this first part of the pre-test they received a CS specific questionnaire to measure what they knew about CS and how they felt about the subject. The questions included questions such as; ‘Do you know what CS is?’, ‘Do you know what you will learn if you take CS?’, ‘Do you know which type of careers there are in CS?’, ‘Do you believe that knowledge about CS can be valuable in your future career?’, ‘Do you think you will choose CS as a subject?’ and ‘Can you explain why you are (not) considering CS as a subject?’. The last question in this test was used to measure self-efficacy regarding CS on a 7-point Likert scale; 'How well do you think you will perform in CS'.

The intervention

The intervention consisted of two sessions where CS was introduced to the students using a wide range of gender-inclusive and engagement increasing methods. Both sessions took place in a classroom that was made more gender-inclusive by removing all technical and nerdy posters and other objects (Cheryan et al., 2009). All the sessions were conducted by the same teacher who was made aware about the role of the teacher regarding engagement for CS (Goode, 2008).

The first session started with an opening discussion about what the students thought CS was, the discussion required the students to be active participants (Brotman & Moore, 2008). With the discussion as starting point the teacher would then introduce the different topics within CS using female role-models (Carbonaro et al., 2010) and real-life contexts (Brotman & Moore, 2008) as much as possible. The next part of the introduction was about the different careers paths within the ICT field. Special attention was given to the roles within the field that girls might enjoy, emphasizing the need for collaboration and communication (Babin et al., 2010). The final phase of the first session was a short introduction into the area of problem solving and how this is important to CS. The students got to experience problem solving by playing Lightbot 2.0, a serious game about concepts behind problem solving. Using Lightbot gave an alternative non-technical approach (Carbonaro et al., 2010) to the introduction of some CS topics by active participation to improve the self-efficacy when it comes to problem solving (Babin et al., 2010). Again, extra attention was given to collaboration and communication. At the end of the first session the students were given a homework assignment. The students were asked to interview a person within their family or acquaintances that worked in ICT. Allowing for a meaningful connection between an authentic ICT context and their personal life (Wenger, 2000).

At the beginning of session two, the students got to share their experiences from the interviews they conducted. Different career options were discussed and special attention was given to any females that had been interviewed so they could be used as role-models. Then the actual CS curriculum as given at the school would be presented. Special attention was given to the projects that students would engage in and the open-ended and self-directed nature that these projects have (Brotman & Moore, 2008; Schlechty, 2011). These types of assignments have been confirmed as being gender-inclusive (Carbonaro et al., 2010 and Fadigan & Hammrich, 2004). The second session was concluded by a general questions section where anything that the students wanted to know about CS could be asked.

Post-test

The post-test questionnaire was identical to the second questionnaire of the pre-test. This questionnaire asked the students about what they knew about CS, how well they thought they would do in CS and whether they would choose the subject. One additional question asked the students whether they had changed their mind about choosing CS. The post-test was conducted in the weekly tutorial during the final weeks of classes. The response rates of the post-test were rather low compared to the pre-test. Several tutors forgot to ask the students to fill-in the questionnaire, so the questionnaire was also sent to all the students personally using the electronic learning environment. This questionnaire was open up to three weeks after the second session of the intervention. This resulted in a total of 125 responses, compared to the 199 students in the pre-test.

Official specialist subject choices

The third dataset consists of the official specialist subjects that the students picked for their secondary school career. The career counsellors of the school provided this dataset.

Interviews

Individual interviews were conducted to determine which factors had been of influence during the specialist subject decision-making process. The nature of these interviews was to gather information about the different persons and other sources that had been used to form their decision and what impact the introduction to CS had during this phase.

Results

Choosing CS as a subject

Differences between the pre- and post-test dataset revealed that 44 students changed their mind at least once between the different datasets. Since not all students participated in every dataset it is difficult to measure the effect of the study based on these numbers. Table 4 lists the students that changed their decision to pick CS and the differences in choice between the datasets, it also includes the number of students that the subject gained or lost compared to the previous dataset. If the data for a student was missing in the previous dataset then they did not count towards the gained or lost numbers.

Table 4 Changes in CS choice between the different datasets.

	Pre-test to Post-test			From first choice to Specialist subject choice		
		Difference with Pre-test			Difference with Pre-test	
	students that altered their choice regarding CS	Gained	Lost	students that altered their choice regarding CS	Gained	Lost
Boys	9	5	4	31	5	15
Girls	1	-	1	13	5	7
Total	10	5	5	44*	10	22

*Twelve students changed their mind twice about choosing CS and came back to their original choice.

Differences between the pre-test and post-test datasets revealed that 10 students changed their mind about CS (1 girl). There were 5 students that went from choosing CS to not choosing CS (1 girl) and 5 students went from not choosing CS to choosing CS (no girls). Adding the official specialist subject choices to the data showed that in total 44 students changed their mind about choosing CS as a subject at least once between the different datasets. Out of these 44 students, 31 were boys and 13 were girls.

Four different types of changes have been found, 22 students went from yes to no (7 girls), 10 students went from no to yes (5 girls), 4 students started out with yes, changed their mind to no and later on changed back to yes (no girls) and finally 8 students went from starting out with no, changed their mind to yes and changed back to no (1 girl). The different changes are listed in table 5.

Table 5 Changes from the first dataset to the last.

	Yes to no	No to yes	Yes to no to yes	No to yes to no
Boys	15	5	4	7
Girls	7	5	0	1

This initial result would indicate that the intervention did not increase engagement for CS in girls. Overall 7 girls chose not to pick CS after they initially considered taking the subject, compared to 5 girls that went from not picking the subject to taking the subject, resulting in a loss of 2 girls. However, the reasons behind these changes and the influence of the intervention on the decisions were further investigated using the interviews.

Interviews were held with 10 of the 44 students that altered having CS as a specialist subject between the different response sets. Eight students (5 girls) reported that the introduction to CS influenced their choice regarding CS. Two students reported no influence from the introduction at all (no girls). During the interviews, most students noted that the introduction gave them a better understanding of what CS is and what they would learn. A similar result was seen in the post-test results, where 91% of the students responded that the introduction to CS gave them a better understanding of the subject.

One reason that several students gave for their change in specialist subjects were the profiles between which the students can choose in secondary school. Since these options seemed to have a large impact on the choice for CS the results of the pre-test were further analysed. In total 58 students chose CS in the first part of the pre-test. Out of these 58 students 14 had CS as part of their profile, 22 students picked CS as a profile elective subject and 22 students picked CS as their extra subject. The majority of the students that chose CS come from one of the four profiles. This means that the other three profiles are underrepresented when it comes to CS. One student said that not choosing CS was mainly due to it not being part of the profile subjects, an extra subject was out of question.

Several additional remarks stood out during the interviews. One girl specifically mentioned that the freedom in the assignments in CS and the fact that she could make her own products made the subject appealing to her. Another girl mentioned that she enjoyed editing movies and photos at home and was hoping that this would be included in CS. During the introduction, it became clear to her that this was not (a large) part of the curriculum, so she decided to keep CS as a hobby and pick another specialist subject.

Another interesting finding regarding the dataset is that CS was chosen more often in the pre-university education programs (gymnasium and atheneum) compared to the higher general secondary education program (Havo). In the gymnasium cohort 35% of the students chose CS, in the atheneum cohort 51% of the students chose CS and in the Havo cohort only 15% of the students chose CS. Table 6 shows all the levels of education split into boys and girls and whether they picked CS as a specialist subject or not.

Table 6 Students that chose CS divided over the different levels of education

			CS as specialist subject		
Gender			No	Yes	Total
Girls	Level	Havo	78 (96%)	3 (4%)	81
		Atheneum	17 (65%)	9 (35%)	26
		Gymnasium	6 (75%)	2 (25%)	8
	Total				115
Boys	Level	Havo	49 (72%)	19 (28%)	68
		Atheneum	11 (35%)	20 (65%)	31
		Gymnasium	9 (60%)	6 (40%)	15
	Total				114
Total	Level	Havo	127 (85%)	22 (15%)	149
		Atheneum	28 (49%)	29 (51%)	57
		Gymnasium	15 (65%)	8 (35%)	23
	Total		170 (74,2%)	59 (25,7%)	229

Further exploration of these findings was not possible at this time. However, it does give reason to take a more thorough look into the profiles and the subject at the different levels of education.

Self-efficacy

The change in self-efficacy was measured by two Paired T-Tests over the 7 point Likert question regarding self-efficacy in the pre-test and the post-test. Changes to self-efficacy for all students ($p = 0.343$, $M = 0.149$, $SD = 1.63$) and for girls ($p = 0.204$, $M = 0.288$, $SD = 1.72$) were non-significant. An independent T-Test was conducted to check if there was a difference in self-efficacy between boys and girls. Boys ($M = 3.610$, $SD = 1.3898$) reported a significant higher self-efficacy compared to girls ($M = 4.455$, $SD = 1.4695$) in the independent T-Test ($t(123) = 3.290$, $p = .001$).

The different scales adapted from the STEM Semantics Survey were correlated to the reported self-efficacy using a Pearson test. There was a positive correlation between how fascinating CS is and how well students think they will be at it, $r = .321$, $n = 112$, $p < 0.000$. There was a positive correlation between how appealing CS is and how well students think they will be at it, $r = .375$, $n = 112$, $p < 0.000$. There was a non-significant correlation between how exciting students think CS is and how well students think they will be at it, $r = .166$, $n = 111$, $p = 0.081$. There was a positive correlation between how meaningful students rate CS and how well students think they will be at it, $r = .359$, $n =112$, $p < 0.000$. There was a positive correlation between how interesting students find CS and how well students think they will be at it, $r = .343$, $n = 112$, $p < 0.000$. These results can be found in table 7.

Table 7 Correlations between self-efficacy and the scales from the STEM test regarding CS

	r	n	p
Fascinating	.321	112	0.000
Appealing	.375	112	0.000
Exciting	.166	111	0.081
Meaningful	.359	112	0.000
Interesting	.343	112	0.000

Conclusion

The non-significant results of this study give a clear message, the intervention did not increase the overall engagement of girls in CS. The results regarding self-efficacy show that girls still report a lower self-efficacy when compared to boys. The self-efficacy and stereotypes when it comes to CS are keeping girls from choosing CS as a specialist subject (Beyer, 2014). The interviews did give some positive results. Several girls mentioned that the intervention gave them a better idea about what CS entails and for at least one of the girls this was the direct reason to choose CS. The study combines many different methods that can be used to increase engagement for CS in girls. And as such it can be treated as a pilot study on what could be implemented in different parts of education to increase engagement for CS and decrease the impact of gender stereotypes.

Discussion

The intervention did not directly increase engagement for girls with CS. The number of girls that chose CS did not significantly change and the reported self-efficacy when it comes to CS was significantly lower compared to boys. Several factors were found that might be keeping girls from choosing CS. The first factor in the decision to take CS as a specialist subject are the different profiles available to the students. When students pick a profile, they get a few compulsory subjects, they get to choose one or two profile elective subjects and get the option to add one more extra subject(s) to their schedule. Since CS is only listed as a profile elective subject in one of the four profiles the students in the other three profiles can only choose CS as an extra subject. Not every student will be inclined to take an additional subject, however they might have been interested in CS if they could have chosen it as one of their profile elective subjects. The influence of the profiles and the room for the CS subject within them is something that needs further examination.

Another, possibly related, factor in the decision to choose CS as a specialist subject are the differences between the levels of education. The pre-university cohorts choose CS more often as specialist subject. Part of this might come from the differences in profiles between the cohorts. Pre-university students often have a more technical profile, where CS is included as a profile mandatory subject or as a profile elective subject. They might also be more interested in choosing an extra subject when compared to the higher general education program students.

The nature of CS as a subject might also be part of the difference between the education levels. During the interviews two girls mentioned that CS in its current form did not match with their aspirations regarding ICT. They preferred design and communication and felt that the curriculum did not include enough of these components. In its current form CS might be more suited for the more technical inclined students, but there is need for ICT personnel in many different careers paths. Many of which do not need to have a big technical component. Girls that wish to go in this direction might be missing out on a lot of experiences that could help them on their way to a career in the ICT. Including more links to arts and design and giving more open-ended assignments with more social interaction might make the subject more interesting to these students (Schlechty, 2011; Brotman & Moore, 2008).

Overall most students seem to lack a good view on what CS entails and what they could achieve if they choose the subject. In a world where computers are everywhere it is important that all students become more aware of the strength of computing and how this affects them. This lack of knowledge makes the choice for CS extra difficult for girls since they already view the subject as masculine (Babin, 2010). Projects around the concept of Computational Thinking (CT) have been popping up around the world to alter this view, but many of the current secondary school students lack these experiences, making an informed choice for CS impossible. Implementing CT and problem solving or programing courses needs to start right now if we do not want the upcoming generations to be missing out. These projects should include gender-inclusive aspects to improve the self-efficacy of girls when it comes to CS. The experienced lower computer confidence still is a major barrier to women's advancement in CS (Beyer, 2014). By increasing the confidence and engagement with computers girls will have a better chance at gaining engagement in CS.

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Appendix A: Chart with aspects of gender-inclusiveness per intervention item

Aspects of gender-inclusiveness in the different parts of the intervention

Part of the Study	Component	Used method/intervention	Theory behind it
Introduction session 1	Environment	Removed technical and 'nerdy' cues	Cheryan et al. (2009)
	Teacher	Awareness of role teacher	Goode (2008)
	Opening discussion	Active participation	Brotman & Moore (2008)
	Introduction of CS topics	Female role-models	Carbonaro et al. (2010), Fadigan & Hammrich (2004)
		Real life contexts	Brotman & Moore (2008)
	Introduction of CS careers	Focus on roles and aspects that girls might enjoy	Babin et al. (2010)
		Emphasize collaboration and communication	Brotman & Moore (2008)
	Experience problem-solving with lightbot	Alternative approach (non technical)	Carbonaro et al. (2010)
		Active participation	Brotman & Moore (2008)
		Increase self-efficacy by solving problems	Babin et al. (2010)
		Emphasize collaboration and communication	Brotman & Moore (2008)
	Homework (talk with someone in the ICT)	Active participation	Brotman & Moore (2008)
Introduction session 2	Environment	Removed technical and 'nerdy' cues	Cheryan et al. (2009)
	Teacher	Awareness of role teacher	Goode (2008)
	Homework discussion	Active participation	Brotman & Moore (2008)
	Introduction of CS subject topics	Female role-models	Carbonaro et al. (2010), Fadigan & Hammrich (2004)
	Introduction of CS projects	Active participation	Brotman & Moore (2008)
		Gender appropriate assignments	Carbonaro et al. (2010), Fadigan & Hammrich (2004)
		Long-term self-directed projects	Brotman & Moore (2008)
		Open-ended assignments	Brotman & Moore (2008)
		Emphasize collaboration and communication	Brotman & Moore (2008)

*girls often have a different approach to solving problems, often these solutions have more re-usability in future problems.