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Technical or not? Investigating the self-image of girls aged 9 to 12 when participating in primary technology education

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Abstract
Variance in interest and engagement by gender is a complex and long-standing research agenda in the field of technology education. Studies report that girls are more reluctant to participate in technology education, less interested in the subject and more negative towards technology than boys. It is argued that specific attitudes and roles hinder girls from engaging in technology education because technology is presented as a predominantly male domain, which fuels ideas about what technological agency is as well as whose interest in technology and what kind of technology are regarded as legitimate. There is, however, the potential to improve female engagement if we can gain knowledge about what girls do during lessons and how they think about themselves when learning technology. Therefore, the aim of this study is to examine the self-image of girls aged 9 to 12 when participating in primary technology education, by using Harding's (1986) three gender levels: the symbolic, the structural and the individual. The methods used for this study were participant observations during technology classes followed by a focus group interview. From the perspective of Harding's three levels of gender, the analysis of the observations and the focus group interview reveals that girls confirm the prevailing male norms and conceptions that are linked to what technology is and what it means "to be technical", despite the fact that the teacher introduces gender-neutral activities. However, there is an ambiguity in our findings because the girls also resist the self-image of not being technical, especially when they work together and have ownership of their work with and learning about technology.

Key Words
Primary education, technology education, girls' self-image, gender, focus group interview, observations

Introduction
Girls' interest and engagement in secondary technology education have been explored to a certain degree. However, there is still a lack of research regarding girls and technology education in the early years of school (Kim, Sinatra & Seyranian, 2018). Previous studies – both the few carried out in primary schools and the majority carried out in secondary school – primarily concentrate on the differences between girls' and boys' engagement in technology education. Hussénius, Andersson, Gullberg and Scantlebury (2013) argue, however, that too many studies are restricted to comparing female and male students on variables such as students' achievement and attitudes. Other previous research (e.g. Kim, Sinatra & Seyranian, 2018; Turja, Endepohls-Ulpe, & Chatoney, 2009) suggests that while males are portrayed as being more interested in technology than females, societal factors such as upbringing,

education and the labour market may discourage girls' interest in and engagement with technology. Cheryan, Master, and Meltzoff (2015) point to how the construction of an identity as not being technical can manifest itself in and affect girls. This demands a new way of studying girls' relationships with technology, particularly in relation to education in which girls' interest and engagement are formed from an early age (e.g. Sultan et al., 2019). Therefore, in this study we focus on girls only, to gather clues and gain knowledge about their relationships with technology apart from boys, to the extent that this is possible.

Technology education is a mandatory subject for all Swedish pupils aged 7-16. In Sweden, specialised technology teachers teach younger children since it has been a mandatory subject since 2011 in current teacher education programmes for teachers teaching 7- to 9-year olds (school years 1-3) and an optional subject for teachers teaching pupils aged 10-12 (school years 4-6). 44.8% of all Swedish teachers in school years 1-3 and 48.3% of all teachers in school years 4-6 are qualified to teach technology education (Swedish National Agency for Education, 2020). According to the technology education curriculum, teaching should promote pupils' development of an interest in technology and their ability to take on challenges in an innovative way. Another purpose is for pupils to develop technological expertise and a technological awareness, to be able to navigate in a technological world. These purposes are the same for both sexes. The curriculum is written in such a way that it covers both technology that is culturally regarded as masculine technology and technology that is considered feminine. The Swedish National Agency for Education encourages activities to be gender neutral, thus moving away from what can be seen as gendered views of technology. The national school system therefore increasingly strives for gender equality and the inclusion of both girls and boys in technology education (e.g. Swedish National Agency for Education, 2018). For this reason, we have chosen not to discuss the idea of masculine and feminine technology further, but we instead describe what kinds of activities the pupils engage in.

In this study, we have chosen to use Ihde's (1993) three dimensions of technology: technology must have a concrete component, enter some set of praxes, and have a relationship with humans. This definition presents a responsive spectrum of human-technology relations, which can be seen as useful when studying gender issues. We define being technical as being knowledgeable or skilled with technology, in some set of praxes; design, construction or use.

Gender theory, technology education and the social construction of (not) being technical

When comparing genders, one gender will often be considered the "normal", and the other not (Cheryan, Ziegler, Montoya & Jiang, 2017). In this sense, boys are often seen as the norm for engagement and interest in technology education. In earlier research, this stereotype is linked with traits such as being handy, objective, rational, and non-emotional (Brickhouse, 2001; Smith & Hung, 2008; Emerson & Murphy, 2014). Given that stereotypes in the field of STEM (science, technology, engineering and mathematics) education tend to be male (Berg & Lie, 1995; Cheryan et al., 2015), female students are less likely to define themselves as being technical. In these settings, girls are more likely to disengage and adopt a self-image of not being technical (Kim, Sinatra & Seyranian, 2018). Labelling oneself as technical or untechnical is

related to social factors. Cheryan, Master, and Meltzoff (2015) suggest that the social environment and feelings of belonging may play significant roles in nurturing or hampering a

STEM identity. This points to the importance of social acceptance or having the community of technology education recognise the individual as a group member who fits in. When technology is constructed as a male domain and comprising male attributes, such as logic and technical knowledge, this tends to produce negative self-images amongst girls (Sanders, 2005). Girls also tend to encounter the technology content taught in school less often, thereby acquiring fewer skills and less knowledge about technology (Klapwijk & Rommes, 2009), which may exacerbate disengagement and the feeling of not being technical. On the other hand, teachers play a key role in dismantling such gendered practices and renewing the image of technology education, because they are well placed to induce changes in pupils' perceptions and identities (Murphy 2007). Previous studies show, for example, that girls are less concerned with negative stereotypes when they have a female teacher (e.g. Master et al., 2014).

Inspired by gender theory, we use Harding (1986) as our starting point and refer to gender issues on three levels, the *symbolic*, the *structural* and the *individual*, because these levels of the gender system are seen as "a pivotal way in which humans identify themselves as persons" (p. 18). Harding (1986) defines gender as an ordering principle by which every society is organised. In our analysis, the symbolic level concerns cultural norms, conceptions and linguistic expressions/dichotomies of what gender and technology are and what it means to be technical. The structural level regards gender in relation to the organisation of teaching; and the individual level involves a girl's (or a boy's) self-image or view of their identity in relation to technology and technology education.

The aim of this study is to examine the self-image of girls aged 9 to 12 when participating in primary technology education, by using Harding's (1986) three gender levels: the symbolic, the structural and the individual.

Methodology and Methods

To understand the complexity of gendered classroom situations we used Harding's (1986) gender levels as our methodological framework. The different levels should not be considered as separate entities, as they constantly interact with each other, but they are useful as analytical tools and for understanding the gender structures. The different levels applied to our view of girls' self-image can be seen in Figure 1.

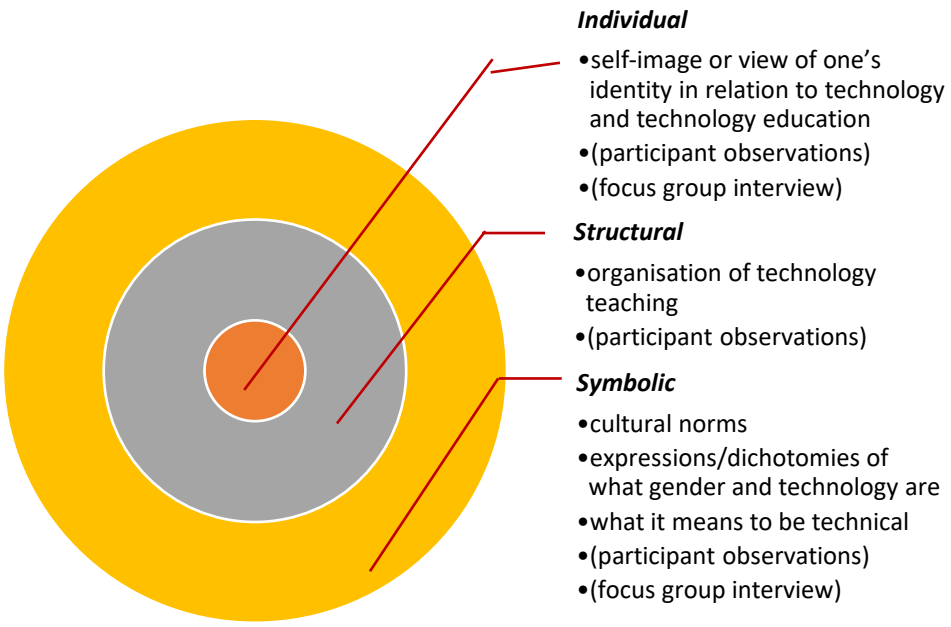

Figure 1. Visual model of Harding's (1986) three gender levels, the symbolic, the structural and the individual, in relation to our methodological approach. Methods used for each specific level in brackets.

Data collection was carried out through participant observations and a focus group interview, i.e. ethnographic methods were used. Conducting observations is helpful in order to understand the participants' world by actively engaging in activities in which participants are typically involved (Kawulich, 2012). The initial purpose of the observations was to develop a narrative (Bryman, 2016) of girls and technology during technology classes. We also used the method as a vehicle specifically to explore the individual, structural and symbolic levels by studying how the self-image of girls was expressed. The observations spanned a technology course of two weeks, involving one Swedish compulsory school and three different classes with pupils aged nine to twelve, during six lessons and a total of fourteen hours. The school is situated in an urban area with pupils representing diverse socio-economic backgrounds. The focus group interview lasted for one hour on one occasion, involving five girls who were observed during the technology lessons. There were two workspaces in the same classroom, divided by a wall, which consisted mostly of windows. One space was intended for woodwork and metalwork, and one was intended for textile work.

To obtain access to the field, an inquiry was sent out via a social media platform. One qualified and experienced technology education teacher responded and gave us access to a classroom and pupils. The teacher acted as a gatekeeper and helped us determine the best time to perform the study, and established a relaxed environment for the research process. The teacher was also an important discussant when trying to make sense of the initially collected data. Furthermore, the teacher's knowledge about the classroom setting and how best to obtain consent from the participants' parents, proved valuable for the study.

The observations were carried out by the first author and were based on knowledge gained from a previous study (Sultan et al., 2019) concerning what might be significant regarding girls and technology. The starting point for the observations – and relating to the structural level – was to document as much as possible about the physical setting, the context, the participants' gender, and their activities, following guidelines for doing observations by Kawulich (2012) and Merriam (1998). The first author focused only on the girls, as their interactions with each other were considered to be of particular importance. Data from the observations was collected by using field notes. There were no checklists or coding schemes to follow during the observations. The first author observed and took notes about conversations between the girls, and between the girls and the teacher, and took notes about which tools the girls used during class and how they expressed themselves in relation to technology. Thus, the field notes consisted of descriptions of the activities, quotations from conversations and the first author's own reflections during the activities. The observations were documented in a narrative style and, using qualitative content analysis, the data was analysed in a hermeneutic tradition and was thus organised and categorised after repeated reading (e.g. Elo & Kyngäs, 2008).

A focus group involves a group of people who discuss a given topic during a limited period of time (Morgan, 1996). As far as possible, the group interaction should resemble natural conversation focused on a specific topic or theme, hence the name 'focus' groups (Smith, 1995). The topic is usually introduced by a moderator and can be initiated by some form of stimulus material, e.g. recounting earlier observations or using visual media. The group members then discuss the topic or theme as freely as possible without much intervention from the moderator (Krueger & Casey, 2000). Focus group interviews allow researchers to gain a deeper understanding of certain events or phenomena observed during the observations. In the present study, the focus group interview was also used as a method to understand the individual and symbolic gender levels.

The hour-long focus group session led by the first author, FA was conducted with five girls, aged 9-12. The girls volunteered to participate and obtained their legal guardians' consent. At the beginning of the session, it was explained that we were interested in what they thought about issues relating to technology education. Extracts from conversations noted in the observations were presented as discussion material at the beginning of the focus group session. A semi-structured interview guide was used. The topics for the session reflected in the conversation extracts included themes such as 'confidence', 'being a girl', 'tools' and 'design'. The session began with a less sensitive topic, in this case how their school day had been, and continued with topics relating to 'girls and technology'. During the hour-long discussion, the interviewer directed and encouraged the discussion, introducing new topics when necessary and appropriate. The responses can partly be seen as the collaborative product of two contributors, the interviewee and the interviewer.

The analysis of the field notes from the observations and the transcripts from the focus group interview was performed in steps, roughly following Elo and Kyngäs' (2008) three main phases, preparation, organising and reporting, and related to the three levels of gender (Harding, 1986). The first step was an "open" reading of the field notes and transcripts to obtain an overall idea of their content. Each activity and conversation was labelled with a descriptive rubric to characterise its central meanings, and to facilitate the next step of the analysis. In the second step, units of meaning/codes were identified with reference to what was observed and

heard concerning girls' self-image in technology education, at the structural, symbolic and individual gender levels. A code consisted of one or more sentences of a narrative from the field notes and transcripts. In the third step, the codes were condensed and merged into categories, and were thereafter re-evaluated in order to avoid overlap. The codes were then related to the three gender levels (see Analysis). In the fourth step, an interpretation of the underlying meaning of the data in relation to the methodological framework and previous research was made – see Discussion (cf. Elo & Kyngäs, 2008).

Ethical considerations and validity of the study

The ethical principles for research were followed by informing the participants about the purpose of the observations and the focus group interviews, and about their right to consent and to discontinue their participation should they wish to do so. Consent was obtained from the participating pupils and their legal guardians. The participants were also informed about their participation being anonymous, and that the data would not be used for anything other than research purposes (Swedish Research Council, 2020).

Concerning the focus group interview, the interviewees/pupils felt comfortable in that they had met the interviewer before. This allowed the girls to feel relaxed. The teacher was involved in discussions about the design of the focus groups, so at the session the focus group members were informed that they could discontinue their participation in the group at any time. The girls who had chosen to take part in the focus group interview could also choose whether to participate actively. One of participants chose to say very little during part of the discussions. Smithson (2000) discusses the problem of dominant voices in focus groups, and the fact that some group members may remain silent. The choice of remaining silent can make the focus group method less intrusive, in comparison with a traditional interview. It allows the interviewee to avoid talking about individual issues that they may find sensitive.

This study is qualitative; the analysis concerns the data of this study and no generalisation should be drawn from it. Participant observations have the advantage of observing relatively rare or unusual behaviours that might have been missed with other deliberate, sampling methods (Emerson, Fretz, & Shaw, 2001). It might be a problem, however, if the researcher expects to see events that are not there and unconsciously creates those events. In this study, we therefore tried to be as open-minded and explorative as possible at all stages - from observation in the classroom to the interview. The research aim and methods reflect this openness.

Results

Observations

During the observations, the girls' conversations were documented. No data was collected on working skills or level of knowledge other than what emerged through the girls' own expressions. The included conversations are highlights from the field notes, and should be read as excerpts from classroom conversations that illuminate aspects of the self-image of 9- to 12-year-old girls in a Swedish technology classroom. Descriptions of activities, as they played out as conversations, and doing technology are marked with [DESCRIPTION OF ACTIVITY].

Reflections on the meaning, and FA's descriptive field notes about the activities and events surrounding the activity, are marked with [REFLECTIONS].

Transcription notations are based on Bailey (2008):

(.)	pause of less than a second
[ ]	encloses overlapping turns
**	encloses speech in a laughing voice
[ ]	encloses transcriber's comments
	(E.g. on non-verbal communication, tone of voice, etc.)

Activity 1: Girls' empowerment together – Girls aged 9 and 10 (years 3-4) (one lesson)
[DESCRIPTION OF ACTIVITY]
In the classroom, the pupils gathered around the interactive board and they were shown YouTube videos about different robots - from industrial robots to more futuristic ones. This was the introduction to a theme about fantasy robots. The teacher chose fantasy robots because it could lead to the pupils designing non-gendered technology – "robots are robots and can do whatever" – and because it might help the pupils when practising designing innovative, functional, and appealing products that are fit for purpose. After the videos, the pupils sat in their workspaces in groups of three or four. The pupils chose where they wanted to sit and who they wanted to work with. The eight girls in the class were divided into smaller mixed-gender group constellations, except for one group of four, which ended up being only girls. This group would turn out to be the most verbal one in the forthcoming group discussions. When the groups had been arranged, they were instructed to first think alone, inspired by the videos they had just been shown, and then to agree on what kind of robot they would like to construct a model of. The pupils were instructed to think individually about what kind of robot they would like to have, and the group must then reach a consensus about what capabilities and functions the group's robot should have. The pupils should use notebooks and sketch the robot they would like to have, write down what its function is, and finish by giving the robot a name. The teacher told the pupils to search on Google for drawings of robots, and then they should draw all the ideas that they could come up with. The pupils googled and discussed. The group with only girls discussed intensely about the kind of materials they wanted to use in their model and the kind of functions they wanted their robot to have.

[REFLECTIONS]
The girls in the mixed groups did not display the same intensity among the participants in the discussions as the girls in the all-girl group, so their roles were more confirming and agreeing with the rest of the group. In one mixed-gender group, however, one girl led her group discussions, taking on a leadership role and challenged the group's ideas. This girl suggested an angry bull with glowing eyes as the group's robot model. The group with only girls wanted the robot to do household chores, such as making the bed, doing the dishes, etc.

Activity 2: Girls reinforcing stereotypical notions regarding technology – Girls aged 11 (year 5) (two lessons)
[DESCRIPTION OF ACTIVITY]
This lesson was a mixed-subject session, in which the art teacher and the technology teacher shared a multidisciplinary project. The theme was space. The assignment that the pupils were asked to do was to create space dioramas. The technology part of the theme involved the use

of one or more simple machines to move the planets, the sun or spaceships within the dioramas. Possible solutions using simple machines could be to use a wheel and an axis to spin the sun, or a pulley to make a spaceship lift off from its home planet. The purpose of this lesson content was for the pupils to learn about simple machines and to apply their functions in new contexts. The assignment covered all aspects of creating a diorama – design, assembly, painting, creating planets and spaceships, etc. The pupils did not get to choose who they wanted to work with, and they were divided into mixed-gender groups with 4-5 pupils in every group. The pupils gave the impression of knowing what was expected of them in this assignment. In the group located in the paint room, a smaller room connected to the main area, the following conversation took place:

1. Girl 1: I don't like technology. [comment made to nobody in particular]
2. Girl 2 to Girl 3: One will instruct and the other will sketch what needs to be sawn. (.) OK?
3. Girl 3: If we do Saturn (.) we need to do the rings also.
   [They produced their sketch and walked over to the jigsaw, to ask the boys for help with the saw.]

[REFLECTIONS]
The girls mostly asked each other for help when they were stuck. Glue guns were the specific tool of choice for the girls. Even when other tools could make the work easier, they chose to use the glue gun. When it came to decorating the dioramas, the girls took the lead and painted what they wanted, even taking a dominant position.

Activity 3: Girls' low self-efficacy concerning technology education – Girls aged 12 (year 6) (three lessons)
[DESCRIPTION OF ACTIVITY]
In the following lessons, the assignment was to build models of the different parts of a playground; a fair, swings and carousels. The class was mixed gender. The assignment was created in a way that allowed the pupils to be creative and follow their own ideas, while also having to use the skills they are expected to have in the subject in school year six. The teacher expected this assignment to engage both the sexes as the playground was considered a place of non-gendered technology. The pupils chose who they wanted to work with and where to sit whilst working on the assignment. There was a clear division between the sexes. Girls chose to work only with girls. Girls and boys engaged in small talk from time to time, but they worked separately.

Girl 1: [Walking around the room.] I'm so bad at this. [tired voice]

[REFLECTIONS]
The comment comes from nowhere while the girl is moving from one point to another in the room. Addressing no one.

[DESCRIPTION OF ACTIVITY]
All the girls except for three went to the paint room, as mentioned earlier. The teacher went after them to ask what they were working on, and commented that the girls should focus on the assignment instead of engaging in small talk. The girls split up and went back into the woodwork and metalwork area. Two of the girls sat down by the computer. They were creating

a spinning chocolate wheel and wanted to insert, create and print a Word document of a table consisting of columns and rows with names of colours to put on their chocolate wheel. The table was the first step in the process of constructing the chocolate wheel:

1. Girl 2 to girl 3: I'm no good at this. (.) We must do it another way to be able to paint [it later]. It has to be nice in terms of colours.
2. [Girl 3 tried to add a line to the document.]
3. Girl 2 to passing boy: Can you help us [with the computer]?
4. Boy: No, I don't know how it works.
5. Girl 2: But (.) you are good at computers.
6. Girl 2 to girl 3: If we insert a table, (.) one here, and add one here (.) then it might work. (.) Yes.
7. Girl 3: Yes.
8. Girl 2: Yes.
9. Teacher: Hey girls. Everything OK? (.) [looking at the computer screen] Are you making a table? You can decide how many rows and columns you want straight away. (.) You don't have to make them yourselves.
10. [The teacher left to help their classmates.]
11. [The girls continued working on the computer.]
12. Girl 2: I'm not good at this.
13. Girl 3: I don't get it.
14. [The girls turned to the same boy as above]: How do you spell lavender?
15. Boy: I don't know. I don't even know what that is.

[REFLECTIONS] The girls continued working at the computer, choosing the colours they wanted to use in the table embedded in their Word document, and making the table look nice. They were meticulous about the spelling of every word. During a period of 20 minutes sitting by the computer, they said eleven times that they do not know, that they do not understand or that they are not able to work with the computer.

[DESCRIPTION OF ACTIVITY] Two girls worked on their model for the playground. They had chosen what they wanted to construct, produced the sketch and agreed on a design, and were now in the process of working on the material for their build:

1. Girl 4: [asks teacher] Can girl 5 use this piece of wood and saw it?
2. Teacher: Yes, (.) no. (.) I'll help her. Be careful [to girl 5].
3. [Girl 5 used the jigsaw by herself, supervised by the teacher.]
4. Girl 5 to teacher: Can I drill a hole?
5. [Girl 5 asked a boy for help/]
6. [Girl 5 went to the pillar drill with two boys.]

[REFLECTIONS]
The teacher did not have a chance to answer before girl 5 asked a boy in the class for help with the drill.

[DESCRIPTION OF ACTIVITY]
Three out of four groups of girls preferred to work in the textile work section of the room instead of the woodwork and metalwork area, mainly sitting by the same table gluing their models throughout the whole lesson (60-80 minutes). The groups had different playground models they were constructing, but they all chose to integrate fabric into their models: pink, lilac, blue and white coloured fabric, or "pretty fabric", as one of the girls explained.

[REFLECTIONS]
The chosen colours were design choices with no practical function, with the exception of one group, which made swings and wanted them to be comfortable for the user. Instead of using a variety of tools, the girls used glue guns to construct their models and combine different parts of the designs. They chose to do so even though they expressed that some tasks would be easier to solve and the models could be made more stable with other tools.

Focus group interview

The following data from the focus group interview was transcribed from audio recordings of the focus group session. It was conducted with voluntary interviewees and represented girls from all studied age groups. The focus group interview was conducted and led by the first author. Just before the first and second examples, FA read some of the transcript of *Activity 3*, and commented, for example, "I saw you spending a lot of time in the painting room and that you chose to sit in the textile area. Are you there often…?"

Conversation 1: Girls' empowerment hindered by boys – Participants one to five (P1 & P2 engaging), First Author (FA)

1 P1 Sometimes the boys are just too much (.) I mean they are nice but if I am having trouble (.) and (.) I'm not allowed to do try (.) stuff (.)
2 FA Mmm.
3 P1 You know, solve it (.) it's like: I don't know (.) it's like you have to go to the side and try it (.) like.
4 FA Mmm.
5 P2 If you are a girl [ ].
6 FA Mmm [ ].
7 P1 I don't want them to tell me what to do

[REFLECTION] As can be seen, P1 first takes an impersonal construction in that she talks about 'boys', but then she starts talking about 'I', signalling that she is putting herself into the experience and sharing her lived knowledge. P2 joins in whilst the others, P3-P5, stay silent.

Conversation 2: Girls' empowerment with stereotypical materials – Participants one to five (P1, P2, P3, P4, P5), First Author (FA)

1 FA You said something about materials and tools (.) that it is important.
2 P1 Yeah (.) it's easier (.) you know.
3 FA Mmm.
4 P1 (.) you get like: should I use this ugly piece of wood or this sparkly textile (points a sequined textile) [I think anyway].
5 P2 [Yeah] it's not (.) like great materials.

6 P3 No.
7 P4 I know you make your own (.) but.
8 P2 It's just not girly.
9 P4 Yeah (.) mmm.
10 P1 And it's always messy. **
11 P4 [laugh] (.) we should clean it more.
12 P1 And the noise (.) it's more fun in the textile area (.) we can talk and work.
13 FA Mmm.
14 P5 And we know how all the things work in there.
15 All (laughter)
16 FA it's easier (.) to ask (.) it's like easier to ask for help if you get stuck.
17 P1 Yeah: [I think so too.]
18 P2 Mmm.

[REFLECTION] Here, the interviewees bring forth shared experiences that make it easy to co-construe scenarios. When P1 talks about ugly materials (turn 4), P2 exemplifies by creating a setting (turns 8–10). In this example, it can also be seen how the FA formulates a leading question (turn 1). The co-construed scenario is a collaborative product, involving participants' co-produced experience, knowledge and thoughts. A key feature of the focus group method is the interaction among participants and creation of articulated descriptions.
In Conversation 3, one of the areas that evoked strong opinions was the question of what technology is.

Conversation 3: Girls' conceptions of technology – Participants one to five (P1, P2, P3, P4, P5), First Author (FA)

1 P1 It's everything (.) robots, programming, space stuff (.) I'm not the best at it (pause) but it's fun. (pause) I'm good at sloyd. [Educational sloyd is a Swedish school subject which can be described as a variant of craft education.]
2 FA Mmm.
3 P1 [and our teacher is great.]
4 P5 [I like using my imagination to make things (.) Like a robot.]
5 FA Is the drill you use also technology?
6 P3 No (.) it's more something you use to make things.
7 P1 No but (.) listen ((annoyed)) the tools are tools.
8 FA Is the glue gun technology then?
9 P3 Mmm [but that isn't what I mean but no (.) yes (.) no. You use it.]
10 P1 Everyone does that today.
11 FA What?
12 P1 Use a glue gun.
13 P3 [Yeah.]
14 P5 [Yes.]
15 P3 Not everything is technology (.) some things make technology.

[REFLECTION] P1 tells the group what technology is and how she feels about it and her teacher. P5 reflects on her statement by talking about what she likes. P1 protests, with a 'no but': 'tools are tools' in reply to FA's question about the drill as technology (turn 5). P1, P3, and P5

collaboratively state that a glue gun is not technology since (turns 9, 13, 14 and 15) 'everyone does that today' (turn 10).
In Conversation 4 we focused on being technical. Do they, the interviewees, see themselves as technical?

Conversation 4: Girls supporting each other – Participants one to five (P1, P2, P3, P4, P5), First Author (FA)

1 P5 I can't really say that I am technical.
2 P1 I think you are.
3 P3 Yeah me too.
4 P5 But I am not (.) Why?
5 P1 I just think you are.
6 P4 Yeah (.)
7 P1 You know.
8 P3 You help us (.) with things and stuff.
9 P1 I don't know (.) you just are (.) technical (laughs).
10 P5 (smile) I don't know (.) I like it (.) I'm just not that technical (.) I just do it (.) I don't ask for help much [pause].
11 P1 You are anyway.
12 P5 I suppose (laughs).
13 FA Yeah (.) it feels good.
14 P5 No [pause] yes [laughs].

[REFLECTION] The other interviewees support P5 in identifying her as being technical. Together, they co-construe her as a person who 'help us (.) with things and stuff' (turn 8). P5 expresses contentment for the support that she receives from her peers. In return, she does acknowledge being technical: 'I suppose' (turn 12).

Analysis

The symbolic gender in relation to technology

According to Harding (1986), the symbolic gender is so incorporated into our culture that it can be difficult to be aware of. It is expressed, for example, through language and through linguistic dichotomies. The analysis of the observations and the focus group interview shows that the girls largely confirm the prevailing norms and conceptions that are linked to what technology is and what it means "to be technical". In the gender homogeneous groups with only girls, the girls also acted as confirmers of prevailing norms, while at the same time confirming and supporting each other as being technical. The dichotomies active–passive were also identifiable, as the girls seemed to assume that the boys were better at using technology (for example, the computer), and they asked for help even when the boys said they could not solve the problem either. By acting as "helpless", the girls not only got the boys' attention but also contributed to the creation of the image of "the technologically competent and handy man". The symbolic aspect of gender was also confirmed by the girls when they discussed what chores they thought a robot should take care of. Making the bed, washing the dishes, etc., are all chores that are linked to the female gender. Likewise, the girls preferred to use tools (glue guns) that can be considered on a symbolic level to be more "feminine" compared to other

tools such as saws and drills, despite the fact that the girls were aware that the other tools would facilitate their construction work. They also chose to focus on materials and colours, and used descriptions like “ugly piece of wood”, “sparkly textile”, “great materials”, “pretty fabric” and “it’s not girly”. Through these descriptions, prevailing dichotomies can emerge and reinforce what is regarded as female and male in relation to technology. Taken together, the girls largely confirmed prevailing norms and conceptions.

However, despite this, we identified a duality. Although the girls confirmed prevailing norms, they simultaneously expressed a dissatisfaction. This dissatisfaction was expressed via statements to the effect that they were not given enough space by the boys to try things for themselves, and that they did not like it when the boys told them what to do. At the same time, they asked the boys for help, even when they had the opportunity to try to solve the problem themselves. This duality can be linked to the individual level of gender, i.e. the girls’ socially constructed identity in relation to technology and technology education.

The individual gender in relation to technology

How the individual gender was expressed by the girls in relation to technology and technology education can be linked to the girls’ view of what “technology” is and what “being technical” means. As mentioned in the description of the symbolic gender, the girls asked boys for help, indicating that they did not see themselves as technologically competent enough to solve problems themselves. This view was also confirmed by statements like “I’m not good at this”, “I don’t know how it works” and “I don’t get it”. One possible interpretation of the girls’ view of being technical is that it is closely linked to being able to use a certain technology without having to ask for help from someone else (preferably boys or men). However, at the same time, the girls expressed that they were not given the opportunity to use their technical ability; that they felt that the boys took up too much space and prevented them from “trying stuff”. However, here too, we identified a duality; in the observations, we noticed that the girls asked the boys for help to solve different technological problems.

Another aspect we noted in relation to gender was that the girls expressed how they were unsure about what technology is. They described technology as “everything”, but only gave examples of what it might be by mentioning robots, programming and “space stuff”. Moreover, they felt uncertain about whether or not tools could be regarded as technology. A drill was not technology since it is something “you use to do things”, but at the same time, they were not sure whether a glue gun was technology. This duality can be linked to the symbolic level of gender, that is, expressed through language and through dichotomies and the individual level connected to “being technical”.

The structural gender in relation to technology

Based on Harding’s (1986) description of the structural gender, we could see that the teacher was trying to influence the organisation of teaching so that it would not reinforce stereotypical notions. For example, the technology assignments the pupils were given can be considered to be gender neutral and the teacher supported both boys and girls equally. Similarly, the analysis of the interviews showed that the girls were aware of prevailing gender structures and they expressed that they were not satisfied with them. However, regarding the teaching groups, there was a clear division; the girls only worked with girls. Although girls and boys talked

occasionally, they worked individually and in mixed-gender groups, the boys took the lead. In relation to the structural gender, the girls preferred to use tools that could be considered more feminine coded (for example, the glue gun) compared to using saws and drills. They also chose to work in the textile work section of the room rather than in the woodwork and metalwork part. Moreover, by frequently expressing that they do not like technology and are not good at technology, and by asking the boys for help, the girls (possibly unconsciously) contributed to reinforcing stereotyped structural images linked to technology.

Discussion

The above analysis shows that the issue of girls' self-image when participating in primary technology education is complicated and sometimes contradictory. By using the methodological framework devised by Harding (1986), we were able to consider girls and gender in technology education on three different, interconnecting levels (cf. Rooke, 2013). On the level of symbolic gender, we identified a complex duality. On the one hand, the girls confirmed prevailing norms and traditional gender roles, and seemed to assume that boys were better at using and constructing technology by asking them for help. On the other hand, the girls simultaneously expressed their dissatisfaction with being set aside and being told what to do, and confirmed one another as being technical (cf. Hallström, Elvstrand & Hellberg, 2015).

The girls' own self-image or view of their identity in relation to technology and technology education is mirrored on the individual level, which shows that although the assignments were gender neutral and the teacher was supportive, the 11-year-old girls in particular adapted an image of not being technical, as discussed by Kim, Sinatra and Seyranian (2018). These girls frequently expressed that they do not like technology, or that they are not good at technology, in contrast to the boys who were seen by the girls as being technical – despite one of the boys protesting about being labelled as "good at computers" (cf. Virtanen et al., 2015). Based on Harding (1986), we suggest that the girls in this study tended to fulfil a negative technological self-image and chose to use artefacts, which may be an obstacle to their unbiased engagement in technology education (e.g. the glue gun). Even here, however, we identified a duality or ambiguity because we also noticed that the girls' view of being technical was closely linked to being able to use a certain technology without having to ask for help from someone else, i.e. from boys. In addition, as we have seen, the girls sometimes did just that (cf. Cheryan, Master, & Meltzoff, 2015).

The analysis of the observations at the structural level with regard to the organisation of teaching does not show the girls to have been subjected to negative stereotyping. Aspects identified as necessary for the creation and implementation of successful STEM education projects for girls include the ability of pupils to form collaborative groups and participate in solving problems that they identify as meaningful, relevant to them and open-ended (Billington et al., 2014; Denner & Werner, 2007), which the teacher in our study provided. However, regarding the teaching groups, there was a division in the sense that the girls only worked with girls, and even in the mixed-gender groups they worked separately and it was mainly the boys who took the initiative. In relation to the structural gender, the girls preferred to use tools that could be considered more feminine coded (for example, the glue gun) compared to using saws and drills (similar to a preschool context, see e.g. Hallström et al., 2015).

In terms of the implications of this study, Rooke (2013) points to a few key factors for gender-inclusive technology education, for example that it should provide a perspective valuing both technology process and product, and should rely on examples relating to both girls and boys. Another factor is working in small groups, without support from the teacher. Rooke (2013) concludes that "To create a gender-neutral environment for education, the tasks and the learning surroundings must allow the pupils to use different ways of solving the assignments. […] By working contextually, you also get the opportunity to value technical solutions. Also, girls' acquirements are gained by putting the task into an everyday perspective." (p. 12.) Another important factor in order to maintain girls' interest in technology education is that the teacher also chooses assignments that are gender neutral and do not separate technology into masculine or feminine attributes (Billington et al., 2014; Denner & Werner, 2007).

Finally, our results regarding the 11-year-old girls might align with earlier research claiming that girls often lose interest and confidence in technology from this age (e.g. Ardies, De Maeyer & Gijbels, 2015; Swedish Schools Inspectorate, 2014), but this needs to be explored further. By using the three levels of gender from Harding (1986), such a study could contribute to the understanding of girls' interest in technology and technology education.

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