Image is everything! Is image everything?!

About perceived images of science, engineering and technology

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Abstract

Images of engineering majors and jobs go along with enduring negative stereotypes of science, engineering and technology (SET) often connected to images of hegemonic masculinity or gender stereotypes. Some of these stereotypical attitudes are still active and have great impact on study decision making processes and students' expectations.

Within the former European Commission (EC) project WomEng discrepancies between the perceived image of engineers, depending on the study subject were revealed. According to this the image of engineering is overshadowed by the picture of the “lonely, machine oriented nerd”. Above this young people often have obsolete and unattractive job images in their minds and combine these with outdated clichés, whereas their ideas and wishes of professions are not far away from studies in SET and related jobs.

These findings build the starting point of the currently running EC project MOTIVATION. The project is looking for factors influencing young people's perception development on SET related degree courses and professions. The paper presents first results from interviews with pupils in Austria and Germany on their perception of science, engineering and technology. Additionally the impact of gendered SET representations in print media will be shown, exemplified by popular Austrian and German youth magazines, as these build a daily companion for youngsters and therefore having an important role in their life.

Keywords: youth, image of SET, media impact, gender, science education

1. INTRODUCTION

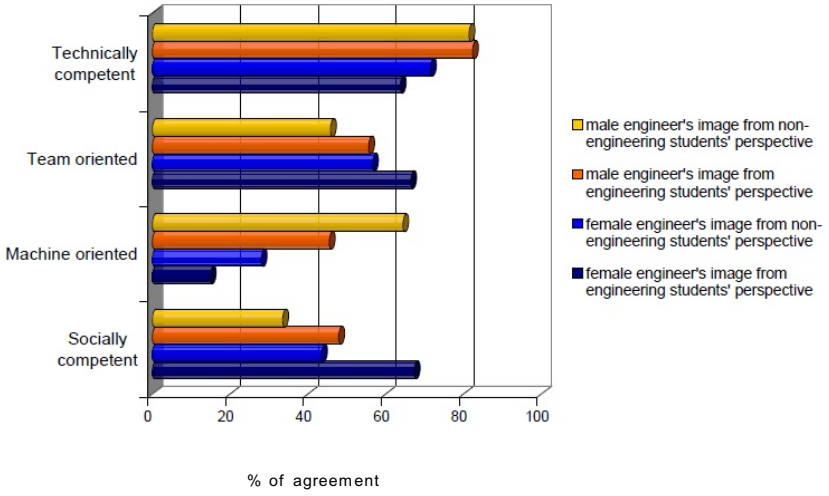
Although the European Council stated in the year 2000 in its Lisbon strategy that by 2010 Europe should be the most competitive knowledge-based economy in the world (http://ec.europa.eu/invest-in-research), the number of students in science, engineering and technology (SET) degree courses is declining in many European countries. For instance Austria, Denmark, Italy, Germany, Hungary and Finland experienced a drop in the share of

university graduates with science and engineering degrees between 1998 and 2004, as did Korea and the United States [1;2;3].
Another field of action is the under-representation of women in SET fields. In the EU-27-member states, in engineering, manufacturing and construction degree courses 75.7 % male students face only 24.3 % female students in 2005 [4]. And although the current students' assessment study PISA [5] found no significant performance differences of female and male pupils in science; degree courses in the category 'mathematics, science and computing' have a huge gender imbalance as well (63.1 male vs. 36.9 female students in the European Union [4]).
The Council of the European Union published a press release in February 2008, where the ministers for education of all 27 EU member states emphasised the importance of "the knowledge triangle (education – research – innovation), emphasising in particular the crucial role of education and training in promoting creativity and innovation" [6, p. 11]. And in an EU-wide survey 82% of all interviewed persons agreed that "young people's interest is essential for the future prosperity of Europe" [7, p.100]. Already in 2001 a "young people and the scientific vocation crisis" has been proclaimed in Europe [8; 9]. One reason for that situation is answered by two thirds of asked senior school pupils and students who stated that "scientific lessons are not appealing enough" [8]. European science education recognized a need of a "renewed pedagogy" in schools [10], which does not incline to isolate science classes from remaining subjects creating some kind of subculture [11].
The PISA study from 2006 astonishingly revealed that 93% of all pupils agreed that science is important for understanding the natural world and 92% uttered their consent on the item that "advances in science and technology usually improve people's living conditions" [5]. But although girls and boys are aware of the importance of science and technology in future times, only a minority of students saw themselves doing science in the future like focussing a career in science (ibd.). This is underlined by the results of the Relevance of Science Education (ROSE) study: the answers of female and male pupils from about 40 countries on the statements "I would like to become a scientist" and "I would like to get a job in technology" showed that especially girls in wealthier OECD countries were more likely to reject this possibility [12; 13]. But above that the research team observed a gap between developing countries, where SET is perceived as attractive job field compared to richer and more developed countries [14].
Additionally to formal educational arenas, out-of-school science experiences and implicit SET-learning through media, especially because of the popularity of information and communication technologies, get more and more importance. These media receptions can be seen as informal learning experiences, which form young people's images of science and scientists enhance SET-interests and young people's self-beliefs as well [15].

2. BACKGROUND

As background for the following deliberations serves one result of the WomEng study [for further information see: 16; 17; 18]. The project with the full name "Creating Cultures of Success for Women Engineers" (www.womeng.net) was funded in the 5th Framework Programme of the European Commission. WomEng lasted from 2002 until 2005, in total

seven European countries were involved (Austria, Finland, France, Greece, Slovakia, United Kingdom and Germany). In the frame of the project totally 699 female and male students out of different engineering majors were asked about their study background, experiences, perceptions etc in all participating countries. As control group 637 students of different non-engineering majors like social sciences, humanities and economics were also asked about their individual study opinions and experiences.



The diagram above shows that actually discrepancies in the perceived image of engineers, depending on the persons' study subject have been found. While engineering students and non-engineering students both attribute more technical competence than team orientation to engineers, non-engineering students ascribe more machine orientation and less social competence to engineers than engineering students do. That means that the image of engineering – and we assume generally the image of SET – becomes more realistic and clearer in SET degree courses when students learn SET and experience SET role models instead of stereotyped SET images of various media.

The second important result of this survey was that so called "softer" qualities like team orientation and social competence were more ascribed to female engineers. The gender gap within the qualities of technical competence, team orientation and machine orientation is nearly the same in both samples. However, non-engineering students have generally a more machine-oriented and less socially competent image of engineers than the engineering students. That interesting result led to our current research project "MOTIVATION", where we wanted to find out, which images of SET teenagers actually have and which image of SET and especially technology is shown in popular youth media.

3. MOTIVATION – A European project on changing the image of SET

The aim of the European project MOTIVATION is to learn more about factors, which influence the image of science, engineering and technology (SET) to attract more young people [for an overview see 19].
The project is built around four content related work packages (WP) which investigate influencing factors of image building from different angles, besides those WP's focussing on coordination and dissemination. WP two analyses if and how youth media impacts the manifestation of stereotypical perception of science and technology. The situation at school and beyond, which includes parents, family and peers is subject of the third WP. Questioned is here how teachers and teaching at school support can contribute towards more positive attitudes of pupils towards the more or less disliked science subjects. Furthermore, teachers are besides family and friends of great importance for job and study orientation processes of young people [20], the impact of all three socialisation agents will be investigated in MOTIVATION. WP four concentrates on the young people themselves, what self-concepts do they have and how do these influence their perceptions of suitable future job and study fields? The theoretical approach of this part of the study builds the 'self-to-prototyping matching theory' [21], which comprises that an individual imagines for his/her decision a prototypical person who would also choose this option. The individual proves how his/her self-image correlates with the corresponding prototype. The higher the similarities, the more likely it is that the individual turns to the fields of interests of the prototypical representative [21; 22]. The last content work package of MOTIVATION exposes so called good practice examples of inclusion measures which try to weaken the stereotypical image of SET by different approaches. Dream jobs of boys and girls are still in line with cultural embedded gender stereotypes, thus the risk of making job and study decisions on basis of gender stereotypes and not on personal potential and performance is always present [23].

3.1 MOTIVATION methodology

The first part of MOTIVATION has been completed. That contains an exploratory analysis of SET school education in Europe, and collecting and evaluation of good practice of formal and informal SET learning. The study used and uses different methodological measures, like content analysis for mass media research (print and non-print), especially how visual representations contribute to a stereotyped image of SET. Focus group discussions with young people to get insights in peer group processes and self-perceived media influences on job decisions. Interviews and focus group discussions with SET education stakeholders (like teachers and job consultants) add information on their perceptions of influencing factors on SET attitudes of teenagers. Special media and education stakeholder workshops and expert meetings support the project-internal knowledge exchange and the dissemination of results externally as well.
For this contribution we concentrate on partial results of Austrian and German investigations in the first project phase, which include biographical interviews with female and male pupils at secondary schools and the analysis of youth magazines in both countries.

3.2 Partial results of qualitative interviews with secondary school pupils

Altogether 14 young people in Austria and Germany have been interviewed about their experiences and opinions about SET in different settings like at the parent's home, at school, among peers and in media. During the time of the interviews the interviewees were between 14 and 16 years old and attended to secondary schools. Interviews were realized in autumn 2008, thus the first results we are going to present here are very recent.

3.2.1 Interest in SET and contradictions

Overall interest in SET seems to be a complex concept. It is definitely influenced by practical experiences and personal connections. It does matter if parents tell about their SET profession at home, if children play with construction or other SET toys, if pupils experience hands on science classes with experiments and if they get to know SET professions in practice (internships, etc.). All those positive influencing factors were mentioned by pupils who described themselves as (quite) interested in SET.

About the role of SET teachers: the popularity of a subject stands and falls with the (un-) popularity of the teachers indifferent of the subject they teach, this was also confirmed by the interviewed teachers in Germany. Good teaching for the pupils means having fun during the lessons. Pupils like if they can do hands-on work at school, may it be experiments in chemistry or constructing robots, it is important for them to experience science by themselves and not only in frontal lessons. Education research has shown that learning is most effective in settings where learners can act as teachers as well. To think about how to explain something and how to teach others is a very effective learning strategy. Therefore it can be deduced that especially SET learning should be connected up to contexts where pupils can become aware of their implicit technical knowledge and their tacit design and engineering skills, and can profit from their formal and informal acquired knowledge; for instance by connecting technology with spare time topics like internet games or music technology [see also 24; 25; 26].

Not being interested in SET also can be a result of identity processes and the conclusion that SET has definitely not the image fitting to a ideal self, like for instance for one Austrian girl. This girl is very upfronted with the topic interests in SET and says that she even hates maths and chemistry because she "*doesn´t see the point*" (AFI_2). In biology, for example, she said about cell division: "*I don´t think that´s necessary for my life*". That seems to be an astonishing statement. First, one might think that especially life sciences could be easily explained as relevant for all pupils in school. It seems sad that even biology, knowledge of the human body that is, can not be explained in a relevant and interesting way. But another interpretation of this quote works, if the whole interview of this pupil is considered. Maybe she does not show any SET interest at all, because she actually thinks that being good at school and especially being good at SET subjects (being "clever" as she ironically called it) – and even more suspicious being interested in them – can conflict the identity of a cool teenager. This possible conflict between the self-image and the public image of persons who like SET is underlined by the statements of a German girl, who sees herself as competent and really interested in science and especially technology and therefore sees herself confronted with stereotypes and prejudices also from the side of her class mates; on the other hand she is constantly engaged in belonging to the 'cool' girls group of the class, who are not the ones who are in SET. But actually she does not conceal her preferences in front

of her friends and class mates, although she made the experience of not be taken seriously as a girl who likes technology: *"If I tell in the breaks that I reassembled a mp3-player and it functions – I am totally proud – and the others say again 'you are kidding, you can't do that'."* (GF2_2).

Interest in SET seems to be connected to the perceived value of SET, but it can not be said which of the two is first. Fact is that pupils who seem to have at least basic interests in SET are the same who see the meaning of SET, that SET makes sense for them personally but for society as well, SET can save the planet or help people. Disinterest in SET on the other hand is connected – in our interviews – with denial of any use or personal relevance of SET.

3.2.3 Draw-a-scientist test

The first part of the interviews with pupils consisted of an adaptation of the 'Draw-A-Scientist Test - DAST' [27]. Introductory the girls and boys were asked to draw a person working in the area of science, engineering and technology, who has passed the same educational training like the interviewees. These drawings brought some additional information on images of SET. Only four of fourteen interviewees, three boys and a girl, who all stated to be SET interested drew persons who are handling actively a technical tool or a computer in their pictures (see left example of interviewee AMI_1, 14 years old), while all other participants have drawn (stick) figures besides vials or other equipment symbolizing science, engineering or technology. Only three of the pictured persons - not stick figures - could be clearly identified as female, all drawn by girls. But beside that it is interesting what images of SET the pupils have and what they associate with science, engineering and technology: vials, microscopes, a car, formulas, computers. This is especially good represented by the drawing of one German boy (interviewee GM2_2, 14 years old, see right), which shows a variety of SET related objects including a calculator, a Bunsen burner, a computer, a biology book, a mathematical function and a test tube. And additionally he confirms the stereotype of people who are in SET and their nerdy touch as he drew a male person, a stick-figure wearing glasses because *"... many teachers in science wear glasses and thus I connect this always with such subjects."* (GM2_2). And a fourteen year old Austrian boy, who is actually interested in engineering, draws a car constructor with a tool beside a car (like a car mechanic) that can be interpreted as a lack of realistic SET job information in school education. What is further interesting is the fact that two of the German interviewees drew more or less themselves in their dream jobs, which was revealed through the later part of the interview guidelines when the pupils have been concrete asked about their realistic job options for their future. The 16 year old girl dreams of becoming a family doctor, while the boy sees himself as chemist working in a lab at a big chemical company which is located in his home town.

Nevertheless the overall professional images about persons in science, engineering and technology are influenced by personally known people or people who achieved a high reputation in science, like the example of a female pupil in Germany whose drawing should represent Albert Einstein in his famous pose sticking his tongue out. But asked about concrete job examples in SET, teachers in science subjects have been the most mentioned examples as these are the jobs which the pupils perceive every day in their direct environment, this was also reflected by three German girls who drew teachers as example for people working in SET. This result is not surprising at all but demonstrates the need for more diverse occupational information about career possibilities in the respective fields.

3.3 Results of media analysis of youth magazines

For the quantitative content analysis a quantitative data sheet was developed by Anita Thaler, including criteria and precise guidelines for all national team members on how to identify and describe relevant SET representations in the youth magazines. Supplementary a qualitative content analysis of the detected gender representations in SET images was prepared.

The analyses include 22 issues of the German "BRAVO" magazine, which corresponds to a complete analysis from July to December 2008. For instance in Austria and Germany "BRAVO" is one very popular youth magazine for more than 1.6 million female and male readers weekly. Of the Austrian youth magazine "Xpress", which is published monthly, 6 issues were closer examined from July 2008 to January 2009. Technology is hereby defined in a layperson's view: technological artefacts (machines, hardware, and software) and SET professionals (scientist, engineers, etc.), in order to analyse technology representations, which would be recognised as technology by teenagers.

3.3.1 Quantitative results

Altogether 601 representations of SET were analysed in the Austrian and German youth magazines. As "BRAVO" is weekly published the majority of images is connected to this magazine with totally 491 cases, that are averagely 22.3 images per issue. In the Austrian "Xpress" 111 images related to SET were found in the sample, that corresponds to an average of 18.5 per issue. In both magazines the majority of SET images is embedded in journalist contents means in articles or reports and not as part of advertisements. In the case of the "Xpress" magazine this means 63.3% and for the "BRAVO" magazine more than three-quarters (76.2%) of all images were connected to journalist parts. Half of the analysed

images in the "BRAVO" magazine show science, engineering and technology as the main topic, the number for the "Xpress" is even slightly higher with 58,9%. The genderedness of certain fields of technology in SET images can be seen in quantitative data and qualitative data as well. "BRAVO" connected cell phones mostly with females and vehicles (cars, motorbikes, boats) mostly with males. In the qualitative analysis of mixed gender relations portrayed in SET images, we could see that for instance males are more often presented as drivers of vehicles.

3.3.2 Qualitative results - Gender and technology representations in youth magazines

Both youth magazines have gender stereotypical and gender equal SET representations. Gender equal SET representations contain mostly unrealistic SET representations, using technological artefacts as props of a scene. The degree of gender equality of SET representations differs between the two magazines. While "Xpress" has less overt gender stereotypical SET representations but additionally some subtle forms as well, "BRAVO" has mostly overt gender stereotypical SET images. The SET fields differ; the Austrian magazine "Xpress" shows beside cell phones mostly music technology; the German magazine "BRAVO" shows cell phones and music technology, but additionally more vehicles, which are explicitly represented as male domains.

3.3.3 Summary – youth magazines

"BRAVO" is more gender and SET stereotypical than "Xpress", f.i. connecting cell phones more with females and vehicles with males. But the gender equal SET representations of both magazines show predominantly unrealistic SET situations, either using technical artefacts as props or in the stage set of a picture to present a certain motive.

Good practices – showing SET professions gender equally and realistically – are seldom, but a little more often presented in "BRAVO", placed in their job specials. Although those good practice examples are representing SET in a realistic way and connecting SET to persons in a non-gender-discriminatory style, overall males are much more often connected with electronic and machine related technology, while chemistry and lab situations are only represented with females. That means although the single pictures are not stereotypical and showing realistic situations, the message of the whole job special sections is, that chemistry is female and electronics and mechanics are mostly male. All in all both youth magazines do not often use their influence for a valuable informal vocational counselling for SET.

4. CONCLUSIONS

The European Union wants to strengthen its economy by accelerating scientific and technological innovations and research. Opposed this aim stands the last years' development with a declining number of students in SET degree courses and a still huge gender imbalance in many European countries. We could show that several studies revealed that although students agreed on the importance of science and technology [5; 7], only a minority of them can envisage a career in SET. Additionally school education, out-of-school science experiences and implicit SET-learning through media are very influencing. Therefore we started the European research project MOTIVATION to learn more about school and out-of-school factors, which influence the image of SET and how to use that knowledge to attract more young people for a SET career. And at this state of our project we can indeed state that both, perceived SET-images of pupils and presented SET images of youth magazines, can explain decreasing numbers of SET students in general and gender imbalances in SET degree courses in particular. We will discuss our findings with several groups of stakeholders (schools, media, etc.) in order to get further insights how to use our findings in a constructive way.

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