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The Significance of Technology Videos for Girls' Interest in Technology

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ABSTRACT
One reason for the near-absent growth of girls' interest in STEM (science, technology, engineering, mathematics) professions could be the culturally and media perpetuated images of technology and people. As a cultural studies approach suggests, societal structures such as male-dominated engineering professions depend on power over the production of knowledge and meaning. Today, the digital public sphere offers spaces for empowering and active media use by girls and women that can highlight their perspectives on future technologies. Using performative social research, this study explored how 12- to 16-year-old girls would like to have technology topics communicated to them. The research question was investigated using a multi-method design, consisting of workshops in which 21 girls produced their own videos on technology topics, individual interviews to evaluate the published videos, and an online questionnaire with 108 girls and a comparison group of 52 boys who watched and rated the videos. Findings suggest the need to prioritise topics that are close to the everyday lives of the target group (in this case, girls), to link technology to other areas of life, such as sport, art, or health, and to show challenges and problems in using technology.

KEYWORDS: technology in media, digital publics, cultural studies, video production, girls' interest in technology, YouTube

The Significance of Technology Videos for Girls' Interest in Technology

INTRODUCTION

> *You have to change images before you can change acts and institutions*. (John H. Johnson[1])

For years, increasing the proportion of women in STEM fields (science, technology, engineering, mathematics) has been the goal of various educational and political initiatives in Germany, such as the annual Girls' Day or the Komm, mach MINT initiative. One reason for the limited progress in disciplines like electrical or mechanical engineering, where women make up only about 18% of students nationwide (VDI & Institut der Deutschen Wirtschaft, 2020), may lie in the culturally transmitted and media-reinforced images of technology and people. Studies suggest that the lack of diversity in technology reporting, such as in the topic selection or to the gender of journalists and featured experts, and in the media more generally plays a significant role (Banholzer & Blask, 2022; Keil & Leonhardt, 2017; Wicharz, 2019). Media data from technology magazines (such as those published by Germany's Heise Group, focusing on IT, technology, and innovation), show that diversity, particularly in terms of gender, is also limited among readers: for instance, only about 10% of readers of the IT magazine *c't* are female.[2] Conversely, compared with other media activities, platforms predominantly used by girls aged 12 to 16, such as Instagram, TikTok or YouTube (Feierabend et al., 2023), currently offer little opportunity for identification with female technicians or natural scientists.

So far, there has been limited research into the impact of more diverse perspectives in communicating technology in the media. However, there is evidence that the media's portrayal of women in scientific and technical careers influences girls' interest in STEM, their confidence in their STEM abilities, and their career choices (Heilemann et al., 2012; Steinke & Duncan, 2023). As Brewer and Ley (2018) highlight in their study, this is particularly true for social media and online videos. According to research on the image of electrical engineering by the International Central Institute for Youth Broadcasting, it is important to portray women in technical professions in a more self-evident fashion (Götz et al., 2023).

The research project on which this paper is based, "Electrical Engineering Instead of BibisBeautyPalace[3]", addressed the central question: how can technical topics be communicated in the media in a way that reaches girls and young women? Due to the largely under-explored nature of this field, an exploratory approach with a multi-method design was chosen. In the first phase, researchers accompanied teenage girls aged 12–16 in producing their own videos on technical topics and incorporating their own perspectives into their videos. These videos were later

[1] John Harold Johnson (born 1918 in Arkansas; died 2005 in Chicago) was a prominent African-American journalist and the founder of the magazine Ebony. Ebony was the first magazine to feature advertisements from major American companies that showed Black models drinking soft drinks and driving luxury cars. The magazine succeeded in boosting the self-confidence of the African-American community and spreading optimism: https://www.ebony.com/.
[2] In the 2021 media data, 91% of readers are male; in the 2024 media data, there is no gender breakdown.
[3] BibisBeautyPalace has been one of the top five Youtubers in Germany by subscribed users.

evaluated in individual interviews and a quantitative online survey by other girls and boys.

Definition of Key Terms and Theoretical Approaches

The following sections define central terms such as technology, gender, and media, and explore theoretical concepts like 'doing gender' and 'digitized publics' in the framework of the research project.

Technology

The understanding of the term 'technology' has changed significantly over time. With the onset of industrialization around the 18th century, 'technology' came to mean "machines and devices, their production and use" (Knoll & Ratzer, 2010, p. 102).

For the question of communicating technology in the media, cultural-sociological perspectives are particularly helpful, as they consider the interplay between technology, culture, and society. From a sociological perspective, technology can be studied as artifacts and material culture, as "the social shapes technology and is, in turn, shaped by it" (Wieser, 2019, p. 630).

Sociologist Tanja Paulitz adds power relations to this process, describing technology as a "socially contested field of knowledge, in which societal hegemonic claims are formulated with the help of various, interrelated strategies of demarcation" (Paulitz, 2010, p. 792). All these definitions suggest that technology is created by humans and strongly influenced by the culture in which it arises. This also means that the development of technical artifacts decisively depends on who is involved. Moreover, culturally conditioned differences can prevail in the understanding of technology. In this empirical study, the term 'technology' was intentionally left open, to be queried by the research subjects.

Gender and Doing Gender

The category of gender is understood in accordance with computer scientist and gender researcher Corinna Bath as a hybrid of social, cultural, and physical aspects (Bath et al., 2013). In this study, the social constructivist approach to 'doing gender' in media production and reception processes is particularly relevant (Lünenborg & Maier, 2013). Both concepts open a view of gender as a continuum beyond classical notions of a binary system.

However, for the purposes of this study and in order to address the research question of interest, the classical dichotomies of female vs. male and girls vs. boys are used to understand how young people are performing gender in accordance with expected binary norms regarding technology. After all, gender remains a decisive characteristic influencing technical interest, often more so than many other variables.

These gender norms are evident in the 2018 German Technology Radar, a study which examined the influence of various variables on technical interest and their intersection through the so-called 'technophile attitude syndrome'. Sociodemographic variables such as gender, age, education, and income are intersectional. The strongest affinity for technology is shown by younger men, while the greatest distance is shown by older women. As this suggests, age also plays a

role, as does social background. These factors, however, are less influential than gender (acatech & Körber-Stiftung, 2018).

Media

Media are understood here in a communication studies sense: what were formerly mass media, through which professional journalists, film-makers and presenters provide audiences with news, entertainment and education. The term refers, first, to the institutions in which newspapers, magazines, radio and television—and today predominantly online content—are produced and, second, to the media products themselves. Moreover, with the advent of the internet and the platforms through which social media channels are distributed, new, more interactive and increasingly audience-specific forms of media content have emerged. What is also new in the context of Web 2.0 is that, in terms of a classic model of communication and in contrast to the mass media, any receiver can now also be a sender (Altmeppen, 2023).

Cultural Studies

Societal structures, such as the gender coding of professions in the technology sector, depend on power over the production of knowledge and meaning. This is one of the central theses of the cultural studies theoretical approach developed in Britain in the 1970s. Proponents focus on symbolic processes, language, and signs of all kinds (i.e., culture) to trace the emergence and maintenance of power relations. Culture is understood here as a process through which interpretations and definitions are constructed but also changed.

According to this understanding, there are many cultures, depending on social background, gender, ethnic affiliation, age, or sexual orientation, for example. The Women's Studies Group, founded in Birmingham in 1978, added a feminist perspective to these theoretical considerations. Their research focused on the empowering and/or subversive potential of the active media use of girls and women (van Zoonen, 1994; Women's Studies Group, 1978). Responding to Raymond Williams's 1960's thesis of a 'long revolution', they assume that the process in which meanings are created and altered unfolds inconspicuously over a long period of time (Pirker, 2010). The present research project aims to identify initial approaches to such a process of changing technology definitions and interpretations.

Digital Public Spheres

When seeking information on technology topics, girls use the internet, and primarily online videos. Thus, they operate within digital public spheres: namely, communities formed on the internet. Engagement in digital public spheres offers individuals the opportunity to take communication and information transmission into one's own hands, independent of established media, and to speak independently of societal institutions. These communities provide "informal spaces for the articulation of personal experiences and subjective impressions" (Paulitz, 2014, p. 2). Today, digital public spheres are relevant reference points for processes of subjectivation, which refer to the manifold interactions between identities, symbolic representations, and social structures through which individuals become social beings (Carstensen et al. 2014; Paulitz, 2014). Conflict, emotions,

and affects—crucial components of identity development—are involved in their use (Drüeke, 2023).

Girls' Interest in Technology

According to the STEM Talent Barometer 2023 of the German Academy of Engineering Sciences (acatech), only one in eight apprentices in STEM fields is female. The proportion of women in STEM programmes that include vocational training is 20%. In 2023, girls still show less self-confidence in STEM subjects, such as mathematical skills, compared to their male peers (acatech & Joachim Herz Stiftung, 2023). This observation merits particular mention when considering the "t" in STEM: the gender disparity in technology is pronounced, with girls demonstrating a lower affinity than boys (acatech & Joachim Herz Stiftung, 2023; acatech & Körber-Stiftung, 2018; Jakobs et al., 2009). The gender gap in STEM – particularly in technology fields such as computer science and engineering persists across most Western countries (UNESCO, 2021). Indeed, an analysis conducted in 2007 revealed detailed gender differences: out of 13 natural science and technical topic areas, 8 had a clear prevalence of one gender. While boys were primarily interested in applications of natural sciences, machines, and technology, girls were more concerned with biological and medical topics and their practical life benefits (Holstermann & Bögeholz, 2007).

Researchers have continued to examine what may support girls' interest in technology (Happe et al., 2020). There are some studies that indicate that girls tend to be most interested in technology when it is framed as useful and socially impactful. According to Diekmann et al. (2020), interest increases when science/engineering roles are framed as helping people or society; highlighting communal impact: "interventions could not only provide opportunities for girls and young women to succeed in mathematics and science but also demonstrate how STEM fields involve helping and collaborating with other people.” (Diekmann et al., 2020, p. 1056).

This is consistent with the findings reported by Cheryan et al. (2015): interest increases when technology—especially computing and engineering—is presented as solving real problems for people and communities, rather than as working with things or abstract problems (Cheryan et al, 2015). Finally, the literature review by Happe et al. (2020) also points out that computer science education should emphasise the creative aspects and social impact of computing work, as well as the usefulness of computer science "in contributing in solving critical, societal, natural and economic challenges” (p. 2826).

Some conclusions about girls' interest in technology can also be drawn from an earlier study examining girls' preferences for how technology is communicated: group discussions with girls found that they are interested in technology when it has practical relevance and clear links to their everyday lives. (Keil & Orth, 2020). Enrolment figures for various technical disciplines are also of interest. In the 2016/17 winter semester, the most popular engineering courses among women in Germany were combinations of engineering with other, more life-science disciplines, such as design, biology, health, or economics, with female enrolment rates ranging from 21% to 55%. However, in classic engineering disciplines like

mechanical or electrical engineering, the proportion of women is only about 10% (Diez-Holz, 2020).

The interest in developing technology for the benefit of people continues in later professional life. Social scientist Felizitas Sagebiel studied female leaders in engineering and found that women, unlike men, always see technology in close relation to people, considering its practical benefits (Sagebiel, 2013). Leading female engineers do not view technology in isolation from users and producers. As a working hypothesis, it seems advisable to emphasise the creative and people-related aspects of technology in media coverage, for example, its problem-solving capacity for people and communities.

Media Usage Among Girls

According to Feierabend et al (2023), online videos are among the most frequently used media among girls and boys aged 12 to 19 in Germany. A 2022 study by Postbank, a branch of Germany's largest bank, albeit among 16- to 18-year-olds, also found that YouTube plays a decisive role, with 81% of girls and 83% of boys using the platform, followed by TikTok with 70% for girls and 56% for boys. This suggests that easily accessible videos via social media may play a crucial role in the communication of technical content. Initial evidence for this comes from group discussions conducted in Germany by Keil and Orth (2020). The authors found that when girls seek information about technology through media formats, rather than through their parents, Google or Wikipedia, they do so most often via video.

Studies on general media usage among adolescents, including video usage (Feierabend et al., 2017; Gräßer & Gerstmann, 2017; Tillmann, 2017; Weber, 2015), show that media contribute to adolescent identity formation by providing role models (or counter-role models). According to Weber, it is helpful if the protagonists are as similar as possible to the recipients in terms of gender, age, and socio-economic situation (Gladstone & Cimpian, 2021; Weber, 2015).

For girls, the motivation for using online content focuses on communication and entertainment. Girls also seem to prefer more emotional content (Feierabend et al., 2022; Gräßer & Gerstmann, 2017; Tillmann, 2017; Weber, 2015). A study by Keil and Orth (2020) suggests that these aspects could also play a role in technology-related communication, as girls emphasised that they would communicate about technology in an entertaining way, using humour and highlighting experiences and feelings while learning about it (Keil & Orth, 2020).

Döring's (2015) study on the gender-specific production and reception of YouTube videos found that in areas like beauty, where girls predominantly interact among themselves, peer exchange plays an important role for mutual advice and reassurance. According to Döring, beauty YouTubers provide a big-sister presence online for their female audience. “"Using beauty as a hook, girls and young women create gender-homogeneous social communication spaces on YouTube, where they sometimes act with strong solidarity and support one another in various everyday matters. "” (Döring 2023, p. 969). If viewers expect help in problem-solving from the YouTuber, girls' technology videos could serve a similar function. However, it is important to note that girls are not yet regular technology influencers.

Communicating Technology in the Media

Current technology communication across various media formats is dominated by men. According to an analysis by the German Pro Quote association in 2019 (Garmissen & Biresch, 2019), in classical journalism, the editorial boards of print magazines in the technology and science sectors, as well as in the automotive press, are almost exclusively male. Analyses of local and national daily newspapers between 2015 and 2019 found that between 20% and 30% of technical articles had a female author (Keil & Leonhardt, 2017; Wicharz, 2019). Consequently, technology in newspaper articles is predominantly presented, explained, and contextualized by male experts. However, it is noteworthy that there are hardly any stereotypical portrayals of women in this context, such as depictions of women as inexperienced users rather than as creators of technology (Keil & Leonhardt, 2017; Keil & Michely, 2019; Wicharz, 2019).

The same pattern is evident in social media, particularly on YouTube: there are no women among the German top 10 tech influencers of 2023 (HitchOn, 2023). Additionally, the thematization of technology is often linked to the negotiation of masculinity, as seen not only in the videos themselves but also in the discussions within the predominantly male community, such as debates on whether electric mobility is "masculine enough" (Franken, 2024). In summary, both the tech field and much of today's tech reporting are largely aligned with interests that are culturally coded as male.

Research Questions

Our overarching research question is "what makes media coverage of technology interesting to girls and young women?" Using the insights from the state of research, the focus on videos, and the possible approaches to technical interest in girls and women, we have arrived at the following sub-question (research question 1):

> **RQ 1:** What technical topics could be addressed in YouTube videos for girls?

A variety of video formats have emerged on YouTube, ranging from vlogs and challenges to hauls (presentations of purchases and their display to the camera) (Kohout, 2017). Digital storytelling also plays a significant role in maintaining audience attention, conveying content more clearly, and increasing interest in it (Ettl-Huber, 2019). In many fictional films, this is achieved through the hero's journey, in which the protagonist faces and overcomes a task or conflict. The main character is typically characterised by their experiences, actions or emotions. Additionally, numerous dramaturgical techniques are employed, such as surprise and humour (Osing, 2022a). In mobile storytelling, especially on social media, a key aspect is the need for an opening that immediately captivates users (Osing, 2022b). Against the backdrop of girls' media consumption and the above-mentioned theoretical concepts, research question 2 arises:

> **RQ2:** How should technology topics be presented in videos so as to best engage girls?

Research question 3 emerges from the current state of research regarding the male-dominated communication of technology in the media, girls' media usage, and theoretical considerations on digitized publics:

> **RQ 3:** What is the significance of the protagonists interacting with technology in the videos?

RESEARCH DESIGN & METHODOLOGY

Data collection was conducted using methodological triangulation in a three-step procedure. The core of the research project was laid out in Phase 1, and the insights gained were validated in research Phases 2 and 3. Phase 1 involved 21 girls producing videos on technology topics. In Phase 2, these videos were presented to eight girls for evaluation in individual interviews. Phase 3 consisted of an online survey in which 108 girls and a comparison group of 52 boys watched and rated the videos from phase 1. Different pupils took part in each of the three phases.

Phase 1: Video Production

Using the video production method developed by Theunert and Schorb (1989) as a data collection method, insights were gained into girls' technical interests and their wishes for a technology communication when they designed and produced films on technical topics. Producing videos as a method of capturing data, can be distinguished from established qualitative methods. Young people communicate to a large extent nonverbally in their everyday lives (e.g., through clothing style, facial expressions and gestures, and linguistic expressions/"secret language" that only their clique understands). Nonverbal and sensory expressions cannot be captured by language-based methods (e.g., interviews), so the qualitative research method needed to be adapted to best capture nonverbal communication.

The video production method falls within performative social research, which draws on artistic/creative modes of expression. It focuses on the processes of meaning-making by research participants and audiences (Mey, 2020; Schreier et al., 2023). The procedure of participants generating visual data usually extends over a longer period. It allows the researchers to incorporate the production process into the analysis (Schreier et al., 2023). Video production offers a broad spectrum of audiovisual expressive forms. The ability to express oneself not only through language but also through facial expressions, gestures, actions, images and sounds creates opportunities to convey sensory experience in sensory form and enables complex self-representations that young people cannot, or do not wish to, verbalise.

For a generation that has grown up in a media world of images and deals with it in everyday life, the audiovisual communication of interpretations and meanings is likely to be familiar to the research participants of this study. Images can be expressed as images and need not first be verbalised and the method accommodates young people's desire to express themselves in the form of "visual signals". Finally, the finished video represents the result of an intensive process of group reflection and is also the outcome of processes of discussion and negotiation; it presents the group's view (Theunert & Schorb 1989).

During the field phase from February 2020 to July 2021, the girls participating in the study engaged in three holiday projects at a university (one of which took place

online).[4] The courses with the label "technology for girls" lasted for one week, were free for all girls of the region and were communicated by press releases. When registering their daughters for the holiday course, parents were informed in writing that it would be accompanied by a research project, and that their daughters would produce videos during the course in which they might appear. Parents also gave their written consent for these videos to be published on a YouTube channel. At the end of the course, the girls were given the option of refusing to have their videos published, which one team did. In total, 21 girls took part in the holiday projects, of whom five girls were aged 13 and 14, four were aged 15 and 16, two were aged 12 and one girl was aged 17. The researchers documented the negotiation processes of the girls when talking about technology and when conceiving and implementing their films. Video material produced by girls in the courses was also used for analysis. Additionally, the videos provided the basis for the surveys in the two subsequent research phases.

Support for the girls during the film production was provided exclusively by young female academic staff and female members of the support staff. This was a deliberate choice to give the girls the feeling of being among themselves as much as possible. As basic guidance for video production, the girls were given tips on designing a screenplay, various video genres, visual design, camera work, and video editing.

In addition to the protocols for participant observation, the videos produced in small groups or individually were included in the evaluation of Phase 1 data. As is usual in video analysis (Moritz & Corsten, 2018), sequence protocols were created. Research from Phase 1 resulted in seven finished videos, six of which could be uploaded to a YouTube channel in a playlist. It is important to note that data from one video that was not released and from one unfinished video project were also available for use in Phase 1 and 2 analyses. In parallel, technology journalism students produced technology videos for girls after an introduction to the existing findings in the summer semester of 2021.[5] Three female and three male students produced six videos, which, alongside the seven videos produced by the girls in Phase 1, were also used for research Phase 2.

Phase 2: Individual Interviews on the Produced Videos

In autumn 2021, individual guided interviews were conducted with eight girls aged 14 and 15 who had not previously been involved in the research project. The girls from the schools cooperating with the university volunteered for an interview. The parents gave their written consent to the interview. Each interviewee watched three videos during a 45–minute interview in a classroom at their school. The selection of videos was randomized.

The interviews were conducted by two female project staff members aged 29 and 25. In each interview, the interviewer was alone with the girl. The audio recordings of the interviews were fully transcribed and subsequently analysed using the

[4] The original plan was to hold all the video workshops in high schools. Due to the Covid pandemic, the very first workshop at a school had to be cancelled

[5] As it was unclear by the end of 2020, owing to the COVID-19 pandemic, how many videos could be produced by girls within the scope of the project, a practice-based media project was planned for the summer semester of 2021 for students of technology journalism. In this project, the students were to produce technology videos for girls, informed by the insights gained up to that point. In the end, the last girls' holiday course took place in parallel with the students' practical project.

MAXQDA software. A deductively developed category system from the interview guide was used to structure the statements from participants, which was inductively expanded by unexpected statements from the girls. Results from the audience's perspective (i.e., potential users) was compared with Phase 1 findings. Many categories overlapped across phases, but Phase 2 also yielded unique categories, for example relating to the critical appraisal of various aspects of the video.

Phase 3: Online Survey

In an online survey conducted in the summer of 2022, 108 girls and a comparison group of 52 boys aged 12 to 16 watched three of the videos produced in Phase 1. Most girls (>70%) were aged 13 (n = 37) or 14 (n = 40). A further 18 girls were 15 years of age, eight were 12, and five were 16 years of age. Among the boys, the majority were also aged 13 (n = 26) and 14 (n = 23). Three boys were 15 years old. The girls and boys also came from cooperating schools in the region and were approached by their teachers. Participation in the survey was voluntary and participants could withdraw at any time without detriment. Written consent was obtained from the parents of all pupils who wanted to participate in the survey. About half of the pupils completed the video evaluation questionnaire at home; the remainder completed it in class. After each video, they were asked to answer questions about it. Questions include, "what do you think of the technique presented in the video?" (used as a measure of interest in the topic), "did you enjoy watching the video?" (used as a measure of video entertainment) and "did you understand the technique shown in the video" (used as a measure of video comprehensibility); both questions used interesting/uninteresting or yes/no response options. Participants were also asked to give the video an overall rating (thumbs up, thumbs down). The aim was to broaden the empirical basis of the findings and to examine the extent to which the girls' videos also appealed to boys' interest. This information is important for professional TV production, for example in children's science television.

In addition to the girls' videos, some of those produced by students of both genders were included in the online survey: the selection was restricted to videos that had aroused interest among the interviewees in Phase 2 due to their thumbnails. These were "What's Inside Your Polaroid", "Your Car Will Soon be Driving You", and "Why Space Junk Affects You". Three questionnaire versions for different videos were created, which were assigned to the respondents in a controlled manner to ensure that all videos were viewed nearly equally often. All published videos used in this study can be accessed via https://www.youtube.com/@gender2technik

Data Analysis

The analysis of the data from Phase 1 and Phase 2 was conducted in two steps: first, using qualitative content analysis in accordance with Kuckartz (2018), and then integrating the individual cases and the phases using elements of grounded theory methodology (GTM) according to Glaser and Strauss (1967; see also Breuer et al., 2019). In grounded theory, the aim is to generate a theoretical concept from the data. The analysis began with the first data collected and several coding cycles per case; in our study, these cases were video production processes. These were followed by cross-case comparisons. Each case comparison and the integration of the new findings into the concept was discussed by the three researchers. An

exemplar of how this was completed is shown in Figure 1. They exchanged views on areas of agreement and disagreement in their coding and drew on contextual information to reach a robust interpretation.

Data from Phase 3 were analysed via SPSS and Excel. The video rating (thumbs up, thumbs down) was correlated with the interest in the topic, the feeling that it was fun to watch the video, and the comprehensibility of the presentation per video. As the number of underlying observations was not the same for all videos, Pearson's contingency coefficient was used to achieve comparability. The weighted arithmetic mean of the contingency coefficients was calculated to evaluate the correlation between topic interest, entertainment and comprehensibility and video rating across all videos. The number of views per video can be found in Table 2. An alpha value below 0.05 was used for determining significance.

Triangulation encompassed both data and methods. Based on a simple communication model (sender, message, receiver), we collected data from senders and their media messages in Phase 1. At the same time, the young video producers drew on their experiences as recipients when designing their own videos. In Phases 2 and 3, we collected data only from the recipients of the videos. By including a comparison group of boys in Phase 3, we obtained additional data from male participants. As noted above, not all phases provided data for all categories developed during the study. For example, the critical appraisal of the videos in Phase 2 was new, particularly with regard to comprehensibility and entertainment value. In Phase 3, only a subset of the developed categories could be assessed. The data from the boys not only confirmed the importance of some categories, but also revealed gender differences, for instance, in interest in technical topics.

As outlined above, we triangulated multiple methods in this project: video production, participant observation, video analysis, guided individual interviews, and a quantitative online survey. As shown in Figure 2, the category system served to code the research data and was further developed into a theoretical framework throughout the entire coding process across all three phases. The developed concept shows the significance and relationship of the different categories to each other. For example, the category entertainment (highlighted in a darker shade of orange) has a stronger influence on the appeal of the video than comprehensibility (presented in a lighter shade of orange). The developed concept is to be tested and supplemented in further studies.

Figure 1. Evaluation Scheme Illustrated by two Cases/Film Teams

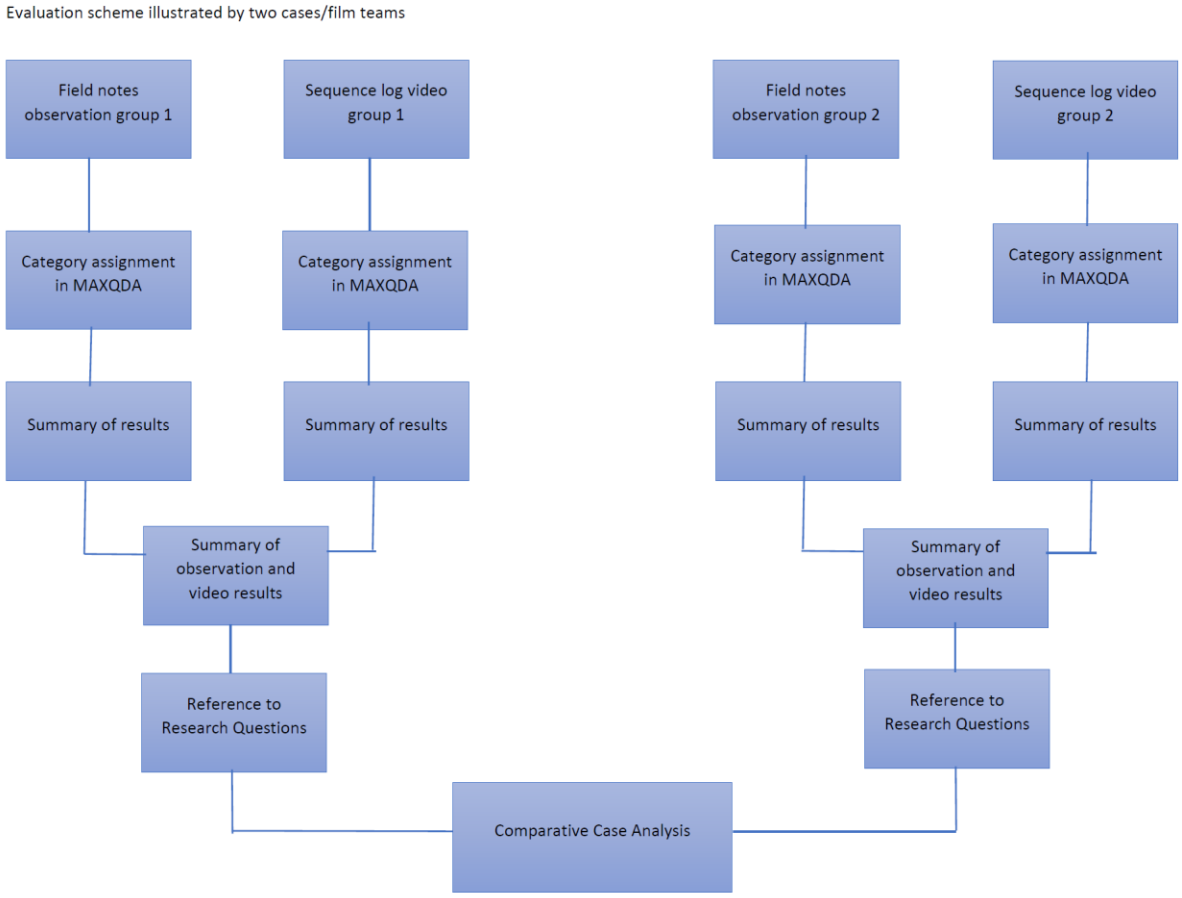
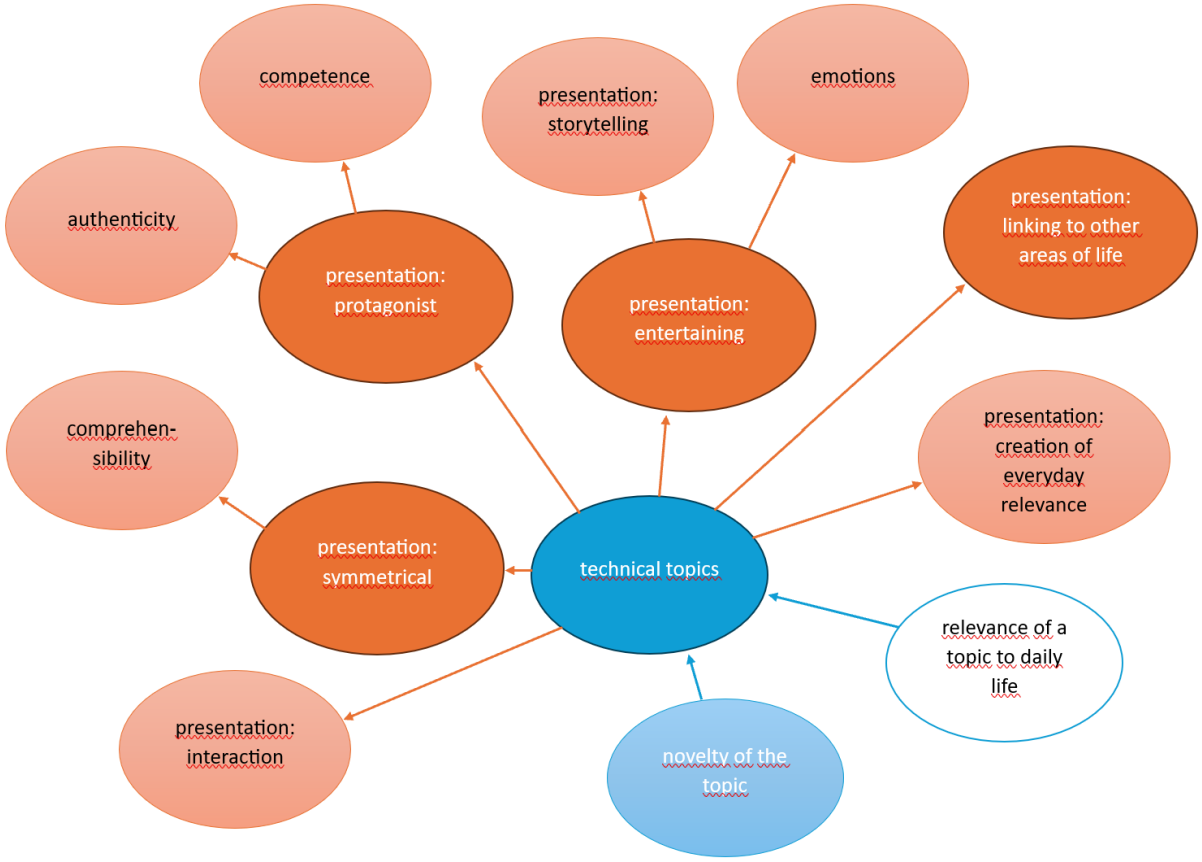


Figure 2. *Category System for Phases 1 to 3 and Developed Concept*



Note: Blue represents the technical topic to be communicated and its characteristics. Orange represents the most important factors for presenting the topic in a video, based on the findings of the project. A lighter shade of orange represents other influential factors, such as comprehensibility and interaction between the protagonists and the audience, based on symmetrical communication at eye level.

RESULTS

Following grounded theory methodology, the results were synthesised across the three data-collection phases and organised around the three research questions. Quotes from participants are used to provide further evidence for the conclusions drawn.

Technical Areas of Interest

Observations during video production, analysis of the produced videos, and individual interviews revealed that girls are interested in technical topics that are close to their everyday lives, offer opportunities for creativity, and have practical benefits. The technical topics of most interest are smartphones, computers, 3D printers, robots, online games, programming, camera and editing techniques, video production, and photography. The concrete applications of technology aroused more interest than the exact functioning of technical devices and processes. The girls also highlighted new topics related to everyday technology as particularly exciting. One participant responding to a video entitled, "This is How Your Bluetooth Speaker Works", shared:

> *I also found it interesting to ask why the different speakers differ in quality. That's something I didn't really know before* (HA, Age 15).

The participants also showed interest in technical innovations that could become relevant to their daily lives in the future: drones, rockets, autonomous driving, space debris, but also renewable energy and technical solutions for climate change. "Wouldn't it be cool if you could 3D print your own smartphone in the future?" is the opening line of a video explaining CAD and 3D printing. A video showing a car that can already drive partially autonomously elicited the following comment from a participant, which shows girls are able to consider future relevance:

> *I thought it was the best of all. (...) because I think it's really cool that we're already that far* (CE, Age 14).

In the online survey, interest in the topics of the videos was queried. For the overall sample of female high school students aged 12 to 16, seven out of nine videos showed a statistically significant medium-strength correlation between video evaluation and topic interest. The topic itself had a similarly large influence on the video rating as its entertaining presentation (weighted mean correlation across all videos 0.46) and was more important than comprehensibility (weighted mean correlation 0.28). All correlations are shown in Table 1.

Table 1. *Correlations of "Interest in Topic", "Entertainment" and "Comprehensibility" and "Video Rating" by girls participating in the survey in Phase 3.*

Video Topic	**Interest and Video Rating (Ccorr*)**	***p***	**Entertainment and Video Rating (Ccorr)**	***p***	**Comprehensibility and Video Rating (Ccorr)**	***p***
Space Debris	0.68	<0.001	0.54	<0.001	0.21	0.217
Autonomous Driving	0.55	0.002	0.56	<0.001	0.38	0.016
CAD und 3D Printing	0.27	0.292	0.35	0.036	0.09	0.614
Renewable Energy	0.55	0.002	0.52	<0.001	0.44	0.003
Game Design Challenge	0.51	0.004	0.54	<0.001	0.13	0.454
The Technical Laboratories of the University	0.64	<0.001	0.57	<0.001	0.62	<0.001
Polaroid Camera	0.37	0.094	0.19	0.210	0.13	0.386
Programming a Game of Pong	0.51	0.002	0.50	<0.001	0.28	0.061
Solar Power Robot	0.44	0.036	0.44	0.004	0.25	0.134
Weighted arithmetic mean of the contingency coefficients	0.50	-	0.46	-	0.28	-

Note: Online survey with 108 girls. The video rating (thumbs up, thumbs down) was correlated with the interest in the topic, the feeling that it was fun to watch the video and the comprehensibility of the presentation per video. The weighted arithmetic mean of the contingency coefficients was calculated to evaluate the correlation between topic interest and video rating across all videos.

Except for the video on the functioning of Polaroid cameras, all other videos received positive feedback from boys as well (see Table 2). Polaroid cameras were the least interesting topic for the boys. On the other hand, topics like CAD and 3D

printing were deemed interesting by three quarters of both girls and boys; however, the implementation of the videos was rated differently by the two groups. Among girls, the video about CAD and 3D printing was in first place with 78.1% thumbs-up reactions, while only 56.5% of boys gave it a thumbs up. For media creators, the topic areas around technology that could appeal to both girls and boys are particularly interesting: these are technologies that will play a role in the lives of young people in the future, a trend also observed in a study by Götz et al. (2023).

Table 2. *Evaluation of the Videos in the Online Survey in Comparison to the Interest in the Topic*

		Girls (n= 108)		**Boys** (n=52)	
Video title	**Topic**	**Thumbs up in %**	**Topic interest in %**	**Thumbs up in %**	**Topic interest in %**
CAD and 3D Printing (G)	CAD and 3D-Printing	78.1	78.1 (*n*= 25/32)	56.5	73.9 (*n*= 17/23)
A Day at the University (G)	The Technical Laboratories of the University	78.0	75.6 (*n*= 31/41)	62.5	75.0 (*n*=6/8)
Your Car Will Soon be Driving You (St)	Autonomous Driving	77.1	68.6 (*n*= 24/35)	81.0	90.5 (*n*= 19/21)
What's Inside Your Polaroid (St)	Polaroid Camera	75.6	65.9 (*n*= 27/41)	37.5	25.0 (*n*= 2/8)
Why Space Junk Affects You (St)	Space Debris	75.0	78.1 (*n*= 25/32)	87.0	65.2 (*n*= 15/23)
Build Yourself a Friend (G)	Solar Power Robot	71.4	57.1 (*n*= 20/35)	57.,1	47.6 (*n*= 10/21)
Create Your First Game ...! (G)	Programming a Game of Pong	70.7	61.0 (*n*= 25/41)	87.5	100.0 (*n*= 8/8)
3-Day Game Design Challenge (G)	Game Design Challenge	68.8	62.5 (*n*= 20/32)	69.6	60.9 (*n*=14/23)
Shit! Will It Save Our Arse? (G)	Renewable Energy	62.9	60.0 (*n*= 21/35)	61.9	61.9 (*n*= 13/21)

Note: Presentation in order of the videos that received the most thumbs up from the girls. There were four groups of respondents, each of whom watched a different set of three videos in a controlled way. It was not possible for all nine videos to be watched by precisely equal number of young people; this is especially true for the comparison group of boys. 'G' stands for girls as video producers, 'St' for students.

Presentation of Technical Topics in Videos

The way technical topics are presented plays a crucial role: if the topic does not provide a natural link to other areas of life, such a link should be established to win over female viewers. Additionally, humour and emotions should be used even when dealing with complex technical topics. Finally, errors in handling technology should be shown along with the possible solutions.

Linking to Other Areas of Life

It is important to clarify what technology is used for. Ideally, the application should lie in areas that tend to interest girls, such as sports, art, health, or lifestyle. Evidence for these insights was found in all three research phases. For example, in one video, an ordinary printer is turned into a 3D mobile phone printer, with the protagonist imagining a future in which she prints several phones a week. In this way, it shows a plausible connection between technology and living environment that research in the STEM field considers to be important (Solga & Pfahl, 2009). In another, the 'expert' explaining programming software is an animated cat, a feature playful referring to everyday life with pets. This approach was well-received in the individual interviews:

> *I think it would be cute if I had such a solar robot rolling around at home* (EV, Age 14).

This preference for relevance is also reflected in the ranking of the videos in the online survey: for example, the video on CAD and 3D printing, in which a small figure in the shape of a cat is designed on the computer and then printed, receive ample approval (see Table 2). The same applies to the student video on space debris: an old plastic bottle falls from the sky and hits a protagonist on the head, which acts as a lively lead into a discussion of issues such as the negative effects on the accuracy of weather apps.

Entertainment, Humour, Emotions, and Storytelling

The young video producers expressed the desire to complement fact-oriented presentations with entertaining elements:

> *So that it isn't always so factual and boring* (SO, Age 15).

They also considered it important to make the audience laugh and to talk about technology in a humorous way. However, it was not always possible for them to meet this aspiration. For instance, one team brought a large garden wind turbine as a prop.

> KA (Age 16) asks: *And then I'm supposed to trip over the wind turbine, or what? (laughs)*.
> LE (Age 15) replies: *I'd do it without tripping; nobody trips over a wind turbine*

As viewers, however, the girls rated the entertaining and humorous aspects of watching a video highly, as the individual interviews and online survey (item 'entertainment') showed. The interviewees spoke out in favour of a humorous presentation:

> *Well, the video was also fun to watch* (commenting on the video "A Day at the University") (KA, Age 14).

> *That's why situations that are a bit funny or have some humour are cooler* (EV, Age 14).

In the online survey, respondents were asked whether they enjoyed watching it at the end of each video. For the overall sample of female students, a statistically significant medium-strength correlation between video evaluation and pleasure was found for eight out of nine videos (weighted mean of contingency coefficients: 0.46; see Table 1).

According to studies on media usage in general (i.e., beyond technology), girls prefer not only more entertaining but also more emotional content (Feierabend et al., 2022; Gräßer & Gerstmann, 2017; Tillmann, 2017; Weber, 2015). Further evidence for this in relation to technology videos could be seen in the results from both Phase 1 and Phase 2. Feelings played a role in the negotiation processes during the development and implementation of the video ideas. At the end of a video, the protagonists say:

> *It was a lot of fun, and we learned a lot* (Participant Created Video, "A Day at the University", Min. 4:09).

The emotions conveyed in the videos are predominantly positive. Music is also consciously used to create a positive basic mood. However, sadness and loneliness are also addressed and musically accompanied, with technology– in the case of the video entitled "Build Yourself a Friend", a small robot– helping to overcome these feelings. During the evaluation of the videos, some respondents were surprised by the emotional presentation but then stated that they preferred a cheerful presentation to a factual one:

> *It had a very cheerful effect. (...) Also, it was factual. But I wouldn't have expected music like this*. Asked which version she preferred, CE said: *This version* (the one with cheerful music, "CAD and 3D Printing") (CE, Age 14).

Emotions also play a role in traditional storytelling. However, the importance of narratives in which a character has to solve a problem has not been confirmed in this study. This may be due to the new very short formats that have become established on YouTube, which concentrate on an attention-grabbing introduction (Osing, 2022b). While the girls' videos include dramaturgical elements of digital storytelling, such as feelings and humour, a successful technology video for girls does not necessarily require the suspense arc of a story.

Errors in Handling Technology

The existing state of research did not lead us to expect that showing errors in handling technology, along with possible solutions, would be important. However, this was the finding our study produced. The young video makers stressed this aspect verbally and applied it across the various YouTube genres: challenges, explanatory videos, tutorials, and vlogs. Discussing errors in technology handling apparently does not contradict the perceived competence of the protagonists. For example, during the exchange while working on the videos, one girl says:

> *I think it’s cool that you also included the errors* (EL, Age 14).

The importance of errors was also emphasized in discussions about sample videos they had watched for inspiration:

> *What I missed in some videos was that the errors weren't mentioned. When you try to recreate what is shown in the video, you make mistakes but don't know how to proceed* (LE, Age 13).

Comprehensibility

In Phase 1, comprehensibility was understood as explaining technical processes in a way that enabled viewers to understand and implement them. Explanations often proceeded step by step, using visualizations (e.g., holding instructions up to the camera). When evaluating the videos in Phase 2, the respondents also emphasised that the topic needed to be presented in full. Especially with tutorials, it was important that they could follow exactly what was happening. They wanted this complete visualisation of a technical process to be guaranteed by design elements such as a bird's eye view, which makes otherwise hidden processes visible.

For the overall sample, the online survey revealed a statistically significant correlation between video evaluation and understanding of the content for only three out of nine videos (Autonomous Driving Ccorr 0.38, Renewable Energy Ccorr 0.44, Day at the University Ccorr 0.62; see Table 1). Compared to the factors 'interest in topic' and 'entertainment', understanding had a less strong influence on liking or disliking the video (see weighted means in Table 1).

In addition to the aforementioned content-related aspects, formal ones such as correct presentation and professional visual and audio design were important across all three phases. The producers also placed particular emphasis on aesthetics in the sense of a 'beautiful' and 'attractive' presentation of technology. For example, the girls selected the 'most beautiful' smartphone for filming and staged it. They also proudly presented particularly beautiful video recordings. If technology is perceived as unattractive, this is commented on:

> *That's so ugly.* (holds up the phone with the opened app to the camera) (LA Age 16).

To beautify technology, they consider painting it, for example:

> *We can paint the rocket in many colours later* (EM, Age 13).

Thumbnail and Title

According to the interviews conducted in Phase 2, though explicitly depicting the topic in the thumbnail helps grasp it at first glance, an overly strong focus on technology might deter some girls. When selecting thumbnails, girls prefer those they find striking and/or aesthetically pleasing. Colourful thumbnails are favoured. Additionally, non-technical design elements, such as flowers placed near the technology, are positively highlighted.

The video titles, on the other hand, were best received if they clearly communicated the topic: "Your Car Will Soon Be Driving You" or "How Your Bluetooth Box Works". Girls shared that the title should also appear on the thumbnail. Video titles that pose questions and directly address the audience were also well-received. One example an interviewee referenced was "Why Space Junk Affects You":

> *I wouldn't have known it affects me. (...) I find it interesting how and why* (EL, Age 14).

Importance of Protagonists

In selecting protagonists, the desire for symmetrical communication (i.e., protagonist and viewer are on equal footing), plays a crucial role in arousing interest in a video. Sociodemographic characteristics such as age and gender are significant so that the girls can identify with the main character. However, for the young female audience, the perceived authenticity and competence of the protagonists in the videos are at least as important as sociodemographic characteristics, regardless of whether they appear as speakers or actors. The findings align with earlier assumptions from research literature. In this section, we draw on findings from the video production and individual interviews. In addition, some references in the free text responses at the end of the online survey were included in the analysis.

Symmetrical Communication

Although the original task in Phase 1 was to create videos for girls, none of the groups explicitly mentioned this target audience when developing their scripts. In one session, the task was criticised:

> *It sounds like girls of our age don't care about or understand technology at all* (KI, Age 13).

Nevertheless, the protagonists and speakers in all videos are girls aged 12 to 16. In some videos, they introduce themselves by name; in one case, they used modified versions of their brothers' names:

> *Let's take our brothers' names in female form* (LE and LO, 13 and 12).

Observations also showed that some teams initially considered male protagonists. Only after further engagement with the character did all teams conclude that the protagonist should be female, mainly because they themselves were girls.

> KA (Age 16): *I wrote 'he'.*
>
> MA (Age 16): *Why 'he'? It should be 'she', we're all girls, aren't we?* (laughter).

In another group, the girls decided that SH should be the protagonist who was conceived as a man.

> SH: *No, I'm a female role*. MO and SH wrote down 'female protagonist' (MO and SH, Ages 12 and 13).

The fact that all videos feature girls as main characters was not particularly emphasised by the interviewed viewers, and the category of gender was not explicitly mentioned. The age of the protagonists, on the other hand, was positively noted. The proximity of the protagonists' age to that of the viewers was seen as a positive aspect:

> *Because I think it's a current topic, and I find it interesting to hear about it from people who are relatively close to my age* (EM, Age 14).

One girl expressed surprise that the technology usage (CAD and 3D printing) shown in the video was already possible at her age:

> *I find it really impressive that we can do such things and that we can already do them at our age* (CE, Age 14).

Analysis of the videos revealed that the protagonists often directly address the viewers (eye contact with the camera) when speaking. To create a sense of closeness between protagonists and viewers, filmic design elements such as handheld camera perspectives or camera movements towards the protagonist are used, along with facial expressions and gestures:

> *While she continues speaking, she walks towards the camera, gesticulates with her hands, and nods her head* (Participant Created Video "Renewable Energy" Sequence Protocol, Min. 0:42).

This approach signals a symmetrical, interaction-focused communication style.

Although the girls favour personal addressing, not all are comfortable with showing their faces to the camera. But even those who are not, fear that their topic would be harder to convey without a 'face in front of the camera':

> *I don't think it makes sense if we don't want to be seen while presenting the topic* (AR, Age 15).

The interviewed viewers, too, wish to experience the technology vicariously through the protagonists and see it 'through their eyes':

> *It was fun to see the university a bit through them* (KA, Age 14).

At the same time, they positively highlight the protagonists' assessments and evaluations of the technology.

Authenticity and Competence

The video producers in Phase 1 aimed to be as honest as possible with the viewers. They emphasised that certain steps were particularly challenging but encouraged the audience not to give up:

> *It doesn't go in [note: attempting to insert a wooden piece into a designated slot] ... does it? It doesn't! But now it does.* (Participant Created Video Clip "Solar Satellite", Min. 2:13)

Additionally, the protagonists tested and evaluated the technology for the viewers, sharing their personal opinions and feelings:

> *I realised it really requires a lot of time and perseverance. (...) But it's worth it. It's cool* (Participant Created Video "Game Design Challenge", Min. 2:30).

Authenticity paired with professionalism was also praised by the interviewed viewers: One student offered both a positive and negative example.

> *I think it should be credible what you tell others, or pass on* (EM, Age 14).

> *It seemed like she didn't really believe what she was saying. (...) She didn't radiate that she was really convinced* (EM, Age 14).

The girls also appreciated protagonists conveying a positive mood. They should appear confident and self-assured, it was argued:

> *I really liked how they were so full of energy and explained everything happily and confidently. And I think they really stand by it and find it cool* (HA, Age 15).

Poorly acted performances or outdated clothing styles or hairstyles were found unforgivable: several respondents stated they could no longer identify well with the protagonists and found them unconvincing. Here is one critical assessment of a performance for illustration:

> *It sounded like the text wasn't rehearsed, resulting in speech errors.* (free-text response from phase 3).

DISCUSSION

The concept developed in this study for presenting technology topics to girls in the media should be seen as a starting point. The important factors identified, and how they relate to each other, need to be examined in future research although some findings align with earlier assumptions from the research literature and have been confirmed and applied to video production. These include the importance of role models and their similarity to the audience in terms of gender and age (Gladstone & Cimpian, 2021; Steinke & Duncan, 2023; Weber, 2015). The results also confirm that video topics should offer practical everyday relevance and be close to the viewers' daily lives. This aligns with existing studies on girls' interest in technology (Happe et al., 2020; Keil & Orth, 2020). The recommendation to connect technology with other areas of life aligns with previous research (Cheryan et al., 2015; Diekmann et al., 2010) and helps differentiate the approach.

Moreover, the study also provides new insights. Most notably, it highlights the importance of depicting errors in handling technology and potential solutions. This applies across various YouTube genres, including challenges, explanatory videos, tutorials, and vlogs. Addressing technical problems does not contradict the required competence of the protagonists in handling technology.

The demand for an aesthetically pleasing, "beautiful and appealing" presentation of technology is noteworthy. The researchers were surprised by the high expectations the girls had for professional visual and audio design. This desire for professionalism is also reflected in their emphasis on the accuracy and completeness of information in the videos. Clear and understandable media coverage of technology is therefore fundamental to sparking the interest of girls and young women. However, according to the online survey, entertainment prevails over comprehensiveness, although this does not apply to all YouTube genres, such as tutorials.

From a theoretical perspective on digital publics (Drüeke, 2023; Paulitz, 2014), it is important to note that despite some interactions during the publication of the videos on YouTube, no discernible community has emerged. Nevertheless, it is assumed and is worth exploring in a follow-up study, that all participating girls were influenced by the project in their subjective positioning towards technology. In the best-case scenario, they expanded their understanding of and interest in

technology. Such shifts in the (de)construction of technology as culture were suggested by their behaviour and statements in the framework of the project.

In line with Cultural Studies (Women's Studies Group, 1978), the subversive and empowering potential of active media engagement around technology themes has been made visible. However, the theoretical framework also calls for patience. In the spirit of a 'long revolution', potential changes in discourses around technology can only be captured through long-term studies.

Critical Evaluation of the Methodological Approach and Discussion of Limitations

When girls express interest in technology topics such as space debris, autonomous driving or CAD and 3D printing in an online survey, they, as well as boys (among whom a video on programming received the highest rating and greatest interest), may be demonstrating a form of "doing gender". Similarly, girls' demand for an aesthetically pleasing representation of technology and the staging of their own person in the videos might have been influenced by societal expectations during the video production process and/or by the aesthetic staging of products and individuals they encounter daily on platforms like Instagram.

The method of video production within a female peer group created spaces in which the girls could freely explore their interest in technology without external expectations, mutually reinforcing their engagement with the subject. A limitation in Phase 1 arose due to the outbreak of the COVID-19 pandemic and subsequent school closures. In a change to the original plan, the courses where videos were finalised were held at a university during summer schools and likely attracted girls already interested in technology. This bias does not apply to Phases 2 and 3. In accordance with qualitative research quality criteria, the researchers continuously reflected on their preconceptions and roles in interacting with the participants, documenting these reflections in documents or analysis tools.

The Phase 3 questionnaire was intentionally kept simple. When assessing video stimuli, which encompass numerous variables beyond those addressed in the questionnaire—such as setting, music, pacing, and editing—it is inevitable that some intervening variables remain unrecorded.

The three research questions cannot be conclusively answered based on the study conducted. However, it is was possible to identify various factors that contribute (or do not contribute) to the attractiveness of technology reporting, and to present their relative importance. Further research could replicate this study in cultural contexts where technology holds a different societal and economic significance from that in Western countries. Based on international statistics (UNESCO, 2021), countries such as Algeria, Bangladesh, or Peru—each with around 50% female engineering students—represent particularly promising contexts for such research. In addition, the influencing factors identified concerning the selection and presentation of technical topics, as well as their interrelationships, should be examined in greater depth in future experimental studies.

Outlook and Guidelines for Practice

Media producers in broadcasting institutions and agencies handling public relations for technology companies can use various approaches for creating technology videos targeting girls and young women. However, they cannot proceed without actively involving the target group, including as protagonists in videos. Girls who genuinely engage with technology and whose enthusiasm for the subject resonates with young viewers must be identified. The following guidelines have been derived from the findings of this study and identified as significant for communicating technology to a female young audience without a strong technical inclination:

1. When choosing topics, favour those that are close to the everyday life of the target group but still have 'futuristic' appeal.
2. Connect technology and science topics with other areas of life, such as sports, art, lifestyle, or health.
3. Explain technical products and processes correctly and comprehensively, avoiding jargon.
4. Ensure professional visual and audio design, focusing on aesthetic presentation even for dry or complex topics.
5. Show challenges and errors in dealing with technology.
6. Prioritise entertainment and fun (through humour and emotion) over comprehensiveness
7. Feature representatives of the target audience – girls and young women – who are competent in handling the depicted technology.

The hope that the videos produced following these developed guidelines might also attract interest from other groups (beyond the initially targeted girls and young women) has been partially fulfilled: overall, boys and young men rated the videos positively. However, differences in evaluations between the two groups were evident. This suggests that further studies should examine whether the guidelines can be applied to other underrepresented groups in technology communication. With the growing reach of TikTok– a platform that had not yet gained prominence at the project's start– future research could incorporate this platform (or whatever new platform will become fashionable) into their analyses.

CONCLUSION

In conclusion, the study adopted cultural-sociological perspectives, focusing specifically on the communication of technology in the media to address the difficulty of achieving gender equality in STEM, particularly in technology. Building on Tanja Paulitz's (2010) idea that technology is a socially contested area of expertise, the argument is that girls and young women should participate in the spaces where technology's meaning is negotiated and defined, whether in media organisations as professional photographers, filmmakers or journalists, or in women's online communities where they can discuss technology and support each other in developing their own perspectives. Döring's (2015) finding that gender-homogeneous social communication spaces develop around beauty YouTubers suggests that this could also be possible for technology.

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