Exploring the Influence of Technology Exposure on Computer Science Self-Concept

A study among young adults in Germany

Claudia Hess, Sibylle Kunz, Cornelia Heinisch and Adrienne Steffen
IT & Engineering / Management
IU International University of Applied Sciences
Erfurt, Germany
e-mail: claudia.hess@iu.org; sibylle.kunz@iu.org; cornelia.heinisch@iu.org; adrienne.steffen@iu.org

***Abstract*— Given the high demand for qualified computer scientists, understanding young adults' career decisions in this field is crucial to ensuring an adequate talent supply. Despite the high demand, women remain underrepresented. This paper examines one particular influencing factor: technology exposure. Based on quantitative data from over 800 young people in Germany, it analyzes how the availability of information and communication technology affects young adults' perception of their skills, abilities, and competence in the field of computer science. Special emphasis is placed on gender differences within this context of digitization adoption.**

Keywords-technology exposure; impact of ICT usage; young adults; computer science self-concept.

I. Introduction

In recent decades, there has been a high demand for well-trained specialists in the field of Information and Communication Technology (ICT), and industry has complained about a shortage of skilled workers. Although advances in Artificial Intelligence (AI) raise questions about the extent to which ICT jobs will be impacted by automation and whether there will still be a need for ICT professionals, recent studies [1] predict a continued strong demand for ICT professionals, as well as specialists skilled in working efficiently with ICT and AI systems. The required extensive re- and upskilling will only be successful if people are interested in Computer Science (CS). A large gender gap can be seen here. Despite the importance of ICT roles, women continue to be significantly underrepresented. In 2023, only 19.4% of ICT specialists in the EU were women, compared to 80.6% men [2]. This gender disparity poses several problems, including the loss of diverse perspectives that are vital for innovation and a reduced talent pool that makes it more challenging for companies to fill critical roles.

In light of these challenges, it is important to explore the factors that influence young men's and women's decisions regarding a career in CS. A critical driving factor is a person's perception and beliefs about their abilities, skills, and competence in this field. Past experiences, feedback, the immediate environment, and comparison with others influence this self-concept. One particular factor is exposure to technology, which is the focus of this paper. While many studies, particularly within school contexts, examine how ICT availability and use affect students' confidence and competence in using technology or its impact on math and science achievement, this study takes it a step further. It investigates whether exposure to technology can inspire interest in CS by making young people more comfortable with the basic concepts and applications of technology. To this end, data from a study on more than 800 young adults conducted in Germany in 2024 is analyzed. Understanding these dynamics will help educators, policymakers, and industry leaders encourage a diverse range of young people, especially women, to pursue careers in CS.

This paper is structured as follows. Section II presents the theoretical background on technology exposure and its effects. Section III explains the methodology used in the presented study, introduces the sample as well as limitations. Then, Section IV presents the data analysis. Section V includes the discussion of the findings. Finally, Section VI concludes the paper and outlines areas for future research.

II. Theoretical Background

A. Technology Exposure of Young Adults

Exploring the aspect of technology exposure requires understanding that it encompasses a wide array of experiences and opportunities through which individuals interact with information and communication technologies. Salanova and Llorens extracted in their literature review different indicators connected with technology exposure, especially "the amount of time using technology, times used before feeling comfortable, frequency of technology use, participation in technology training, use of technology at work and at home, personal computer ownership, computer usage frequency and computer usage level" [3]. Apart from the term "technology exposure", the terms "technology experience" and "technology use" are also commonly used [3], as well as "ICT use" [4]. The impact of young adults' exposure to technology has been particularly studied. Figure 1 shows the four different perspectives taken:

1) Availability and use of ICT devices at home: Access to digital devices, such as computers, tablets, smartphones, game consoles and even VR glasses at home allows young people to explore technology on their own. The presence of ICT devices can encourage experimentation and the development of digital literacy from an early age [5]. In addition to availability, the type of usage can be differentiated according to whether it is used for leisure, such as social media or gaming, or for schoolwork [4].

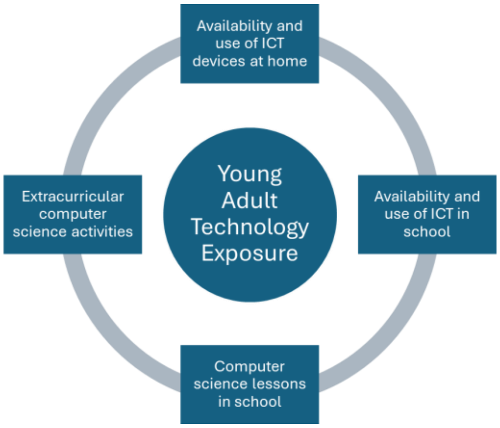


Figure 1. Technology exposure of young adults, Source: own depiction.

2) Availability and use of ICT in school: In many countries, and especially since COVID-19, ICT has become available in schools. Students of all ages are learning basic ICT skills, such as creating presentations, using spreadsheets or ten-finger typing. Sometimes, technology is integrated into different subjects, which helps students recognize the relevance of ICT across diverse fields. The extent to which ICT is used as a tool for learning—such as engaging in interactive learning experiences via websites and mobile apps—can have a significant impact on students' familiarity with technology [6].

3) Computer science lessons in school: In recent years, many countries have introduced in-school offerings of CS education, though lesson frequency and depth often vary [7]. In Germany, the annual "computer science monitor" published by the German Informatics Society reveals significant differences between federal states, ranging from minimal voluntary classes to compulsory CS lessons for all school types [8]. Formal CS education, which includes hands-on experiences, such as programming or robotics, can foster students' interest in the field [9]. Such lessons provide foundational knowledge and boost students' confidence in pursuing studies or careers in the field.

4) Extracurricular computer science activities: Participation in technology-related extracurricular activities, such as coding clubs, robotics teams, or competitions allows students to explore technology in creative and applied ways [9]. Students may also be exposed to online tech communities where people discuss technology trends, share projects, and exchange knowledge. These interactions not only provide informal learning opportunities, but also help build a sense of belonging to the broader tech community.

B. *Impacts of Young Adult Technology Exposure*

The effects of technology exposure on young adults have been analyzed from different perspectives.

1) Impact on students' performance in science and math: In the last fifteen years, many studies have used the data from OECD's Programme for International Student Assessment (PISA), which evaluates how well 15-year-olds can apply their knowledge and skills in reading, mathematics and science to real-world tasks. In particular, the effects of ICT use in classrooms for teaching and learning purposes as well as ICT availability at home on students' performance in math and science were analyzed for various countries [4][10]. None of these studies specifically examined the impact on CS achievement, as CS was traditionally not in the focus of PISA.

The review of a large number of studies in [4] shows mixed results on how ICT availability, use, and engagement affect students' math and science scores. To provide clarity, they compared the results of the four PISA surveys from 2009, 2012, 2015 and 2018. They found no meaningful positive link between math or science performance and ICT use, whether that use occurred in or out of school, and whether it was tied to specific academic subjects or not [4]. Similarly, [11] examined the relationship, noting mixed effects of ICT availability on academic achievement, with a negative direct effect for males, neutral for females, and positive indirect effects via ICT mastery and autonomy—topics explored further in the next paragraph.

2) Impact on digital literacy: Exposure to ICT also influences comfort and competence with ICT. Starting in 2025, PISA will include a new assessment, the "Learning in the Digital World" test, which will evaluate how well students can use computational tools to engage in an iterative process of building knowledge and tackling real-world problems [12]. Pre-tests indicate that students who regularly use ICT across various subjects tend to perform better [6]. Moreover, students who feel confident in their ICT skills and show interest in ICT perform at higher levels. Further studies investigate more specific aspects of students' ability to use ICT tools effectively. For instance, [13] examines how the usage of educational technology affects students' internet self-efficacy. While these studies focus on digital literacy, CS self-concept is about how confident students feel when it comes to engaging with CS tasks.

3) Impact on career decisions in STEM: Research has examined whether and how technology exposure increases the sense of familiarity, confidence and interest in pursuing STEM subjects and, consequently, influences an informed career decision regarding STEM. Among the different perspectives of technology exposure, these empirical studies often focus on STEM school lessons or STEM programs. An example is the impact analysis of a program for students about robotics design and production in the USA, which increased participants' career choice in STEM [14]. While many studies have examined the effects of various variables on young adults' STEM career choices (e.g., interest, self-efficacy, influence by family) [18], less attention has been given to the role of ICT availability and use at home or during leisure time in career choice specifically in CS.

C. Ability Self-Concept

The expectancy-value theory by Eccles and Wiegfield [15] posits that a person's motivation to engage in a particular task is determined on the one hand by their expectation of success in that task, and on the other hand, on the value they place on it. It helps explain motivational factors that translate into behavioral outcomes, such as selecting a particular study program or career path [16]. The ability self-concept refers to a person's perception of their own competence in a particular domain, e.g., to perform tasks or succeed in activities. An example that is extensively studied is the self-concept of math ability, or short math self-concept. It is influenced by previous experiences regarding math, feedback from significant others, such as parents, teachers, and peers, the immediate social environment, and social comparisons, e.g., to classmates in math tasks [16].

1) Computer Science Self-Concept

Just as with math self-concept, the idea of self-concept can be applied to CS, referring to the question "How do I assess my own skills in CS?". While some studies address the self-concept of computer ability [16], these usually focus on general computer usage skills, such as using software, or internet navigation. In contrast, CS self-concept is concerned with perceiving CS as an academic and professional field, including for instance programming, understanding algorithms, or problem-solving. It reflects confidence in handling tasks central to the field, such as coding or designing computational solutions. Unlike math and science self-concept, the CS self-concept seems not well covered.

2) Gender differences in STEM-related self-concepts

Past research often revealed gender differences in STEM-related self-concepts, being already apparent at school. Typically, boys express greater confidence in their success and skills in areas traditionally considered male-dominated, such as mathematics, physical sciences, and sports [16]. Conversely, girls tend to have a higher self-concept of their verbal abilities compared to boys.

III. Methodology

A. Study Design

The data analyzed in this paper come from a German-wide study on young adults' CS career choices. Ethical clearance was obtained from the ethics committee of the authors' institution. In June 2024, an online survey was conducted with a reputable market research organization using their market panel of young adults in all German federal states. This form of collaboration was chosen because regulations on whether and how students can be contacted via schools differ among Germany's federal states. The study was funded by the authors' higher education institution.

The online questionnaire contained closed and open-ended questions, taking a total of about 15 minutes to complete. It asked for the determinants of students' career decisions and their perceptions of CS as a viable professional path. One set of questions was about technology exposure.

B. Sample Composition

The survey targeted 15- to 20-year-olds who are deciding on a career or have recently done so. As the aim of the study is to analyze the factors influencing career choice, it was crucial that participants were in this decision phase, hence excluding those outside this age group. Those under 15 often have not yet chosen a profession, while those over 20 usually have. A total of 822 respondents participated in the survey. The sample comprised 315 (38.3%) young men, 506 (61.6%) young women, and one person who identified as non-binary (0.1%). Table I summarizes the sample characteristics.

TABLE I. SAMPLE CHARACTERISTICS

Age	**Results**			
	Female N (%)	***Male N (%)***	***Non-binary N (%)***	***Total N (%)***
15	37 (7.3%)	44 (14.0%)	0	81 (9.9%)
16	60 (11.9%)	53 (16.8%)	0	113 (13.8%)
17	84 (16.6 %)	58 (18.4%)	0	142 (17.3%)
18	133 (26.3%)	75 (23.8%)	0	208 (25.3%)
19	99 (19.6%)	37 (11.7%)	1 (100%)	136 (16.6%)
20	93 (18.4%)	48 (15.2%)	0	141 (17.2%)
Total	**506 (100%)**	**315 (100%)**	**1 (100%)**	**822**

C. Research Questions

The studies in Section II analyzed technology exposure effects on various aspects but, to our knowledge, did not examine its impact on CS self-concept. Building on the Expectancy-Value Theory, we hypothesize that as students become more familiar with ICT, they will develop a greater appreciation for the underlying principles of these technologies, thereby increasing their interest and belief of success in promising and well-paid technical careers. Analyzing a particular subset of the study should help fill this research gap by examining whether technology exposure at home has a positive impact on young adults' CS self-concept. Special emphasis is placed on gender differences, as studies in STEM often report significant gender disparities.

D. Limitations

There are some limitations based on the study design and the data obtained. Although the participants were drawn from all federal states, the data are not fully representative of all German students and should not be generalized. Regarding the respondents' age, the young men were slightly younger than the young women. The data set contains only one non-binary person, who was excluded from all gender-specific analyses as no meaningful statistical conclusions can be drawn from a single participant. Moreover, the assessment of technology exposure has certain limitations, notably that it did not quantify the frequency of use of each device in terms of hours per week, nor did it assess the purpose of use like it was done for instance by [10].

IV. Data Analysis

A. *Young Adults' Technology Exposure at Home*

The survey asked about the use of ICT devices at home, especially a computer/laptop or tablet, the constant availability of Internet access, and the availability of a game console or Virtual Reality (VR) glasses. A 5-point Likert scale was used [1-strongly disagree to 5-strongly agree].

1) *Overview*

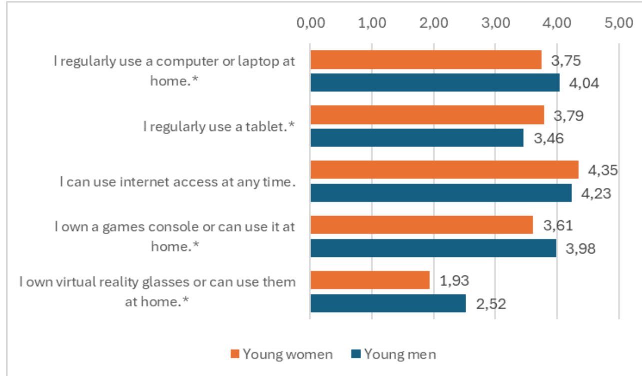
Table II shows the extent of technology exposure of the young adults surveyed. The vast majority of the young adults, 83.4% (sum of the top-2 boxes "agree" and "strongly agree"), have consistent internet access, underscoring prevalence of connectivity. Only 7.2% report limited internet access, indicating a minority facing potential barriers to ICT.

About two-thirds, 66.3% (top-2 boxes), regularly use a computer or laptop at home, indicating widespread access. A small percentage, 13.9% (top-2 boxes), do not engage in regular use, which may reflect either a lack of necessity or access. Tablets are also common (61.5%, top-2 boxes). A higher percentage (19.9%) report not using tablets regularly compared to computers/laptops (13.9%). Game consoles are popular, with 66.1% reporting access and 17.8% without. VR glasses have the least exposure, with only 19.6% reporting access and 67.2% lacking or not using them at home. These low figures reflect either the novelty, cost barrier, or niche market status of VR technology compared to more established devices like computers and tablets.

2) *Gender Differences*

The next step was analyzing gender differences. Figure 2 shows the technology availability and accessibility reported by young women and men for all five statements. Using an independent samples t-test, statistically significant gender differences could be identified.

Regarding the regular use of a computer or laptop, young men have a higher mean score (M_m=4.04, SD_m=1.108) compared to young women (M_f=3.75, SD_f=1.164). The difference is statistically significant (t(691)=-3.164, p<.001) with a small effect size (Cohen's d= -0.256), suggesting a slight gender preference towards computers among males. The opposite is the case for tablets, which are used more by young women (Mf=3.79, SDf=1.204) than young men (Mm=3.46, SDm=1.369). This difference is also statistically significant (t(602)=-3.518, p<.001) with a small effect size (Cohen's d= -0.260).



t-test, N female: 506, N male: 315, *. p < .001

Figure 2. Gender Differences in Technology Exposure.

Young men (M_m=3.98, SD_m=1.182) reported higher values with regard to the ownership and use of games consoles than young women (M_f=3.61, SD_f=1.311). This difference is statistically significant (t(717)=-4.219, p<.001) with a small effect size (Cohen's d=-0.296), indicating a more noticeable gender disparity.

With respect to the ownership or use of VR glasses, young men have a substantially higher mean (M_m=2.52, SD_m=1.408) compared to young women (M_f=1.93, SD_f=1.191), indicating greater access or usage among males. This disparity is statistically significant (t(584)=-6.175, p<.001) with a medium effect size (Cohen's d= -0.461).

Regarding the availability of internet access, there is no statistically significant difference between the genders (M_f=4.35 / M_m=4.23, SD_f=0.915 / SD_m=1.078).

B. *Young Adults' Computer Science Self-Concept*

To assess CS self-concept, an established scale based on the expectancy-value theory was used, adapting items from [17] originally measuring expectations of math success. For instance, the item "I am talented at math" was changed to "I am talented at computer science". While this approach uses an established scale, it carries the risk that essential CS-specific attitudes or experiences may be overlooked, potentially leading to an incomplete or less valid assessment of CS self-concept. The same 5-point Likert scale as for technology exposure was used.

TABLE II. Results on Technology Exposure

Technology exposure at home	**Answers: Total number = 822 (100%)**				
	Strongly disagree N (%)	***Disagree N (%)***	***Neutral N (%)***	***Agree N (%)***	***Strongly agree N (%)***
I regularly use a computer or laptop at home.	35 (4.3%)	79 (9.6%)	163 (19.8%)	236 (28.7%)	309 (37.6%)
I regularly use a tablet.	70 (8.5%)	94 (11.4%)	153 (18.6%)	229 (27.9%)	276 (33.6%)
I can use internet access at any time.	18 (2.2%)	41 (5.0%)	77 (9.4%)	223 (27.1%)	463 (56.3%)
I own a games console or can use it at home.	74 (9.0%)	72 (8.8%)	133 (16.2%)	245 (29.8%)	298 (36.3%)
I own virtual reality glasses or can use them at home.	362 (44.0%)	191 (23.2%)	108 (13.1%)	98 (11.9%)	63 (7.7%)

For the independent samples t-test, these items are aggregated for each participant to a single score “CS self-concept”. The average CS self-concept in the sample was M=2.96 (SD=0.950). The results show some caution in self-assessing one's competence, with many values falling in the moderate range. Comparing genders, young men have a higher average CS self-concept (M_m=3.35, SD=0.891) than young women (M_f=2.72, SD=0.906). The difference is statistically significant (t(819)=-9.735, p<.001) with a medium to large effect size (Cohen’s d = 0.699).

C. Impact of Technology Exposure On CS Self-Concept

Having analyzed technology exposure and CS self-concept separately, the relationship between these two concepts is explored. Like the CS self-concept, the overall technology exposure scale score for each participant is calculated based on the mean score of the above presented five items measuring various aspects of technology exposure.

1) Correlation

First, it is explored whether there is a positive correlation between technology exposure and CS self-concept. The hypothesis is: The higher a young adult’s overall exposure to technology, the higher their CS self-concept. Pearson's Correlation Coefficient was calculated. According to [18], there was a moderate to strong positive correlation between technology exposure and CS self-concept, $r(820)=.403$, $p<.001$. Looking only at young men, a strong positive correlation can be seen with $r_m(313)=.542$, $p<.001$, while there is a moderate positive correlation ($r_f(504)=.292$, $p<.001$) for young women.

2) Regression Analysis: Technology Exposure as Predictor of Computer Science Self-Concept

The next step was to examine whether technology exposure predicts the CS self-concept. Overall, the regression analysis showed a moderate effect with $R^2 = .163$, $F(1,820) = 159.297$, $p < .001$. For young women, the analysis indicated a small effect, with $R^2 = .084$, $F(1,504) = 47.134$, $p < .001$. Conversely, for young men, a strong effect was observed, with $R^2 = .294$, $F(1,313) = 130.110$, $p < .001$. These results suggest that technology exposure has varying predictive power on the CS self-concept based on gender. For young women, the small effect size highlights that technology exposure is a minor predictor of their CS self-concept. In contrast, it is a substantial predictor for young men. Approximately 30% of their CS self-concept is explained by technology exposure. This means that there are other factors that explain the remaining 70%, which could be factors, such as school experiences, family background, or friends.

V. Discussion and Implications

The data indicates gender differences in technology exposure at home, with males generally reporting higher usage of computers/laptops, game consoles, and VR technology, while females reported higher usage of tablets. The differences, though statistically significant, mostly indicate small effect sizes except for game consoles and VR, which show moderate gender-specific preferences. These results are in line with a German-wide study on the media equipment and media usage of teenagers (12-19 years) in 2024 [19]. In terms of owning devices, boys are more likely to own fixed and portable game consoles and computers compared to girls. In contrast, girls tend to own smartphones, tablets, and e-book readers more frequently than boys [19, pp. 7–8]. The study did not ask for the ownership or usage of VR glasses.

Bitkom e.V. analyzed the usage of consumer technology in Germany in 2024 [20], differentiating between age groups but not gender. In the group of 16 to 29-year-olds, 43% have already used VR glasses. Nearly half of this age group thinks VR glasses will become standard household equipment in the future. In the study presented here, about 20% of young adults reported the availability of a VR glass at home. This discrepancy between usage and availability suggests that while many young adults may have tried VR glasses, possibly at exhibition centers, in museums or event arenas, fewer of them have made the transition to owning this technology. This might be due to factors, such as cost, perceived need or little knowledge of possible applications.

The analysis in Section IV showed an overall moderate effect of technology exposure on young adults’ CS self-concept. Placing this effect in the context of device availability suggests that widespread access to ICT devices can nurture general comfort with ICT. While this baseline familiarity may build initial confidence, more advanced experiences – like using a computer for programming or a VR setting for simulations – may contribute more significantly than passive use for entertainment. This underscores the importance of school lessons that provide creative, hands-on, project-based CS learning opportunities and integrate CS concepts across subjects (e.g., use and discuss generative AI in art). Partnerships with industry can further reinforce exposure to real-world applications of CS. Additionally, other factors contribute significantly to an individual's CS self-concept, highlighting the complexity of self-concept formation, where experiences like school interactions, family support, peer influence, role models and personal interest play a crucial role, too [16][17]. Linking CS education in schools with the family and ICT usage at home—such as involving parents in collaborative digital projects including for instance programming or simulations in VR environments—could strengthen students’ perception of CS as valuable and accessible.

The analysis shows a gender disparity in the predictive power of technology exposure, suggesting young women need additional initiatives to address other influential factors. With statistically significant lower levels of exposure to computers, notebooks, and game consoles for young women, there is a clear need for targeted efforts to bridge this gap. Enhancing access to technology is essential, but equally important is addressing broader motivational and confidence-related barriers. Comprehensive strategies that foster inclusive learning environments, provide relatable role models, and actively challenge stereotypes can encourage young women to develop a stronger CS self-concept.

VI. Conclusion and Future Work

The study examined the relationship between technology exposure and CS self-concept among young adults, with a particular focus on gender disparities. The findings suggest that while technology exposure plays a role in shaping CS self-concept, it is not the sole factor, especially in the case of young women. It is recommended to complement this quantitative analysis in future research with a qualitative analysis. The sample contains open questions about critical incidents regarding CS. A first screening has revealed that some incidents describe successfully using ICT, installing software, or solving hardware issues, and highlight how overcoming technical problems can foster a sense of pride and motivate further exploration of CS. Moreover, age-specific differences, e.g. under and over eighteen, could be explored. If the quantitative survey is to be repeated, the questions regarding technology exposure should be refined. A further topic not yet considered is to examine the impact on economically disadvantaged youth who might have less access to more expensive ICT devices. By addressing these areas, future work can inform strategies that create a diverse and inclusive CS workforce.

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