Exploring students' stereotypes regarding computer science and stimulating reflection on roles of women in IT

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***Abstract*—The under-representation of women in IT has multiple possible causes, ranging from sociocultural aspects to individual dispositions and social attribution. This full research to practice paper explores secondary school students' (age 12-15) stereotypical perspectives of computer scientists and possible ways to challenge them. The major goal is to let young students form a more accurate concept of a computer science professionals by alleviating distorted images, often transmitted through media and the environment. Students who might not think of themselves as fitting in the prevalent stereotype of a computer scientist and may even lose interest in the field. Consequently, our approach challenges stereotypes in order to make any effort to raise young students' interest in computer science and in pursuing careers in this field.**

As part of this endeavor, we analyzed the drawings and descriptions of IT professionals made by 87 students aged 12-15 to determine what sets of preconceived perspectives and misconceptions are present in the learners' minds regarding persons in the IT profession. Our results have shown that that stereotypical views on IT actually exist in students' mindsets, but are subject to change when systematically challenged in a friendly and safe atmosphere. Aside of the scientific contribution, the paper aims to inspire and support educators in their efforts to help women and underrepresented groups in computing outgrow inaccurate stereotypes and to uncover young students' potential interest in the field. With this we aim to contribute to overcoming the gender imbalance and foster more equality in the occupational field of information technologies. Strategically, by creating a more sensitive, diverse and harmonious future that computer scientists knowingly and unknowingly co-shape.

***Index Terms*—gender, stereotypes, engineering, qualitative content analysis, reflection**

I. Introduction

The under-representation of women in IT has been a constant issue over the last decades. While other STEM areas have seen an increase in female students and practitioners, computer science and related disciplines have remained a largely male dominated domain. In fact, there actually might have been a trend of regression since according to Cheryan et al. [1, p. 1] "by the mid-2000s the percentage of bachelor's degrees in computer science earned by women had actually dropped by nearly half to around 20 percent". Further data from recent years on female students of computer science related studies published by various sources paint a similar picture and describe that the amount of women pursuing a computer science education has been mostly stagnant over the last decade [2]–[4].

Since many other STEM fields such as mathematics or biology seem to not have the issue of female under-representation in their respective fields - apparently mathematics has up to 44% female majors at some educational facilities [1] - the question stands what differentiates computer science from other disciplines and leads to such strong gender disparity in IT education.

There are various possible reasons for students' disinterest in taking up an IT education, such as economical issues and the fact that decisions on educational paths have to be made very early, when students are not fully aware of their goals and interests yet. However, the authors of this paper would like to argue that one major factor are inaccurate stereotypes of what being a computer science professional looks like which impact students' decision making.

According to Cheryan et al. [1] typical computer science stereotypes include technology-orientation, a singular focus on computers, a lack of interpersonal skills, high intelligence, negative physical features such as unattractiveness, pale skin and glasses and most noticeably a high degree of masculinity in the sense of computer science being a domain 'for males'

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or male dominated.

Previous studies on the effect of computer science stereotypes on the career decision affirm a significant impact of such stereotyping on the decision making of learners [5], [6].

The results of a second study conducted by Cheryan et al. [7] on the impact of media representation of stereotypes on the interest of pursuing a computer science major, showed that a fake article that aimed to dismantle stereotypes towards CS practitioners had a significant impact on the likelihood of women being interested in CS. Likewise increased exposure to IT courses can also lead to a significant decrease in the production of stereotypes among women when describing computer scientist [1]. However, it has to be stated that, the same research on descriptions of CS majors showed that women and men do not differ in their likelihood of mentioning certain categories [1]. Thus it can be deduced, that the reproduction of computer scientist stereotypes is not gender specific as it is culturally encoded practice. Especially, the stereotypical perception of STEM fields as masculine disciplines seems to have a considerable impact on the educational decision making process since, as shown by Makarova et al. [8], learners who perceived stem fields as more masculine had a lower likelihood of enrolling in them.

Additionally to the masculinity aspect of CS being a universal perceptions of both genders, it can be argued that women might feel contradicted in their self-image if they were to gain interest in a masculine coded field like computer science whereas men might feel an affirmation in their gender identity.

Furthermore, it is argued that educators might´´ disproportionately and unconsciously encourage students who fit the computer scientist stereotype to pursue CS" [9] and as such the opposite could be true for those who are contrary to such archetypes - women. But how come these stereotypes take the upper hand in the common discourse in the first place? In their report on diversity gaps in computer science , Google and Gallup argue that one of the key issues is the under-representation of women 'doing computer science' in media since students who expressed often seeing people like themselves do computer science in media were around twice as likely to have an interest in learning more about the field [9]. Thus, negative stereotypes and a lack of visibility of female computer scientists could form self-fulfilling prophecy based on stereotyping by reducing the interest and chances of women and elevating men instead. Through this, considering the already mentioned lack of female computer science majors, it is clear that female students will continue to lack an appropriate amount of computer science role models [7, p. 13], as the majority of their teachers and peers working in the field will be male. Under the assumption, that a lack of female role models will lead to less women enrolling in IT studies, we would have already reached a vicious cycle we need to escape.

It thus becomes clear that one of the main objectives of early computer science education and job orientation should be to break preconceived or culturally and socially taught or normalized stereotypes towards computer scientist and provide proper role models to encourage learners of all genders to be open minded towards taking up an IT career. However, the first step in this endeavor has to be to determine the stereotypical thinking present among the learners.

In this paper we are going to investigate the various innate conceptions towards professions in the IT-field students posses by analyzing student-made images and descriptions of the what they perceive to be typical IT professional. By addressing these stereotypes as part of our overarching project (see Section 3), we hope to abolish the system of misconceptions and negative self-perception that many students, especially women, have when deciding whether to pursue an IT profession. As the results of our research will confirm, there are sets of common stereotypes shared among most young learners that need to be addressed and dismantled to foster interest for IT in all genders evenly.

Thus, we aim the contents of our paper at educators at the secondary level (K 5-8 of computing and other STEM disciplines) as well as educational policy makers in hopes of fostering a greater understanding for underlying cultural issues based on stereotyping that contribute to gender inequality in STEM.

Our research paper is structured in 5 sections. Section 1 provides the reader with an overview about the gender disparity in IT professions and the impact of stereotypes on this matter. Next, Section II will discuss the research context and importance of our overarching project - "Digital Equality Fast Forward" (Dig-Equality FF) Then, Section III will discuss the methodology of our research approach towards stereotypes in IT, which are the main topic of this paper. Section 4 will continue with presenting and discussing the results of our qualitative analysis of our collected data sets. Lastly, section 5 will provided a summary and conclusion of our paper.

II. Research context and didactical design

The research described in this paper is part of the project "Digital Equality Fast Forward" (Dig-Equality FF) that aims at designing an inclusive, gender-sensitive educational offering for the subject "digital basic education" (DBE) at secondary level 1 (10 - 14 year old students). In Dig-Equality FF, digital media and tools are directly experienced, reflected upon and used in a playful way. Our objective is to remove potential barriers that are based in stereotypical representations or misconceptions regarding careers in IT. As such, one work package of this project is devoted to producing video-clips showing computer-scientists – both male and female – at work and interviewing them about their job. The goal is to capture the diversity of IT professions by inviting role models to share their motivations, real-world experiences and career paths. The video-clips are intended to provide students with realistic images regarding the CS profession and thus to contribute to the "professional orientation" learning outcome of digital basic education.

Another work package foresees the provision of a simple educational video game and reflective scenario that challenges students to assign job-roles to pioneers populating a new planet. However, before we had students engage with the

reflection tool and watch the video-clips, we were interested in there current perspective on and conceptions of computer scientists. Capturing these in advance would help us find out in how far our educational interventions were effective in alleviating distorted images. This is why we asked students of 8 different courses aged between 12 and 15 years to draw a computer scientist and subsequently analyzed the drawings as described in Section IV. Within the research context described above, the research questions we pose for the current paper are:
1) How do students (K6-K7) envision and describe computer scientists? To which stereotypes do these descriptions point?
2) How can existing stereotypes regarding computer scientists be challenged in class and redirected towards more accurate images and job-profiles of computer science professionals?
To answer these research questions, we proceed as follows: The exploration of students' conceptions was carried out by asking students to draw a typical person in a computer science occupation and/or provide written descriptions. The resulting images were then analyzed using qualitative content analysis [10] (see Section IV). In brief, the results showed an overwhelming display of antiquated distorted perceptions of computer science and IT professionals.

The results of the content analysis informed the second research question addressing the didactical design of educational scenarios aimed at the loosening of stereotypes. As will be discussed in more detail in Section IV-B, the findings were used for reflective dialogue in class.

Further, the results of our research fed into the implementation of a playful research and reflection tool with which students go on a journey to a distant planet, putting together their team of specialists and assigning them to specific tasks [11]. Hereby, we aim to stimulate thought regarding gender, profession and perception of gender roles.

III. Methodology

Our research builds on a Qualitative Content Analysis [10]. However, meaningful insight was further gained by looking on the quantitative side of our qualitative evaluation, to recognize frequencies of certain statements and stereotypes. While this approach shows some traits of Mixed Methods Research [12]–[14] it is not a mixed method scenario in a strict sense were both, qualitative and quantitative surveys, are conducted. We waived an additional quantitative survey in favor of having more (of the limited) time in school with the participants for the qualitative part. We used the chance that the research material allowed a quantitative approach as well and proceeded with a quantitative analysis accordingly.

A. Data gathering

To get to the bottom of prevailing stereotypes among teenage students with regard to persons in an IT profession, we invited them to complete an assignment, in which they were encouraged to draw and describe a person working in the field of computer science. Through this constructivism inspired approach to teaching [15] , we hope to activate the students' prior knowledge and prompt them to materialize it in their drawings and descriptions of IT persons so that we may analyze them and learn what conceptions and stereotypes are innately present in students.

The initial version of the assignment consisted of one question followed by some details:

"How do you imagine a person working in a computer science profession to be like? Draw a picture of your idea of a person in computer science and describe it in your own words (keywords are enough, but if you want, you can also write complete sentences). For example, think about:

- *What does this person look like?*
- *What characteristics does he or she have?*
- *What does he or she like to do?*

If you can think of other things, you can draw and/or write them. You can do this task in different ways:

- *One way is to draw/write on paper and then upload a photo of it (e.g. with smartphone, tablet, scanner).*
- *You can also use an image editing software, such as Paint, and then upload the saved image.*
- *If you have a digital pen, you can of course use that too.*
- *You can also combine these suggestions and, for example, draw on paper and type a description in Word. You have many possibilities. But please do not save a picture taken from the internet and upload it!"*

B. Approach

The response, as depicted in Fig. 1, contained 87 submissions in the form of either images, texts or the combination of both. All images were available only as raster graphics in the JPG-image format. Since the text passages were not provided purely as text-coded instances — rather as a combination of image and text — they had to be treated in the same way as the image information with regard to the coding areas. Additionally, due to the possibility of double occurrences and the issue of how to weight them, we decided to have text information take priority over figurative (visual) information and if both, text and figurative information are present we only coded the text information to ensure the reliability of our coding process. For instance, when an IT person was drawn with glasses and the textual description included "wears glasses", we only coded the text, because otherwise the contributions of students who chose to draw and write, would have had the double weight/count compared to the contribution of students who only wrote or drew.

C. Categorization of the research material

The analysis was carried out following Mayring's [10] qualitative content analysis and using MaxQDA [16] as coding software. The coding process was carried out by three independent raters. These raters will be referred to as Rater1, Rater2 and Rater3. The rating process was performed in 3 steps - defining categories, applying codes on an individual basis and lastly comparing and discussing the results. In the first step, the raters developed a code system which included top level and second level category codes in order to properly categorize all codes.

The top level categories of the coding system consisted of

1) Age
2) Appearance
3) Characteristics of the person
4) Equipment
5) Gender of the described person
6) Gender reflection practice
7) Use of gender sensitive language

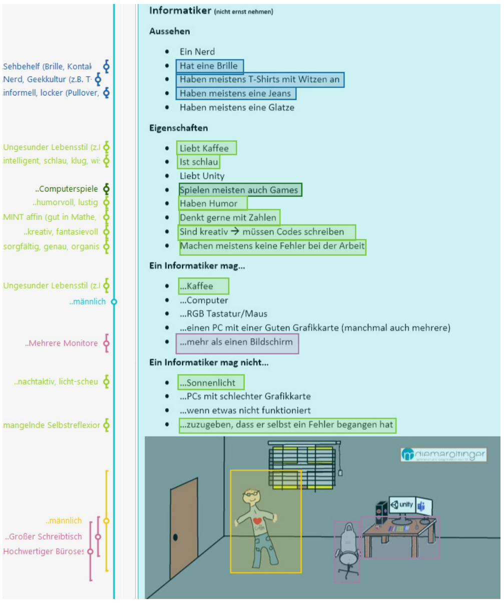

Fig. 1. Coding of the description and depiction of a person in an IT profession

After reaching consensus on the initial categories (=coding system) the first iteration of categorizing (=content-coding or short coding) was conducted, in which Rater1, Rater2 and Rater3 coded the set of documents independently. Subsequent to the completion of the first iteration of coding, the three raters discussed their findings and adapted the coding system (= categories) based on issue that arose during the coding process, such as ambiguous descriptions or missing synonyms. In a second iteration, the three raters completed another round of coding with the updated coding system. Consecutively, the three partitions were merged into one research document which served as basis for the analysis of the intercoder agreement[1] [16] [17] [18]. The intercoder agreement was computed with the software MaxQDA for all combinations of raters: Rater1-Rater2, Rater1-Rater3 and Rater2-Rater3. The computation of the Kappa value provides information on the level of agreement among raters and serves as indicator for the inter-rater reliability of our approach. We relied on Landis & Koch [19] for our agreement level-classification (Tab. I).

Due to the situation that texts as well as images or a combination of text and images were available, a common procedure had to be determined for coding (Fig. 1) and comparing text and image areas. Text was available in images only as raster information and was not extracted as Unicode,

[1]also widely known as interrater reliability

TABLE I
KAPPA VALUES & STRENGTH OF AGREEMENT ACC. TO LANDIS & KOCH

Kappa value	Level of Agreement
[-1.0, 0.0)	Poor
[0.0, 0.2)	Slight
[0.2, 0.4)	Fair
[0.4, 0.6)	Moderate
[0.6, 0.8)	Substantial
[0.8, 1.0)	(Almost) Perfect

so we basically worked with the information provided in raster images. When coding images a pixel-perfect match is much more difficult to achieve than a character-perfect match within text. The larger coding area can include 100% of the smaller coding area. Still the smaller area covers only a part of the larger one which lies within the borders of the smaller area (e.g. 75%, 50% or even less). To avoid loosing correctly and consistently coded areas due to this fact, we used minimal code overlap rates (MCOR) of 20% in the first and 5% in the second pass. The calculation of Kappa according to Brennan and Prediger [20] led to the results depicted in Tab. II.

TABLE II
INTERCODER AGREEMENT - KAPPA (BRENNAN & PREDIGER) WITH PRE-DEFINED MINIMAL CODE OVERLAPPING RATES (MCOR)

Rater	MCOR 20%	MCOR 5%
Rater1 - Rater2	0.77	0.82
Rater1 - Rater3	0.49	0.61
Rater2 - Rater3	0.54	0.64

To put our approach to the test, a second round of intercoder agreement analysis with a different type of agreement procedure was conducted. For the second round we compared code occurrences for each pair of coded documents of Rater1-Rater2, Rater1-Rater3 and Rater2-Rater3 and focused on the values of agreement between them. We then successively compared the individual document-pair by calculating Kappa values according to Rädiker and Kuckartz [17]. The results showed values between 0.86 and 1.00 for *Rater1-Rater2*, 0.84 and 1.00 for *Rater1-Rater3* and 0.84 an 0.94 for *Rater2-Rater3*. These almost perfect values presumably derive from the fact that the students' assignment was straightforward, the illustrations from students were simple and clearly illustrated and that the "occurrence in document" rating mode in MAXQDA by was robust against losses of valid results through deviations[2].

D. Merging the analyses

To distill the common results of the three qualitative analyses, the documents of Rater1 and Rater2 were merged to a Rater12 version and subsequently Rater12 was merged with Rater3 to Rater123. The codings that were not present in both documents were reviewed and either omitted or added to

[2]i.e. deviations that might occur, when an area was not tagged with absolute pixel perfect accuracy or had a small enough overlap threshold

the merged document and conflicting codings were resolved. The resulting document set was translated into English and a quantitative analysis was performed on the number of code counts.

IV. Results

A. Quantitative results

The following section provides further quantitative analysis of the gathered data (Fig. 2).

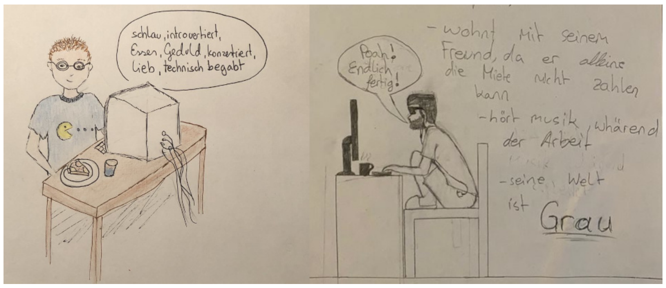

Fig. 2. Samples of illustrations of an IT-person submitted by students (age 13 -15)

1) Age: Students drew or described the imagined person in an IT profession (short: IT-person) as a young adult followed by middle-aged to older adult, teenager and old person, see Fig. 3.

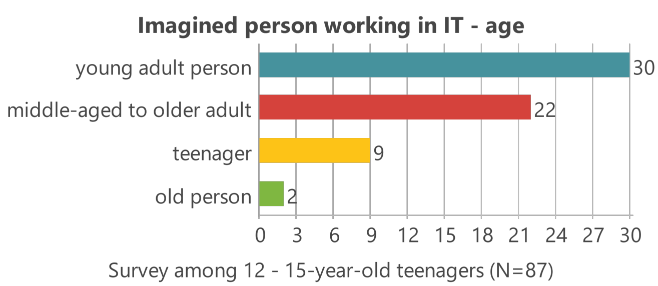

Fig. 3. Perception of the average age of an IT-person by students

2) Appearance: The appearance was characterized by wearing glasses or having visual impairments (n = 64), in some cases a beard (n = 14), being unkempt (n = 9), overweight (n = 10) and in some cases traits of a geek culture (n = 7). Although only the visual impairment was mentioned in 69% it is notable that the other characteristics like beard, unhealthy lifestyle, overweight and unkempt were at least for the students important enough to express, which shows quite some of significance. Fig. 4 provides a summary with regard to appearance.

3) Characteristics of the person: The stated characteristics of an IT-person were interesting in two ways. Students mentioned quite opposite characteristics like on the one hand being "introverted, quiet and shy" (n = 20) and on other hand being being "sociable and extroverted" (n = 19) (Fig. 5). Furthermore, 29 statements portrayed an IT-person with an unhealthy lifestyle with insufficient compensation activities for a lack of movement and displaying unfavorable nutrition habits, whereas in 13 statements a healthy lifestyle was mentioned. Another set of contradictory traits were being "calm, relaxed and patient" (n = 13) on the one hand and being "stressed, impatient and frustrated" (n = 11) on the other hand. While "calm, relaxed and patient" could also be a projection from the students for a very helpful basic requirement for an IT-person, the opposite being "stressed, impatient and frustrated" is seen by students as a result from the sometimes stressing, straining and frustrating work of an IT professional. In the 1990s in Japan "Researchers found that programmers stress is both extremely common and extremely problematic" [21, p. 17], possibly also leading to being "angry, aggressive and/or vicious" like students expressed it in their contributions about persons working in IT.

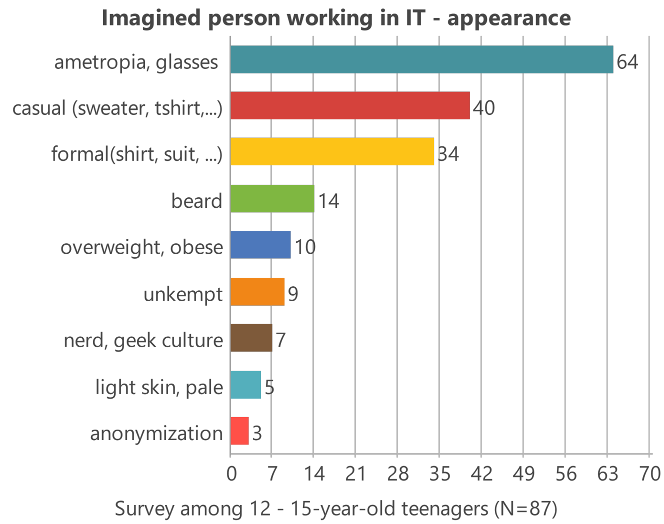

Fig. 4. Perception of the appearance of an IT-person by students

The less conflicting characteristics led to a more congruent picture of a "STEM affine, logical thinking" (n = 44) person who is "intelligent, smart, clever and inquisitive" (n = 34) combined with being "accurate and organized" (n = 19). Those useful traits are rounded up with a "concentrated, committed and ambitious" way (n = 19).

A "friendly, nice, polite and sympathetic" (n = 17) way connected with "being helpful and considerate is both a wish and an expectation" from the young participants. Further, the attributes "humorous and funny" (n = 9), as well as "creative and imaginative" (n = 8)were mentioned a few times[3].

Besides numerous other characteristics a "nocturnal" life and work preference was stated (n = 12), which is not too far from the truth for around 33% of IT professionals, as Claes, Mäntylä, Kuutila and Adams report: "that one third of software developers do not seem to follow a typical office hour rhythm at all as they perform a lot of activities during evenings and weekends" [22, p. 656].

[3]but at least they were mentioned.

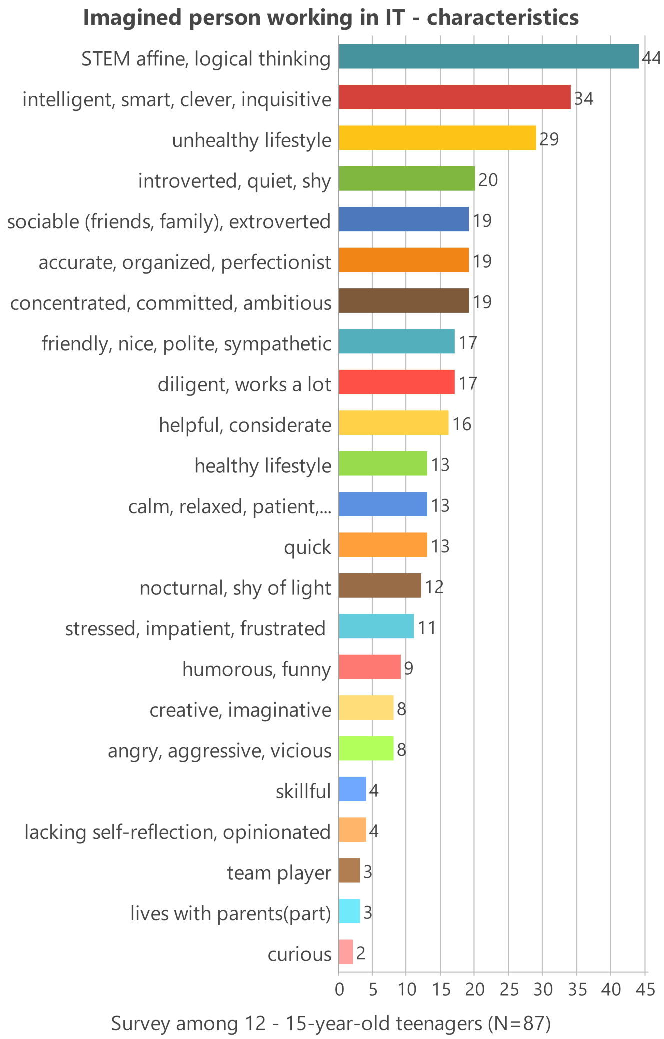

Fig. 5. Perception of the characteristics of an IT-person by students

4) Equipment: Students depicted an IT-person with the following equipment: a large desk (n = 35), a monitor (n = 32), a high quality office or gaming chair (n = 16), multiple monitor setup (n = 13), a laptop, notebook, convertible or netbook (n = 13), a cell phone or a tablet (n = 5), webcam (n = 1).

5) Gender of the described person: The secondary school students assumed the gender of an IT-person 85.2% male, 12.3% female and 2.5% non-binary. Compared to the results of actual gender distribution in Austria for engineering overall, where there are only 9% female specialists in engineering occupations [2], 12.3% is only slightly higher. However, in Austria the share of university-level students is higher than in the occupational field: 31% of engineering sciences students in universities are female and in "Universities of Applied Sciences" 25% are female [2].

Starting from the overall picture of gender stereotypes of students towards a person working in IT, it seemed interesting to shed light on the potential influence of the teacher. Therefore, the students' contributions were divided in two groups: The group of contributions where students had a 61 year-old female teacher (see Fig. 7) and a group of contributions where students had a 40 year-old male computer science teacher (see Fig. 6). The gender of the students themselves was evenly distributed, half of the participants were girls and the other half were boys.

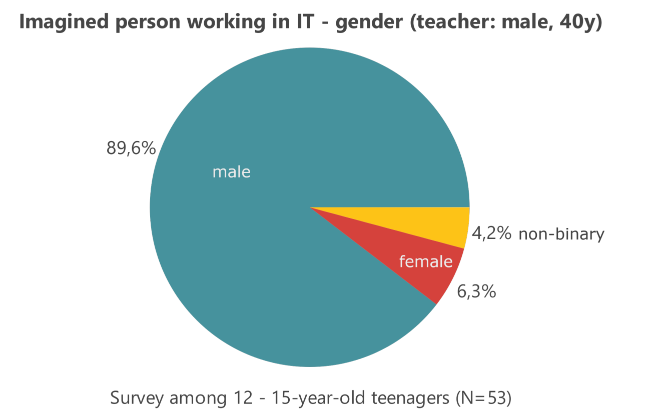

Fig. 6. Perception of the gender of an IT-person by students taught by a male teacher

While the overall trend of attributing IT-persons as male remained intact, differences between the students of the female and the male teacher were found. Students who had a female computer science teacher showed nearly three times as many female representations for a person working in IT.

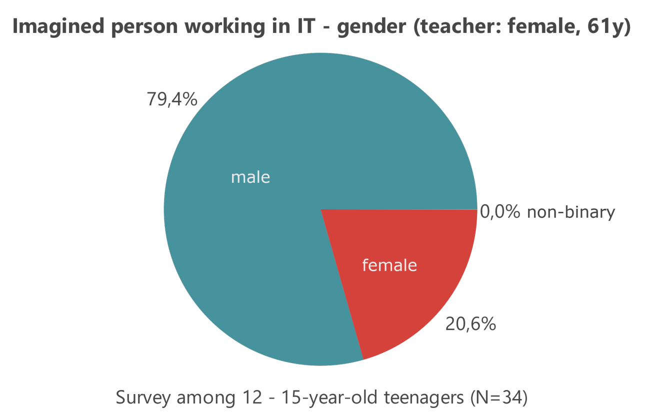

Fig. 7. Perception of the gender of an IT-person by students taught by a female teacher

6) Gender reflection practice: Statements expressing awareness regarding gender, roles and stereotypes - or reflecting on them - were categorized as "Gender reflection". Examples for text coded gender reflection are *"I decided to draw a woman because I think everybody else imagines a male person."* or *"A person who has a computer science profession, [possibly] looks [the same] as a person who does not have a computer science profession."* as well as direct reference to stereotypes, *"I mention this [attribute] because I am referring to stereotypes"*.

7) Use of gender sensitive language: Grammatical gender is an integral part of the German language [23], [24]. The English phrase ”the computer scientist” translates to either “**der** Informatiker” if the computer scientist is male or to “**die** Informatiker**in**”[4]. In the English language determined gender is present in specific words like “policeman” or “salesman” and might be replacement by “police officer” or “sales person”, while other terms are quite neutral from the language point of view, e.g. doctor, teacher. However in German, Spanish and numerous other languages the presence of gendered words is very common (imagine every occupation like doctor, teacher, worker, cashier and every position mayor, principal, director, president was written and spoken traditionally just in the male form). In the historically male dominated (language) environment the importance of gender neutral language was soon recognized and was elevated to high recognition in 1997 in the *Treaty of Amsterdam amending the Treaty on European Union* [25]. The idea that language influences thought roots back to philosophers like Humboldt and grew into popular attention with Benjamin Whorfs concept of linguistic relativity. The concept of linguistic relativity was posthumously recognized as the Sapir-Whorf-Hypothesis [26]. The assumption of the Sapir-Whorf hypothesis that language shapes thought led to commitment for using gender neutral language, first and foremost in education and the public sector [25].

In our analysis, we took a look at the gender language displayed by the young learners. We strove to find out if the learners’ lingual expression is largely neutral or if there is a tendency to one kind of wording. In the students’ expression a mixed expression (n = 14), the feminine form (n = 3) and the gender-neutral form (n = 29) appeared (see Fig. 8). The gender-neutral articulation would be the desirable way to express oneself in the classroom setting. Yet, the masculine lingual expression was the most commonly used (n = 37) (see Fig. 8). The way of the students’ expression matched the stereotypes of the male-dominated IT-professional.

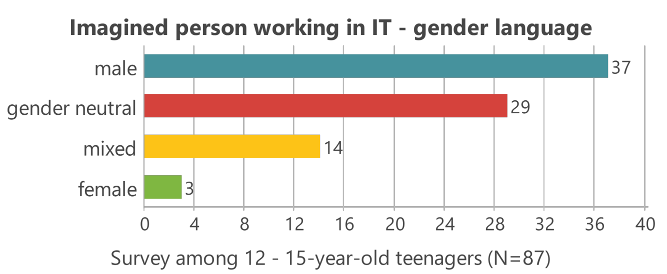

Fig. 8. Gender language used by students describing an IT-person

While conducting research on gender and stereotypes in class already provides valuable data in itself, disregarding the potential of bringing in activities that could possibly enhance students’ world perspective would be letting go off a great chance. Thus, some additional activities based on produced depictions of computer scientists were planned and executed.

[4]“der” is the definite article for the male grammatical gender and “die” is the definite article for the female grammatical gender

After the “Drawing and describing an IT-professional”-assignment, students got a chance to introduce their contributions to class (some students were very eager to do so) and the students discussed together with researchers and teachers their views and reflected on their views and opinions. Additionally, students got the chance to visit IT-researchers and professionals in an online meeting.

B. Reflection

All those activities aimed to stimulate critical thinking and reflection on views and stereotypes regarding ICT-professions, ICT professionals and ICT in general. We had already collected a lot of information during the “Drawing and Describing an IT-professional”-assignment, but to get more hints on whether new perspectives were gained or any kind of reflection has started, we asked 10 learners for some written feedback. Eight learners returned a short, written response. As a stimulus we provided three questions: *Q1. What was your image of people from IT and digital media sectors like in the past? Q2. Has your image of people working with digital technologies changed and if so, how has the image changed? Q3. A girl aged 14 who is faced with the decision whether to go to a school with a focus on computer science asks you for advice. Based on your computer science class experience, what would you advise this student to do?* The students’ answers to question Q1 displayed overall concordance with the results of the qualitative content analysis of the pictures and descriptions of IT-persons. *“When I used to think of people in the field of computer science or digital media, I always imagined a man with glasses and the look of a nerd sitting in front of a screen all day.”* or *“In the past, my image of people who work in the field of computer science was often that they are computer freaks who constantly type in 0’s and 1’s”*. Only in one case the answer was *“I actually never had a certain image of people in this field.”*. Another student was attracted by electronics and digital media before. She wrote: *“I have always been a fan of electronics and digital things. When I was little I already played a lot with the PC and other consoles and learned a lot of things on the PC. People who could work in this world were always huge role models for me, I always wanted to become like them!”*.

The question Q2, *if* anything and, if so, *what* has changed due the gender-stereotype-reflection activities, was answered positively in 7 of 8 statements. Typical responses were “yes, absolutely, because I understood that anyone can learn it, and it is not that complicated, which also made other people fit into the computer scientist scheme in my eyes.” and “My image has changed in the sense that now I know that you do much more than just sitting at the computer and there are also different areas.”.

Openness for careers in IT was expressed in the answers to question Q3 or in the words of a student as an answer to whether a girl should pursue an education in computer science or not: *“I would tell her for the first time that she has to be prepared to do many different things and that computer science is not only related to programming. Also that she will* *probably hear more often that these professions are more for men, although this is not true."*

For past, present and future efforts it is meaningful that the activities in school actually had a positive impact on young people to ensure the validity of our project. According to our learner feedback our first attempts succeeded — at least in the form of providing new perspectives to our students.

V. Discussion

A. Implications of the study

Our findings have shown that in the minds of young learners IT is still predominantly perceived as a field of occupation for young to middle aged males. The predominant stereotype categories that Cheryan et al. [1] mentioned - intelligence, lack of personal skills, and certain physical features - coincide with our own findings.

However, students were more open-minded regarding the perspectives ICT can offer and for whom IT is the right field after our activities. Basically students came equipped with their role views and stereotypes from their prior lives, but also those stereotypes varied.

Based on our results, it can be argued, that frequent interactions and experiences with practitioners of IT can have an especially strong influence on the perception and bias building of students. In our research it was noticeable, that some learners seemed inspired in their depictions and descriptions by the appearance and mannerism of their IT teachers, especially the female teacher. Thus, it becomes clear that teachers involuntarily serve as role models and can either emphasize or dismantle stereotypes. Furthermore, recent research results imply that the representation of the stereotypes have an impact on career choices [27]. Especially regarding the estimation of their own success, Cheryan found that "women who interacted with non-stereotypical role models believed they would be more successful in computer science than those who interacted with stereotypical role models. Differences in women's success beliefs were mediated by their perceived dissimilarity from stereotypical role models." [28, p. 656]. In combination with the results of our research, we can deduce that diverse role models are essential for students to gain a positive and non-stereotypical perspective of the IT field and encourage pursuing for a computer science profession.

B. Impact

The goal of the project team was to get rid of *barriers* in the *perception of the IT-field* of students. The activities targeted removing barriers coming preconceptions and self esteem that prevented female students from entering IT despite their interest. This was fostered for one part by directly deconstructing prejudices and stereotypes. For the other part we employed a more subtle way by exploring interest and connecting the interests of learners, if appropriate, with the chances for self-actualization and benefits that manifold possibilities IT has to offer, or in other words:

> *When considering the future, instead of asking, "What do you want to be when you grow up?" adults should ask, "What activities do you enjoy?"* [27, p. 912]

VI. Conclusion

Over the course of this paper, we discussed the Dig-Equality FF project and its intended measures to address misconceptions and stereotypes with regard to IT and related careers. An analysis of 87 textual and graphic depictions of CS professionals, devised by high school students, provides first insights into their views and displays both strong tendencies in some regards (e.g. a dominance of the male gender) but also conflicting views on other attributes. Our results have shown that while common stereotypes had a strong impact on the depictions, teachers may dismantle these stereotypes and positively influence students' perceptions of computer scientists.

The presented results will be incorporated in the development of a broad set of educational material, including the development and deployment of a game-based tool to reflect on stereotypes and videos that display the career path of diverse role models in IT.

Aside of the scientific contribution, the paper aims to inspire and support educators in their efforts to help women and underrepresented groups in computing outgrow inaccurate stereotypes and to uncover young students' potential interest in the field. With this we aim to contribute to overcome the gender imbalance and foster more equality in the occupational field of computer science. Strategically, this would serve society in terms of economic stability and by creating a more sensitive, diverse and harmonious future that computer scientists knowingly and unknowingly co-shape.

VII. Limitations and future research

Although research was conducted in different courses and even with different teachers, the biggest limitation is that the sample of students all came from the same school. While the participant count regarding the depictions in the main research cycle (N=87) was sufficient, the written feedback in the post activity cycle was rather small (N=8). Another limitation is that the education of setting in class always comes with social demands and assumptions from students about the expectations of the teachers and the school environment. However we aim to combat this drawback of our research approach soon, by increasing the reach of our project to additional schools.

Future research will explore students' reactions to watching video-clips about computer scientists at work and the traces they leave on students' images of the occupation of computer science professionals. Furthermore, we are in the process of designing reflective scenarios that would follow students engaging with the educational game that we employ as a research and reflection tool on gender-related attributions and stereotypes. Since all materials and tools developed in the course of our research are going to be available as open educational resources, several teachers and schools we be invited to use them and to extend the database for the respective research.

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