Girls' technological knowledge

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ABSTRACT

This study investigates technological knowledge among 13-14-year-old girls at a technology-focused summer camp using a Science and Technology Studies (STS) lens. As they are already interested in technology, they attend the camp out of genuine interest instead of ones to become interested. The girls' expressions of technological knowledge are aligned with societal norms associating technology with hands-on engagement and activities, solidifying their self as belonging in technology. While the camp introduced certain gendered assumptions through "girlified" tasks, the girls wished to transcend these stereotypical activities. They wanted to broaden their technological interests beyond the confines of gendered expectations. Actor networks and external recognition influence their technological knowledge, often motivating their engagement in technology. During an interview, the girls voiced dissatisfaction with existing technology education, mentioning uninspiring teaching methods, outdated materials, and a focus on theory. The girls were critical of the technology education they encountered and emphasised the value of practical learning and a longing for real-life applicable skills. Despite some finding technology classes engaging, low self-confidence in comparison to boys emerged, possibly due to teacher expectations. Their inclination towards practical experiences highlights the importance of a well-rounded learning approach. Implications for school technology education curricula underscore the significance of blending theory with practical application to keep technical girls engaged. By embracing girls' perspectives, educators can craft initiatives that resonate with their interests, rejecting the need for gender-specific content. These insights challenge the stereotype that technical knowledge is gender-bound, recognising that girls' genuine interest is an asset.

Key Words: Technological Knowledge, Technology Education, Technical Girls, Girlification, STEM camp

1. BACKGROUND – GIRLS' TECHNICAL KNOWLEDGE

Even if there is evidence of an existing difference in technical interest between girls and boys at the end of primary school (de Vries 2005; Mawson 2010), Adenstedt (2018), when comparing girls' and boys' interest in developing technology knowledge, found no significant difference. Other studies investigated various aspects of technical knowledge, including girls' attitudes towards technology (Niiranen, 2016), self-efficacy beliefs (Pajares & Miller, 1994), educational experiences (McLain et al., 2019), career aspirations (Klapwijk & Rommes, 2009), and the impact of societal and cultural factors (Cheryan et al., 2015; 2017; Kim et al., 2018) on their engagement

with technical subjects. Archer et al. (2015) and Arifin Mim (2019) aimed to identify barriers and challenges that girls face in developing and expressing their knowledge and skills within STEM (Science, Technology, Engineering and Mathematics), as well as effective strategies to overcome these barriers. Others like Gagnon and Sandoval (2020) and Sultan (2022) focused on examining the role of various educational environments in fostering girls' technical knowledge, such as summer camps. Moote et al. (2020) explored the influence of different interactions on girls' motivation, learning outcomes, and engagement in technical fields. Research regarding different aspects of girls' in technology often aims to identify effective strategies and interventions to bridge the gender gap and inspire girls to pursue and excel in technical fields, ultimately fostering a more diverse and inclusive landscape in technology-related domains (e.g., Adebimpe, et al., 2011; Alam, & Tapia 2020; Blickenstaff 2005; Mammes, 2004). What links the research mentioned is the willingness to understand the factors influencing girls' engagement, participation, and achievement in technical subjects and fields, not uncommonly focusing on how to make girls interested in learning and future work.

Additionally, Archer et al. (2013) investigated the effect of gender stereotypes, cultural norms, and representations on girls' perceptions of STEM subjects and their identification with related career paths. Lane and Sorby (2022) and Sultan et al. (2019) have highlighted the importance of promoting inclusive and supportive learning environments that encourage the development of technical knowledge. This may involve learning in and outside the classroom.

2. METHODOLOGY

This section describes the camp, the girls attending, the theoretical framework, data collection and ethical principles.

2.1. Empirical setting

The camp organisers were a national but municipality-based technology association, and the camp aimed towards girls aged 13-14. The summer camp is a yearly recurring event that spans three consecutive days and offers various technology-related activities. The venue for the camp included an upper secondary school known for its industrial and educational programs, as well as the premises of a national technology association. The decision to create a camp exclusively for girls was motivated by the intention to provide an environment where girls could feel at ease and receive support without competing with boys for attention, resources, or knowledge. The camp activities included computer coding, welding, laboratory work, design elements and 3D printing, laser cutting, and electronics. The camp organisers aimed to promote technological literacy and encourage girls to pursue educational programs focusing on technology. The main aim of the camp was to spark interest and enthusiasm among girls for a future in technology.

2.2. The girls

The camp accommodated 100 participants who identified as non-binary individuals or persons identifying as girls. All participants will in this paper be communicated as "girls". These participants came from diverse socioeconomic backgrounds and had varying levels of prior technical experience, ranging from beginners to highly skilled, depending on the specific content

and context. However, a shared factor among them was their interest in technology, and they voluntarily applied to attend the camp.

2.3. Theoretical standpoint

Science and Technology Studies (STS) is a field that examines the interrelationships between science, technology, and society. It provides a framework for analysing how technology is shaped by social, cultural, political, and economic factors and how it, in turn, influences society. When applied to the analysis of technological knowledge, STS can offer insights into the broader context in which knowledge is produced, disseminated, and applied. STS emphasises the social construction of technology, highlighting that its technical aspects do not solely determine technological knowledge but are also influenced by societal values, norms, and power dynamics (e.g. Sismondo, 2011). By employing STS approaches, one can examine the social processes through which technological knowledge is generated, validated, and legitimised. An STS analysis of technological knowledge can involve studying various dimensions, including social construction Klein & Kleinman (2002), actor networks (Sayes, 2014), and technological artefacts (Pinch & Bijker, 1984). These three dimensions are explored in this study since they can be considered part of the camp.

STS also explores how social factors, such as cultural beliefs, historical contexts, and political agendas, shape gender and technological knowledge (e.g., Schiebinger, 2014). Using this as a tool for analysis can reveal how girls have different understandings and perspectives on technology. Exploring the actor network involved in producing and disseminating technological knowledge involves tracing the relationships and interactions in this study, it is, for example, schools, teachers, and legal guardians. STS also examines the materiality and design of technological artefacts and systems and how they embody specific forms of knowledge. This analysis can uncover technological solutions' assumptions, biases, and values. By applying STS frameworks and methodologies, researchers can gain a comprehensive understanding of how technological knowledge is situated within broader social contexts (Schiebinger, 2014). This approach helps to reveal the complexities, uncertainties, and values that shape technological development and use, enabling critical assessments of technological knowledge and its educational implications.

2.4. Focus group interview

On the last day of the camp, a focus group interview took place. This interview involved a diverse group of girls who had collaborated in, by the organisers, a pre-decided group throughout the three-day program. Participation in the interview was voluntary. The interview followed a semi-structured format, with questions generated from the researcher's observations during their active participation as an observer over the three days. The focus group session lasted approximately 30 minutes and included nine girls. The semi-structured approach of the interview allowed for probing and follow-up questions. This allowed the girls to provide more details and context about their experiences. This method is rooted in established research practices, similar to semi-structured interviews that encourage a thorough exploration of participants' viewpoints (Galletta, 2013; Krueger & Casey, 2000). Through the discussion and interaction among the girls, the researcher aimed to gain insights into their discourse, dynamics, and technological knowledges. This approach provided an opportunity to explore the girls' experiences and perspectives within the camp setting, allowing for a richer understanding of their engagement with technology and

their social interactions during the camp. On the other hand, there can be possible distortions in the data due to the interview being a group discussion with a comparatively large group of girls who presumably hardly know each other.

The interview was transcribed and analysed through the lens of STS. The analysis process went through three phases. First, it was coded from Social construction, Actor-networks, and Technological artefacts and systems. The second phase was to identify and generate preliminary codes for statements related to the motioned categories in the transcript. Next, statements were identified as containing words and phrases describing the categories.

Table 1.
Example of phase three - words and phrases used to identify STS,

Code	Examples
Social construction	Girly, creative, boring, fun,
Actor-networks	Dad, teacher, home, school, class, friends
Technological artefacts and systems	Computer, mechanical, programming
	"How things work." "Push a few buttons, and something will happen."

The words and phrases stand for the communication of the identified themes. These themes are organised based on the types of technological knowledge expressed. Under each theme, summarising analysis and quotes from the participants' responses are included to support and illustrate their perspectives.

2.5. Ethical principals

Adhering to ethical principles, in compliance with the guidelines set by the Swedish Research Council (2017), the study ensured informed consent by providing participants with information about the focus group interview's purpose. Participants were informed of their right to withdraw at any time, and those girls who chose to engage actively were granted the opportunity. Consent was obtained from both participants and their legal guardians, with anonymity guaranteed. Data usage complies with the General Data Protection Regulation (GDPR) regulations, ensuring secure storage and protection.

3. RESULTS

The following section presents the analysis results using the three STS categories: 1. Social construction, 2. Actor- Network and 3. Technological artefacts and systems, to express technological knowledge.

3.1. Girls' expressing technological knowledge in forms of social construction

The girls' technological knowledge perspectives reflected a societal norm of associating technology with hands-on activities and creation, contributing to a sense of identity as doers and makers. However, the camp also had certain assumptions since they made some activities girlified. With girlified means taking non-gendered activities and making them "girly". In this case by organisers adding glitter or pink to the artifacts presented as possible ideas. During the interview, the girls expressed a desire to move away from these gendered activities, suggesting they wanted to explore beyond stereotypical pursuits. The motivation for participating in the technology camp stems from multiple aspects. One of the reasons is a critique of traditional school technology education as not being good enough, suggesting that the girls may find the camp as an alternative and more engaging learning environment. Additionally, they indicated an aspiration for academic success and future studies. Furthermore, they were eager to meet new friends who share a common interest in technology, highlighting the social aspect of the camp and the opportunity to connect with like-minded individuals.

3.2. Girls' expressing technological knowledge in the forms of actor-network

When asked the girls perceive themselves as having technical abilities, although they may find it difficult to acknowledge this openly to others. They reflect their technological knowledges in the eyes of others. One girl talked about a father inviting her to participate in everyday activities, and another spoke about the feeling of belonging and non-belonging a teacher can give in the classroom. Comparisons with others often shape their self-perception. The recognition of being seen as technical by others motivated their participation in the camp. These girls frequently encounter inquiries about technical matters both at home and in school, and they often demonstrate their problem-solving skills by successfully addressing these inquiries.

The girls expressed their dissatisfaction with technology education, describing it as bland and unappealing. They attributed this to a range of factors, such as incompetent teachers, outdated or broken materials in school, and a focus on theoretical aspects rather than hands-on activities. They emphasised the importance of practical work and expressed a desire to learn relevant skills they can apply in real-life situations. However, there were also some positive comments. Some girls indicating their interest and eagerness to spend more time on technology-related activities in school. Additionally, they perceived women teachers as more enjoyable or thorough, suggesting a positive influence of women role models in the field of technology education.

The interviewees articulated tending to downplay their capabilities and exhibited low self-confidence, even though they generally believe they are better than the boys at technology. This is likely influenced by the expectations set by teachers mentioned in the interview, which the girls felt portrayed girls as less technically savvy. As a result, they often compare themselves to boys

and feel inferior on an individual level. However, when stimulated by their peers at the camp, the girls exhibit a strong sense of technical identity and proudly identify themselves as technical.

3.3. Girls' expressing technological knowledge about technological artefacts and systems

During the focus group interview, it was clear that several girls had a pre-existing interest in and fascination with technology before applying to the camp. This was reflected in the response of one girl who stated being good at computers and being a problem solver if something is wrong with the computer. The girls also expressed interest in soldering and mechanical work. The girls strongly preferred practical and hands-on experience, emphasising the importance of learning how things work and acquiring knowledge that has practical applications in the real world. They did not perceive only writing about technology as highly valued. The girls expressed a desire for improved technology education that focuses on both knowing and doing.

4. DISCUSSION

Using three STS categories, this study examines how nine girls aged 13-14 expressed their technological knowledge when taking part in a summer camp for girls interested in technology. Even though the interview has a limited scope, it can still provide insights by using the three STS categories. It can also be seen that the camp's design could influence the girls' attitudes negatively and positively more than what the results show. However, since I lack questions exploring this possible insight, I will not discuss this. What can be seen as extra interesting is the girls' pre-existing interest in technology. They are girls who do not need to become interested but rather attend the camp because of interest, which is an unusual scope of research. The focus group interview highlighted the girls' fascination with technology before camp participation. The motivation underlying the girls' partaking in the technology camp is multifaceted. Firstly, their critique of conventional technology education. Secondly, the camp's actor-network dimension is noteworthy. The girls are enthusiastic about forming friendships with peers who share their technological passions, underscoring the importance of communal engagement and the potential for connecting with like-minded individuals.

Girls understanding about technological knowledge aligns with a prevalent societal norm associating technology: hands-on engagement and activities, solidified their self-identity as being technical. However, the technology camp they attended also introduced certain socially constructed assumptions by including "girlified" tasks, incorporating stereotypically feminine elements like glitter and pink. Interestingly, during interviews, the girls expressed a desire to transcend such gendered activities, signalling an aspiration to broaden their technological interests to encompass a broader range of non-stereotypical pursuits. This can be because they already identify and align with what is generally seen as technology and belonging in a technical setting. They need not be persuaded into technology by "girlified" activities. By girlified I mean the manifestation of the general misconception that girls need special activities or colours to engage in technology. We can compare it to believing girls can only become interested in driving Formula 1 or playing rugby or football if the car, balls, track or fields are pink. Girlification can be off-putting for girls already interested in this kind of activity.

When asked about their interest in technology, the girls saw themselves owning technical knowledge, though they might struggle to admit it openly. Their self-perception of technological knowledge is often influenced by how others perceive them. For instance, one girl mentioned her father's involvement in her daily activities, while another discussed the impact of teacher attitudes on her sense of belonging in the classroom. These external comparisons shape their self-identity, with recognition from others as technical motivating their participation in the camp.

The girls expressed dissatisfaction with their current technology education, finding it uninspiring. They attributed this to inadequate teachers, outdated materials, and a focus on theory over hands-on experience. They stressed the importance of practical learning and a desire to get applicable skills for real-life scenarios. A thing encouraged in the curricula but maybe not to the practical extent the girls wished for. Despite this critique, some girls found going to classes engaging and wished for more scheduled time learning technology. They also saw women teachers as more enjoyable and thorough, indicating the positive effects of teacher role models in technology education. This is interesting since none of the girls mentioned their mothers as inspiration or companion when engaging in technical activities. Even if they believe they outperform boys in school, the girls tend to downplay their abilities and exhibit low self-confidence in class, possibly due to some teacher expectations of girls as less tech-savvy. This behaviour is in line with what is noted in Sultan (2022). Consequently, girls expressed to feel often inferior when comparing themselves to boys.

4.1. Implications for school technology curricula

The girls showed a strong inclination toward hands-on, practical experiences. They placed significant value on understanding the inner workings of technological components and gaining knowledge with real-world relevance highlighting a multifaceted wish for technological knowledge in school. Their ideal technology education combined theoretical insights with tangible applications, reflecting a preference for a well-rounded learning approach. What emerged notably from the data was the girls' belief that their interaction with the subject matter significantly shaped their sense of belonging in the realms of technology.

Empowering technical girls through a balanced blend of theory and practice in technology education does not just engage them – it equips them to navigate the intricate realm of technology. By bridging the gap between hands-on experience and reflective thinking, educators provide girls with the tools to grasp technology's multi-dimensional aspects. These insights, echoing findings by Mawson (2010) and de Vries (2005), underscore the value of contextual learning that aligns with individual interests. This perspective challenges the notion of using 'girlifying' content and recognises that technical competence is not defined by gender. By embracing girls' perspectives and experiences, educators can craft initiatives that resonate with girls and steer clear of the pitfalls of over-simplification that sometimes "girlified" activities turn out to be. After all, these young technical minds have already cultivated an identity within the technology landscape, making girlification counterproductive to their genuine interest.

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