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Abstract

Images of engineering majors and jobs often go along with general and gender specific stereotypes of science, engineering and technology (SET) and outdated clichés about scientists and engineers. Some of these stereotypical attitudes are still active and have great impact on study decision making processes and students' job expectations. This paper will discuss first results of the currently running European Commission project MOTIVATION, which is looking for factors influencing young people's perception of SET and SET careers. Results from interviews, including the Draw-A-Scientist Test, with female and male upper secondary school pupils in Austria and Germany will be presented. Additionally the impact of gendered SET representations in youth magazines will be shown as these magazines build a daily companion for youngsters and therefore have an important role in their lives.

1 Set education in European schools

In 2000, the European Council stated 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). Beside other factors the proportion of students in science, engineering and technology (SET) can be seen as a crucial factor in the Lisbon process. But in fact, the number of students in SET degree courses is declining in many European countries. For instance in Austria, Denmark, Italy, Germany, Hungary and Finland the share of university graduates with science and engineering degrees had been going down between 1998 and 2004, the same could be noticed in Korea and the United States (OECD 2006, BMBWK 2003, 2005, Statistics Sweden 2008).

In an EU-wide survey 82% of the respondents agreed that "young people's interest is essential for the future prosperity of Europe" (European Commission 2005, p.100) and the European Commission proclaimed already in 2001 a "young people and the scientific vocation crisis" in Europe (European Commission 2001; see also Millar, Leach & Osborne 2000) and called for a "renewed pedagogy" in schools (European Commission 2007), which does not incline to isolate science classes from remaining subjects creating some kind of subculture (European Commission 2004).

Furthermore, a study which elaborated students' perceptions of science teaching found out, that two thirds of senior school pupils think that "scientific lessons are not appealing enough" (European Commission 2001). European science education recognized. And the current PISA (Programme for International Student Assessment) study corresponds with those previous research results. The way science is taught in many schools in Europe can be seen as "not appealing enough": pupils have only rarely the opportunity to carry out experiments, to generate and test ideas of their own and to apply scientific knowledge to their everyday lives (OECD 2007). Moreover, Langen and Dekkers (2005) could show that the decision in science education of teaching either broad-based interdisciplinary or narrow defined mono-disciplinary science classes with early specialisation has an impact on opting for science, engineering and technology degree courses in higher education.

Problem-based, inquiry-based learning, hands-on-experiences and learning by doing have proved to be successful didactical approaches (European Commission 2007). Education research has

shown that explaining something to others and to think about how to teach others (learning by teaching) is one of the most effective learning methods. That means connecting SET learning to pupils' own knowledge and competencies is a logical next step. Thus, they can become aware of their implicit technological knowledge and can profit from their formal and informal acquired abilities (see also Thaler and Zorn 2009a, 2009b).

But these learner-centred and informal learning approaches do not replace good teachers. Far from it! Teachers have to become aware of their powerful positions during the socialisation process of young people on the content level of SET and on the social interaction level as well. Teachers and counsellors should carefully reflect how they possibly perpetuate certain assumptions and (gender-) stereotypes of the 'hidden curriculum'. Ignoring gender and intercultural issues in science education reinforces stereotyping and for instance can lead especially to self-underestimation of girls' performance in science (Whitelegg 2001) or weaken girls' science-related self-efficacy (Hackett 1997).

The ongoing under-representation of women in SET fields is another field of action. While in 2005 75.7% males studied engineering, manufacturing and construction and 63.1% enrolled in the category mathematics, science and computing, only 24.3% (engineering) respectively 36.9% (science) females studied those majors in the EU-27 member states (Eurostat 2007). This gender imbalance is especially striking since we know that there are no significant performance differences of female and male pupils in science (OECD 2007a). The PISA study revealed that 93% of all pupils agreed with the fact 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" (ibd.). But although both, girls and boys, are generally aware of the importance of science and technology in future times, only a minority of students sees themselves doing science in the future (ibd.). This is underlined by the results of the Relevance of Science Education (ROSE) study, which pointed out that especially girls in wealthier OECD countries are more likely to reject science and technology careers for themselves (Schreiner 2006, Schreiner & Sjøberg, 2006). The gender differences in attitudes to science were most prominent in Germany, Iceland, Japan, Korea, the Netherlands and the United Kingdom. "The largest gender difference was observed in students' self-concept regarding science. In 22 out of the 30 OECD countries in the survey, males thought significantly more highly of their own science abilities than did females" (OECD 2007a p. 30ff). And because we know that dream jobs of boys and girls are still in line with cultural embedded gender stereotypes, the risk of making study and job decisions on basis of gender stereotypes and not on personal potential and performance is always present (Cornelißen & Gille 2005).

This underlines the importance of promoting approaches in science education which support a positive development of girls' self-concepts towards science and technology issues. Taking into account these gender differences regarding pupils' self-concept is especially important because boys and girls showed no difference in science performance in the majority of the PISA countries (OECD 2007a). Another study with interview results of 72 secondary school students found out that science teaching influences how scientists were perceived as persons (Cleaves, 2005). This

demonstrates the importance of research of images of scientists and engineers and SET generally and the question how they relate to those images.

One of the theoretical concepts which can explain how images of professions can influence professional choices of young people is the 'self-to-prototyping matching theory' (Hannover & Kessels 2004). It says that individuals imagine prototypical persons who would choose certain career options. The individuals prove how their self-images correlate with these corresponding professional prototypes. The higher the similarities, the more likely it is that the individuals turn to the fields of interests of the prototypical representative (Hannover & Kessels 2004, Rommes et al. 2007).

Additionally to formal educational arenas, out-of-school science experiences and implicit SET-learning through media, can be seen as influential learning factors. A survey about internet technology knowledge amongst 9000 teenagers found out that in that age-group (of 12 to 18 years), learning at home (in self-teaching mode or with their siblings) is more prominent than learning in schools (Mediappro 2006). Especially youth relevant media, like TV, Internet, computer games and their implicit information about jobs and about SET as a field of (non-)interest play a key role in the socialisation and educational decision processes of pupils in secondary school level. Thus, these media receptions can be seen as informal learning experiences, which form young people's images of science and engineering, enhance SET-interests and young people's self-beliefs as well. Whereas we are interested in construction and co-construction processes of technology and gender, other studies set a solely gender focus in their youth magazine analysis. Gitta Mühlen Achs (1996) for instance criticized in her study, that youth magazines emphasize "special female needs" and further stereotypical approaches. Parissa Chagheri (2005) evaluated two girls' magazines feminist-linguistically and could show that the visual and verbal discourse of women in both magazines is far from an emancipatory approach. And Mareike Herrmann (1999) explored a German teenage girls' magazine and found a reinforcement of the femininity myth. The absolutely new research perspective in the MOTIVATION study and our paper is the analysis of science, engineering and technology and the gender analysis of those SET representations as well. This brings more insights about the role of media in the process of shaping stereotypical images of technology in youth's minds (Osborne, Simon & Collins, 2003); and help explaining effects like the declining of SET students.

2 Background: from "WomEng" to "MOTIVATION"

Another background for the following deliberations was one of our own research results, which we gained in the WomEng study (for further information see: Dahmen 2006, European Commission 2006, Thaler & Wächter 2005). Beside other methods we did a survey where we asked 699 female and male European students out of different engineering majors and as a control group 637 students of different non-engineering majors (social sciences, humanities, economics, etc.) – among other things – about the image of female and male engineers.

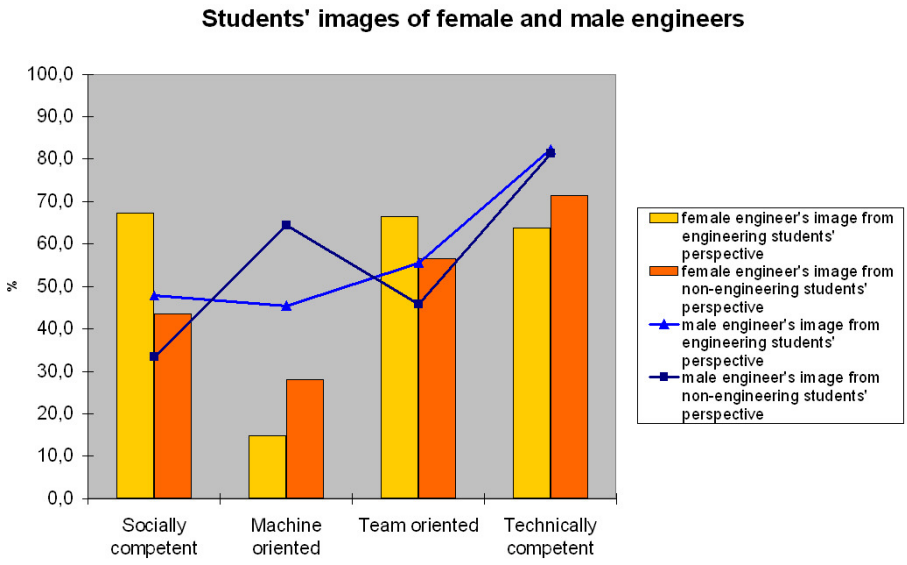


Figure 1: Engineers' images from students' perspectives

The diagram above (figure 1) displays the gender stereotypical image of engineers depending on the persons' study subject. While engineering students and non-engineering students both generally attribute more technical competence than team orientation to male engineers, non-engineering students ascribe additionally more machine orientation and less social competence to engineers than engineering students do. Female engineers are rated as less machine-oriented as their male counterparts, but the machine orientation is overall lower rated by engineering students. 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 that engineering is "more than machines" and SET jobs include also social competencies. In short, personal experiences help young people to overcome stereotyped SET images (Thaler 2005).

Those interesting results 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 is shown in popular youth media – can SET images found in youth magazine explain some of the technology-distant and stereotyped attitudes of young people? The actual aim of the European project MOTIVATION (www.motivation-project.com) is to learn more about factors, which influence the image of science, engineering and technology (SET) in order to attract more young people to those fields (Sagebiel et al. 2008).

The project analyses:

- if and how youth media impacts the manifestation of stereotypical perception of science and technology.
- how teachers and teaching at school can contribute towards SET supportive job and study orientation processes of young people.

- what SET-related self-concepts pupils have and how these influence their perceptions of suitable future job and study fields.
- how so called inclusion measures designed and organised for attracting adolescents for SET.

3 Methodology

The MOTIVATION study (2008 to 2010) used and uses different methodological measures, we refer in this paper especially to an exploratory analysis of SET school education in Europe and content analysis for youth media research.

3.1 Magazine analysis

For the analysis of popular youth magazines a data sheet has been developed (Thaler 2009), including criteria and precise guidelines for all national team members on how to identify and describe relevant SET representations in their country-specific youth magazines. Supplementary a qualitative content analysis of the detected gender representations in SET images was prepared.

Technology for the project purposes is defined in a layperson's view: technological artefacts like machines, hardware, and software and SET professionals for instance scientist, engineers, etc., in order to analyse technology representations, which would be recognised as technology by teenagers (ibid.).

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, which is published since 1956. Of the Austrian youth magazine "Xpress", which is published monthly, six issues were closer examined from July 2008 to January 2009. Supplementary and in contrast to the two other magazines which are focussing on the same audience, seven issues of girl's magazine were analysed. The German magazine "BRAVO GiRL!" is published every second week and reaches 0.59 million readers per issue, of which the majority is female with 0.55 million (Bauer Media 2009).

3.2 Biographical interviews

For the exploratory SET school education analysis 14 pupils of upper secondary schools in Austria and Germany have been interviewed about their experiences and opinions regarding SET in different settings like at their parent's home, at school, among peers and in media.

Additionally in the first part of the interviews an adapted 'Draw-A-Scientist Test – DAST' has been included. The test was first applied by David Chambers (1983) for exploring stereotypic perceptions and views about scientists reflected in drawings of school pupils. In the beginning of our interviews all 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. The idea behind this wording of the task was first to broaden the field from science of the traditional DAST to SET, the focus of our study. And the second part of the formulation "who has passed the same educational training like the interviewees" should make an identification of the pupils with the drawn person more probable.

4 Results

For this paper we concentrate on partial results of Austrian and German investigations in the first project phase, which include the analysis of youth magazines in both countries and biographical interviews with female and male pupils at secondary schools (a shorter overview of these results can be found in Dahmen and Thaler 2009 and Thaler and Dahmen 2009).

4.1 Youth magazine analysis

Altogether 801 representations of SET were analysed in the Austrian and German youth magazines. As the German "BRAVO" is weekly published the majority of images is connected to this magazine with totally 491 cases, that are averagely 22.3 SET images per issue.

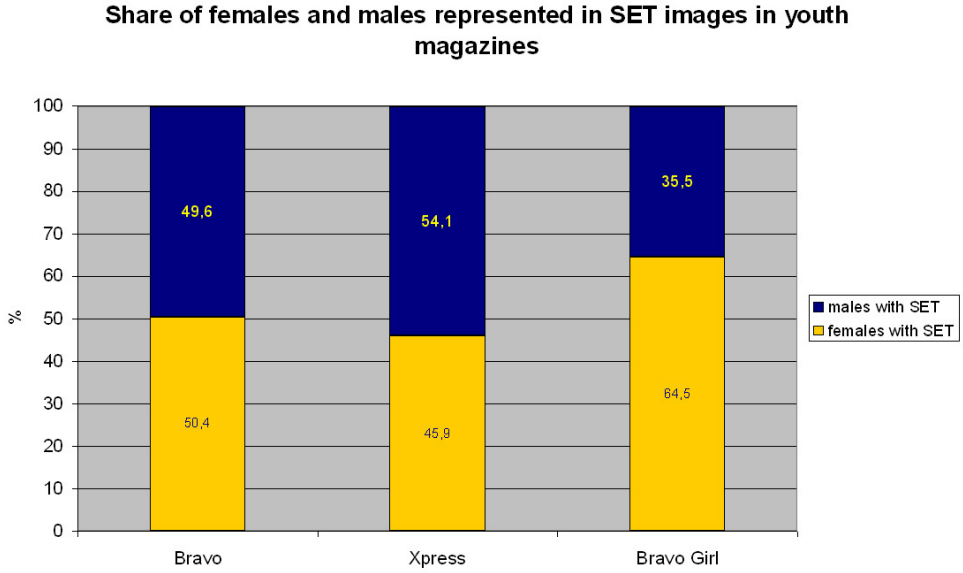


Figure 2: Gender distribution of SET pictures in youth magazines

The three analysed magazines have a different share of females and males represented in their SET images. While "Xpress" and "BRAVO" are nearly equally often portray females and males

with science, engineering and technology, the girls' magazine "BRAVO GiRL!" certainly emphasize their female focus by presenting females in two thirds of their SET pictures.

One of the points we are interested in is what fields of technology are presented, and whether they vary from magazine to magazine and if they are more or less connected to females or males portrayed in the same picture. We can firstly say that the field which is presented in SET related images is very closely connected to topics typically presented in youth magazines. The mostly presented SET field is music technology (277), followed by vehicles (133) like cars or motorbikes, then other – not pre-defined – technology (125) like digital clocks. Images with cell phones/handhelds are common as well (115), followed by a little fewer camera/TV pictures (75), computers (41) and video games/toys (35).

Besides asking which technology is shown in youth magazines, it is also interesting to look at differences regarding the gender of portrayed persons in those SET images (figures 3-5).

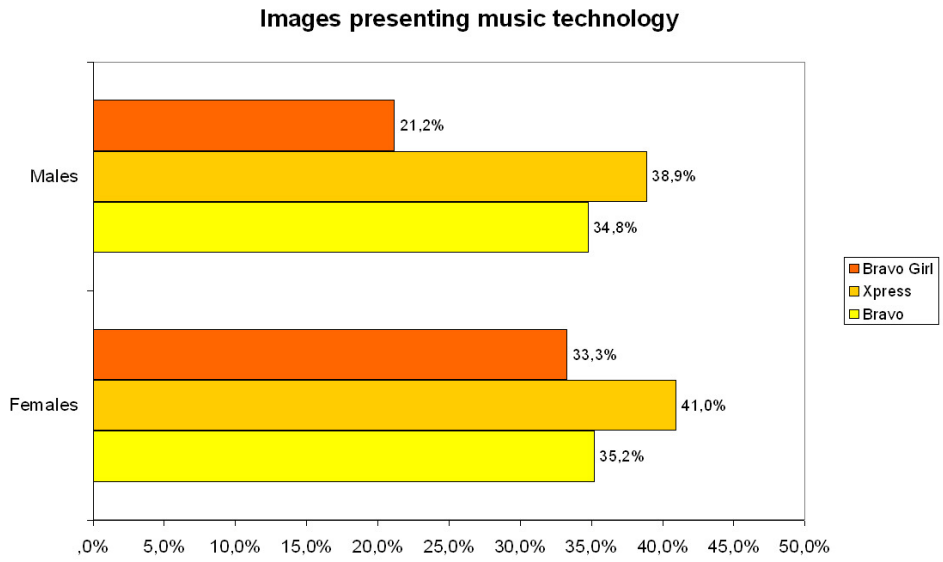


Figure 3: Gender distribution of music technology pictures

In the figure 3 above, it could be seen that pictures with males presenting music technology are relatively more often shown in „BRAVO" and „Xpress" – the magazines aiming at boys and girls –compared to „BRAVO GiRL!". On the other hand are images with females more often connected to music technology in the Austrian „Xpress" than in both German magazines „BRAVO" and „BRAVO GiRL!".

That means in short that first music technology is mostly presented in Austrian „Xpress" and the quantitative gender difference in music technology pictures of „BRAVO GiRL!" can be explained by their general over-proportional portraying of females in this girls' magazine.

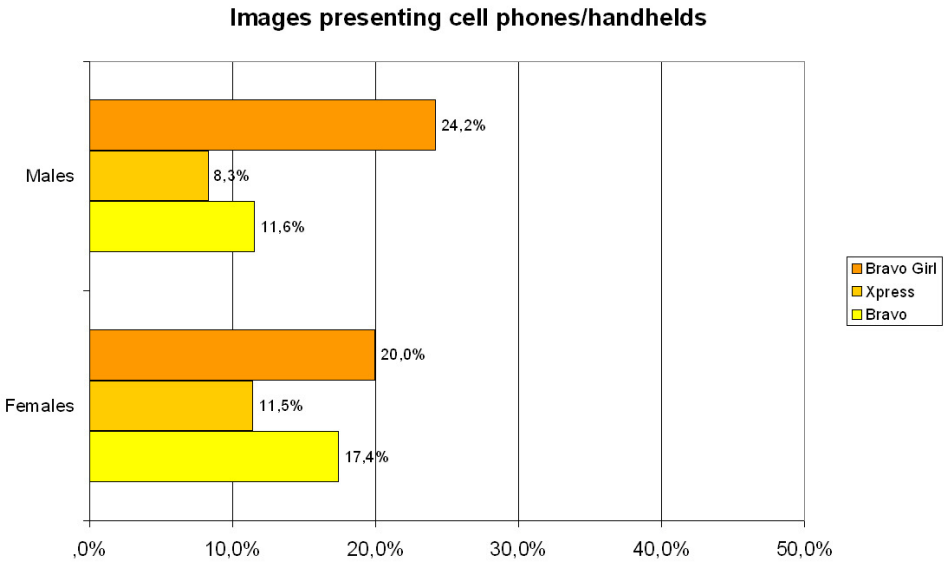


Figure 4: Gender distribution of cell phone pictures

Cell phone technology is relatively more often presented in „BRAVO GiRL!" than in „BRAVO" and „Xpress", but while these two "both-genders-magazines" magazines connect cell phones a little more often with females, the girls' magazine „BRAVO GiRL!" shows cell phones/handhelds more often in SET images with males than females (figure 4).

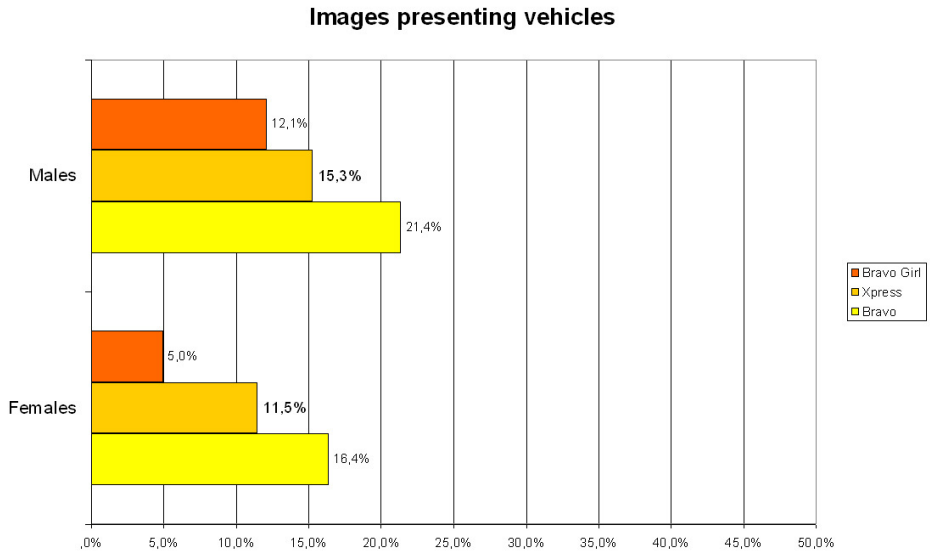


Figure 5: Gender distribution of vehicle pictures

Pictures displaying vehicles could be found mostly in „BRAVO", then in „Xpress" and least often in „BRAVO GiRL!" and in all three magazines vehicle images portray more males than females (figure 5). The gender difference is very obvious in „BRAVO GiRL!" males are more than two

times as often shown with cars and motorbikes etc. than girls, and that in a magazine where overall only one third of SET pictures display males. That is a very clear connection of a technology to masculinity.

Another question which interested us was if gender was co-constructed by using certain colour codes in pictures of females or males presented with SET. In absolute numbers all three youth magazines present SET pictures predominantly coloured in black/grey (397), followed by white (249), blue/turquoise (223), red (162), green (161), yellow/orange (152) and pink (137). Purple (96), brown (92) and other colours (20) are presented less often with images of science, engineering and technology. Further interesting results can be gathered when certain main colours of SET images were compared by gender – on a relative level – from magazine to magazine (figures 6-8).

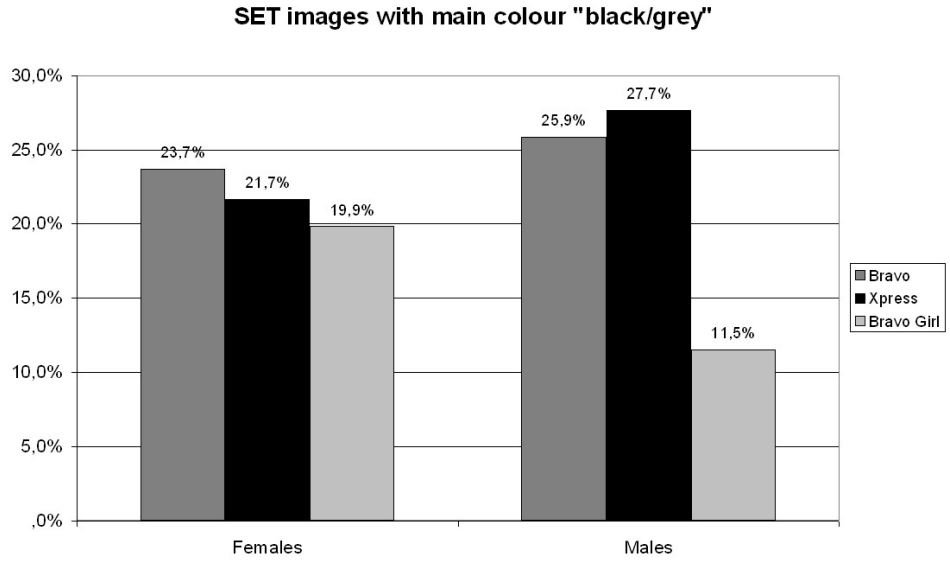


Figure 6: Gender distribution of black SET pictures

In all three magazines about every fifth SET image which portrays females is connected to black/grey. But it looks different for SET images with males (figure 6). While about every fourth picture in „BRAVO“ and „Xpress“ is coloured black/grey in „BRAVO GiRL!” only every tenth picture of males presented with SET is black/grey. But that finding can at least partly be explained with the overall gender difference in the girls’ magazines’ SET pictures.

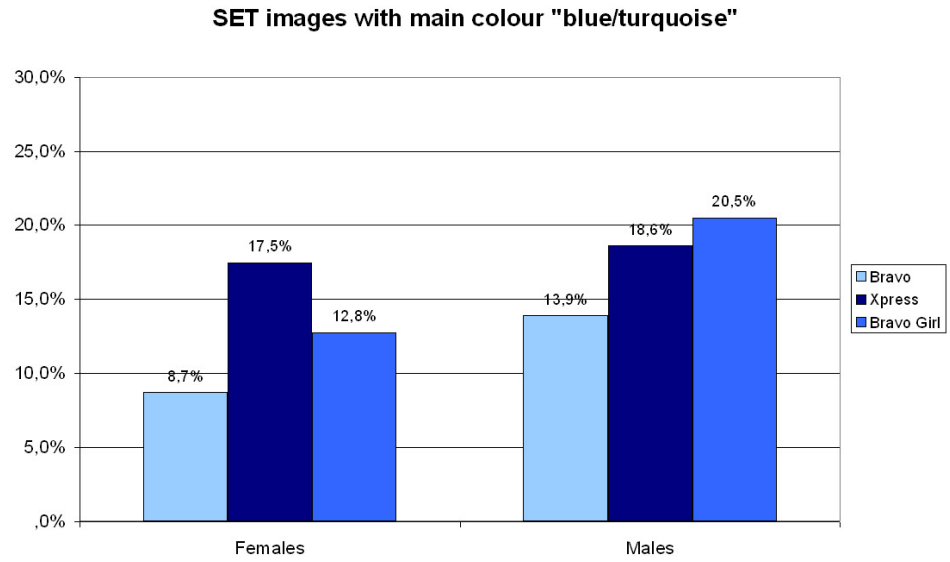


Figure 7: Gender distribution of blue SET pictures

The second most used colour of SET pictures, blue/turquoise, is differently used with females and males in each magazine. While SET pictures with females are blue/turquoise about every sixth time in „Xpress“, it is less often presented in „BRAVO GiRL!” and at least in „BRAVO“. The relative frequency of blue/turquoise SET images is different when males are portrayed. Every fifth „BRAVO GiRL!” and nearly every fifth „Xpress“ SET image with males is blue/turquoise, but only every seventh of „BRAVO“. That means blue/turquoise is used gender equally in the Austrian „Xpress“, while both German magazines connect it more to males with SET. It can be stated that in „BRAVO“ and „BRAVO GiRL!” blue/turquoise has a gender colour code function.

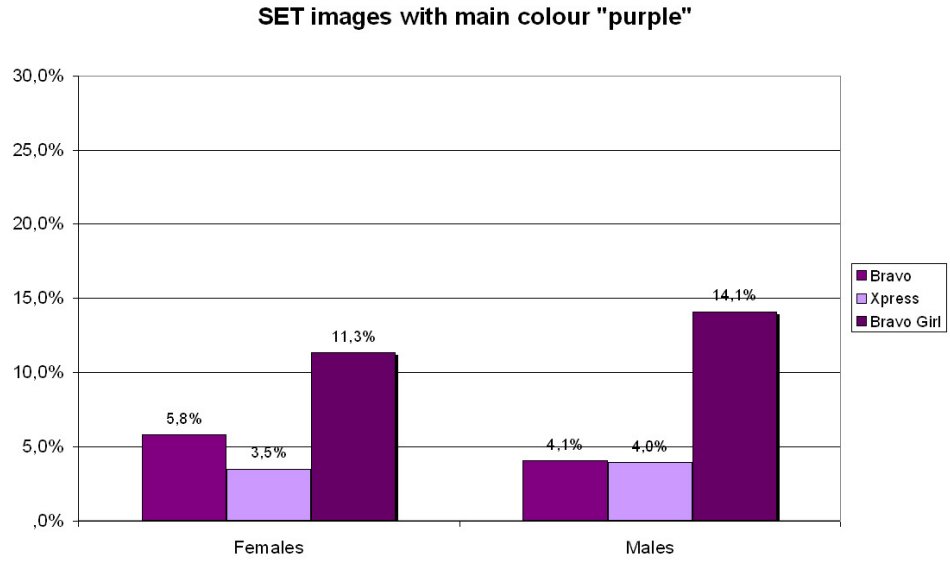


Figure 8: Gender distribution of purple SET pictures

Purple is certainly the most differentiating colour regarding magazine type. While „BRAVO“ and „Xpress“ use purple equally seldom in SET pictures with both genders – only every 20th to 25th times – the girls' magazine „BRAVO GiRL!" uses in about every tenth SET image with females and even in about every seventh SET picture with males purple as predominant colour (figure 8). Interestingly in „BRAVO“ purple is a little more often presented in SET images with females. It seems as if purple has a certain gender colour code function. That could mean that girls' magazines can be distinguished from others by using relatively more often purple in their SET pictures, while youth magazines aiming at readers of both genders are using purple more in their female portraying SET images.

In the qualitative analysis of the two general youth magazines "Xpress" and "BRAVO", we focused on SET pictures portraying male and female persons in the same picture, so that we could say something about the represented gender relations. And we can shortly summarize, that both youth magazines have gender stereotypical and gender equal SET representations as well. But, gender equal SET representations contain often unrealistic SET representations, using technological artefacts more as props of a scene than in their technological context (Thaler 2009). The degree of gender equality of SET representations differs between the two magazines. While in those mixed-gender-representations "Xpress" has less overt gender stereotypical SET representations but additionally some subtle forms as well, "BRAVO" has mostly overt gender stereotypical SET images.

Overall, representations of SET professionals are rarely to find, only about 3% of all analysed SET pictures show SET as a job and not as a product (Thaler 2009). A positive exception is the irregular published job special of "BRAVO" called "job attack" [German "Job Attacke"]. This initiative is a cooperation of "BRAVO", McDonalds and the German employment agency and introduces so called dream job fields to young people, and informs about legal aspects of apprenticeships and ways to find the right job as well. This job special can on the one hand be considered as good practice initiative for SET job information and counselling and it is more or less the only place in all analysed youth magazines, where SET is presented as a job and not as technological product. Striking was the fact that the main headings or sub-titles suggest that the presented jobs are 'cool' ones. Also the so called "CSI effect" (Els Rommes, see for instance Rommes et al. 2007), is taken up by "BRAVO" too (issue 43/2008), regarding the work in forensics as a potential "dream job". This effect sees a linkage between the popularity of the "CSI" series on TV and the increasing number of young people who opt for a career in forensic sciences and related technology fields like biomedical engineering. On the other hand this job section perpetuates certain gendered SET stereotypes, for instance portraying males with electronics and mechanical engineering and females with chemistry and medical sciences.

Additionally the German girls' magazine "BRAVO GiRL!" was qualitatively analysed with the aim to reveal the representations of SET in this youth medium which explicitly aims on young female readers. The magazine was first published in 1985 and on the publisher's website it's promoted as substitute or addition to real life companions: "With the core areas stars, fashion,

beauty and boys "BRAVO GiRL!" offers everything which interests girls. She has the closeness of a best friend and the knowledge of a big sister" (Bauer Media 2009).

And indeed the analysis of seven issues in autumn 2008 confirmed this. The content of the "BRAVO GiRL!" magazine aims exclusively on young female readers. Beauty, fashion and lifestyle have been the most important topics in each issue, all three strongly linked to the "boys topic". Doing so, the magazine has a strong hetero-normative approach, it is all about girls and boys and their relationship to each other, respectively information and tips for girls how to appeal to boys and how to understand them. These tips were always formulated in a hetero-normative manner. In one issue an interview with an openly gay living singer and moderator was included about his personal experiences with coming out and being gay. But this was the only exception.

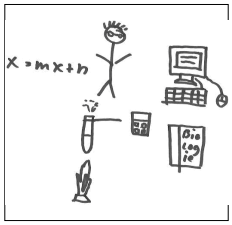
Coming back to our focus SET it is interesting, that if a relation to SET is actively produced in the journalist magazine content it is again related to the "boys topic" in most of the cases, like the following two headings illustrate: "Natural, sexy, shy – which internet profile appeals most?" (issue 19/2008, p. 68), it is a story about a girl, who tested three different internet profiles – natural, sexy and shy – in an internet community for pupils. "Boys & sms: what works, what not?" (issue 21/2008, p. 18), this article informs the female readers on the "tops and flops" of short messaging – again – in connection with boys.

4.2 Draw-a-scientist test

The fourteen drawings of our interviewees 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 actively handling a technical tool or a computer in their pictures (see left example of interviewee AMI_1, 14 years old). All other participants drew (stick) figures besides vials or other equipment symbolizing science, engineering or technology. Only three of the pictured persons – not stick figures – could clearly be 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, and 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 a certain stereotype aspect of scientists 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). Another fourteen year old Austrian boy, who is actually interested in engineering, drew a car constructor with a tool beside a car (like a car mechanic). We interpret this as a lack of realistic SET job information in school education, as car construction and engineering is nowadays definitely a computer job, while car mechanics only repair but do not construct and design new vehicles. 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 asked concretely about their realistic job options for their future. The sixteen 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 – a personal connection like different others which we found out influenced some of the other SET interested pupils as well.

Nevertheless the overall professional images of persons working in science, engineering and technology reflect on the one hand personal relationships with SET people, but on the other hand public mediated SET images. For instance people, who achieved a high reputation in science, like Albert Einstein, who was drawn by a female pupil in Germany in Einstein's famous pose sticking his tongue out. This image of Einstein is very well-known as an icon of science, it is probably more known than the scientific content of Einstein's research.



But when pupils were asked about concrete job examples in SET, they mostly referred to science teaching, certainly because these are the SET-related jobs which they experience every day in personal environment. This was also reflected by three German girls who drew teachers as examples for people working in SET. Or on the other hand the "nightmare job science teacher" as it was mentioned by Austrian interviewees. This result is not surprising at all but demonstrates the need for more diverse occupational information about career possibilities in the respective fields and more SET role models in pupils' real lives and in media.

4.3 Interview results

The results of our fourteen interviews can only be seen in addition to our media analysis. We wanted to bring in teenagers' voices to our research question about what images of SET exist and how they are constructed by media. Therefore the following results should bring further clues for interpretation of our research topic. What do teenagers in Austria and Germany tell about their SET classes in school and what influences their interest and images in SET.

To begin with, interest in SET turned out to be a rather complex concept. Clearly it is 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.

The role of SET teachers seemed influencing as well, the popularity of a subject – especially in the German interviewee's group – stands and falls with the (un-)popularity of the teachers regardless the subject they teach. This was also confirmed by teachers who were interviewed in Germany.

Good teaching for the pupils means most of all having fun during the lessons, but also recognizing the sense of the subjects. Especially one Austrian interviewee – who admitted in

being not interested in SET – referred to the concept of meaningfulness, generally, but even more important meaningful for ones own life. Therefore, pupils like hands-on work at school, they want to try out experiments in chemistry by themselves or construct robots, it is important for them to experience science by themselves and not only during lecturing lessons. Education research has shown that learning is most effective in settings where learners can act as teachers as well. Thinking about how to explain for instance science to 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 see the relevance of school subjects and become aware of their implicit knowledge. For instance realize that their often informally learned technology skills can help them with classes in schools, by connecting SET with spare time topics like internet games or music technology (Gansmo 2004, Pitt 2004, Thaler & Zorn 2009a, 2009b).

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 an ideal self. This was the case for one Austrian girl who is very upfronted with her disinterests 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 discourse. First, one might think that especially life sciences could be easily explained as relevant for all humans, and of course for all pupils in school. It seems sad that even biology, and especially the knowledge of the human body, can not be explained in a meaningful and interesting way. But another interpretation of this girls' discourse is that she deliberately shows her SET-disinterest, because she actually thinks that being good at school and especially being good at SET subjects (being "clever" as she ironically called it) can conflict the identity of a teenager, as she wants to present herself. SET-interest and SET-competence is certainly not appropriate for her self-concept. 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.

5 Discussion

Contrary to the efforts of the European Union to strengthen its reputation as scientifically and technologically innovative and knowledge based society, the declining number of students in SET degree courses and gender imbalance in SET bears a need for ongoing improvement especially of SET education and public understanding of science. We could show that several studies revealed that although students agreed on the importance of science and technology (OECD 2007a, European Commission 2001), only a minority of them thinks about a career in SET. Additionally school education, informal science education and implicit SET-learning through media are very influencing. Therefore the European research project MOTIVATION wants to explain some interdependencies of school and out-of-school factors, which influence the image of SET and how this knowledge could be used to attract more young people for a SET career.

Science, engineering and technology is not an unusual topic in youth magazines. But opposite to official SET job brochures youth magazines embed SET mostly in other leisure topics, like music or movies and gossip about famous persons in those businesses. This results strengthens current SET education approaches which want to use leisure topics of teenagers as a vehicle to transport SET in a more (for pupils) appealing and meaningful way (Gansmo 2004, Pitt 2004, Thaler & Zorn 2009a, 2009b).

About the genderedness of SET images in youth magazines we can conclude on two different levels. Quantitatively the proportion of portrayed females and males in SET pictures is nearly the same in the girls' magazine the female share is even higher, because this reflects the magazine's direction as a "female medium". On the quantitative and even more on the qualitative level we found out that gender stereotyping takes place in reinforcing the female or male connotation of certain technology fields. The over-representation of female portrays with cell phones and under-representation of vehicles in the girls' magazine – compared to the both general youth magazines – can be seen as one indicator. The quantitatively higher proportion of males connected to vehicles and qualitatively analysed relationship of gender and vehicle usage (males are more often presented as drivers while females stand outside or beside vehicles, using them more as props) is another one.

The colour code used in SET pictures gave us further information about the composition of SET images and their implicit doing gender processes. We found out that blue and especially purple have some gender-constructive function in SET images. Purple can be seen in SET pictures of the girls' magazine (and we assume in the whole magazine) generally much more often. And as if the girls' magazine wants to somehow "neutralize" SET images with males it uses purple as predominant colour in those male SET pictures, while other youth magazines (aiming at readers of both genders) are using purple more in their female portraying SET images.

Representations of SET professionals are rarely to find, 97% of all analysed SET images show technological products. But a positive exception is the irregular published job special of one youth magazine. This job special can be considered as good practice initiative for SET job

information and by connecting SET to this dream and "cool" job section SET degree courses can only hope for a certain "CSI effect" (like Els Rommes called it, see for instance Rommes et al. 2007), where a connection of the popularity of the "CSI" series on TV and the increasing number of young people who opt for a career in forensic sciences and related technology fields like biomedical engineering is considered. The fact that at least in the German sample the interviewees referred mainly to SET teachers at school or at university, let our hopes not grow too much. It underlines two important aspects: first, there seems to be lack of diversified job information for SET professions and second, the high visibility of teachers serves as SET role models for their pupils. The latter point leads to another, the importance of positive attitude towards SET on both sides – on the teachers' as well as on the pupils' side: Teachers who transmit liking their job and having fun to teach seem to be a high motivating effect for engaging pupils in the class room. Uttered didactical preferences of the pupils for hands-on work, experiments and interactive exchange of course can not be implemented without knowing and transferring the necessary concept behind, but for the young people this necessity and meaningfulness is often not comprehensible.

Regarding our research question about genderedness of SET images the most relevant result is probably the following: We found gender equal representations of science, engineering and technology, but they represent SET very often in an unrealistic manner, using technological artefacts as props of a scene and not in a meaningful technological context (Thaler 2009). Keeping those results in mind, it is interesting what our adapted draw-a-scientist-test (DAST) could show. Indeed, the results of the DAST in both countries exemplified that the pupils' perceptions reflect a narrow picture combined with existing stereotypes of these fields. That girls are more likely to draw a female scientist than their male counterparts is also confirmed by Steinke et al. (2007) whose study revealed that in 50% of the girls' drawings female person could be identified compared to 12,5% of the boys. However, it is striking that the majority of our drawing interviewees has not much clue about SET. They use certain symbols like vials to add a scientific meaning to a stick figure or they draw a person – a man – in a lab coat with glasses. Their drawings mirror certain images of SET, and only very seldom the persons in the drawings have a connection to the other drawn SET symbols or tools, in the most drawings the scientists and engineers do not touch their professional instruments, they are passively standing beside their SET objects and if those objects were not there, you would not identify them as scientists or engineers – like in the youth magazines SET artefacts serves as props.

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6 References

Bauer Media (2009) Aktuelles aus dem Bereich Bravo Girl!, Available from http://www.bauermedia.de/b_girl.html (Accessed 24 April 2009)

BMBWK (2003, 2005) Statistisches Taschenbuch. Available from: http://www.bmbwk.gv.at/ (Accessed 19 September 2006)

Chagheri, Parissa (2005) Die Sprache in Mädchenzeitschriften. Eine sprachwissenschaftliche Untersuchung von BRIGITTE YOUNG MISS und BRAVO GIRL, Available from: http://www.linglit.tu-darmstadt.de/fileadmin/linglit/sprache/download/dox/ chagheri_p.pdf (Accessed 2 April 2008)

Chambers, David W. (1983) 'Stereotypic images of the scientist: The draw- a-scientist test', Science Education, 67 (2), pp. 255-265.

Cleaves, Anna (2005) 'The formation of science choices in secondary school', International Journal of Science Education, 27 (4); pp. 471-486.

Cornelißen, Waltraud; Gille, Martina (2005) 'Lebenswünsche junger Menschen und die Bedeutung geschlechterstereotyper Muster', Zeitschrift für Frauenforschung & Geschlechterstudien, Heft 4, 2005, pp. 52-67.

Dahmen, Jennifer (2006): I like to study in a male domain – Female students in engineering majors. In: Proceedings of 34th Annual Sefi Conference, Uppsala, Sweden, 28th June – 1st July 2006 (CD).

Dahmen, Jennifer & Thaler, Anita (2009). Image is everything! Is image everything?! About perceived images of science, engineering and technology. In: Maartje van den Bogaard, Erik de Graf & Gillian Saunders-Smits (eds.). Proceedings of 37th Annual Conference of SEFI. "Attracting young people to engineering. Engineering is fun!", 1st-4th July 2009, Rotterdam. CD-Rom. ISBN 978-2-87352-001-4. [Reviewed.]

European Commission (2007). Science Education Now: A renewed Pedagogy for the Future of Europe, Available from: http://ec.europa.eu/research/science-society/document_ library/pdf_06/report-rocard-on-science-education_en.pdf (Accessed 22 February 2008)

European Commission (2006): Creating Cultures of Success for Women Engineers -Womeng. Final report, Available from: http://ec.europa.eu/research/social-sciences/pdf/womeng_en.pdf (Accessed 12 March 2009)

European Commission (2005). Special Eurobarometer – Europeans, Science and Technology, Available from: http://ec.europa.eu/public_opinion/archives/ebs/ebs_224_report_en.pdf (Accessed 22 May 2007),

European Commission (2004). Europe needs more scientists, Available from: http://ec.europa.eu/research/conferences/2004/sciprof/pdf/hlg_report_en.pdf (18 February 2008)

European Commission (2001). Eurobarometer 55.2 – Europeans, Science and Technology, Available from: http://ec.europa.eu/public_opinion/archives/ebs/ebs_154_en.pdf (Accessed 22 May 2007)

Gansmo, H. J. (2004) 'Computing: excludingly boring at school - includingly cool at home', in Strategies of Inclusion: Gender in the Information Society, Vol. III: Surveys of Women's User Experience. N. Oudshoorn, E. Rommes and I. v. Slooten. Trondheim, NTNU. pp. 337-362.

Hackett, Gail (1997). "Self-efficacy in career choice and development", in Bandura Albert (Ed.) Self-efficacy in changing societies. Cambridge: University Press, pp. 232-258.

Hannover, Bettina and Ursula Kessels (2004) 'Self-to-prototype matching as a strategy for making academic choices. Why high school students do not like math and science', Learning and instruction, 14. pp. 51-67.

Herrmann, Mareike (1999). "Feeling Better" with Bravo: German Girls and Their Popular Youth Magazine', in Sherrie A. Inness (ed.). Millennium Girls: Today's Girls Around the World. Rowman & Littlefield Publishers, pp. 213-242.

Langen, Annemarie van; Dekkers, Hetty (2005) 'Cross-national differences in participating in tertiary science, technology, engineering and mathematics education', Comparative Education, 41 (3), pp. 329-350.

Mediappro (2006). The Appropriation of New Media by Youth. In: http://www.mediappro.org/publications/finalreport.pdf [12. 2. 2008]

Millar, Robin; Leach, John; Osborne, Jonathan (Eds., 2000): Improving science education. The contribution of research. London: Open University Press.

Mortimer, Jeyan T. et al. (2002) 'The Process of Occupational Decision Making: Patterns during the Transition to Adulthood', Journal of Vocational Behavior ,61, pp. 439-465.

Mühlen Achs, Gitta (1996). '„Schön warten auf den Richtigen?" Die Inszenierung heterosexueller Romanzen in der Jugendzeitschrift BRAVO', in Margrit Lenssen, Elke Stolzenberg (eds.).Schaulust: Erotik und Pornographie in den Medien. Opladen: Leske + Budrich, pp. 11-36.

OECD (2007a) PISA 2006: Science Competencies for Tomorrow's World. Volume 1: Analysis. Available from: http://www.pisa.oecd.org/dataoecd/30/17/39703267.pdf (Accessed 3 March 2008)

OECD (2007b) Education at a Glance 2007. OECD Indicators, Available from: http://www.oecd.org /dataoecd/36/4/40701218.pdf (Accessed 18 August 08)

OECD (2006) OECD. Science, Technology and Industry Outlook. Available from: http://www.oecd.org/dataoecd/39/19/37685541.pdf (Accessed 29 March 2008).

Osborne, Jonathan; Simon, Shirley; Collins, Sue (2003) 'Attitudes towards science. A review of the literature and its implications', International Journal of Science Education, 25 (9), pp. 149-1079.

Pitt, L. (2004) 'IT Beat: Bringing Pop and Glam to IT', in Strategies of Inclusion: Gender in the Information Society. Vol.II: Experiences from private and voluntary sector initiatives. C. MacKeogh and P. Preston. Trondheim, NTNU. pp. 219-240.

Rommes, E.W.M.; Overbeek, G.; Engels, R.C.M.E.; Kemp de, R.A.T.; Scholte, R.H.J. (2007) 'I'm not interested in computers: Gender-based Occupational Choices of Adolescents', Information, Communication & Society, 10, no.3, June, pp.299-319.

Sagebiel F., Dahmen J., Davidsson B., Godfroy-Genin A., Rommes E., Thaler A., Urbancíková N. (2008) Motivation of young people for studying SET. The gender perspective' in Proceedings of the 36th Annual SEFI Conference of SEFI, 2-5 July 2008, Aalborg. CD-Rom.

Schreiner, Camilla (2006) Exploring a ROSE-garden: Norwegian youth's orientations towards science – seen as signs of late modern identities. Doctoral thesis, University of Oslo, Faculty of Education, Department of Teacher Education and School Development, Oslo.

Schreiner, Camilla; Sjøberg, Svein (2006) Science Education And Young People's Identity Construction – Two Mutually Incompatible Projects? Available from: http://www.ils.uio.no/english/ rose/network/countries/norway/eng/nor-schreiner-values2006.pdf (Accessed 20 May 2007)

Sjøberg, Svein; Schreiner, Camilla (2006) 'How do students perceive science and technology?', Science in School, Issue 1, 2006, pp. 66-69. Available from: http://www.scienceinschool.org/2006/issue1/rose/ (Accessed 14 April 2008)

Statistics Sweden (2008) Programnybörjare mot yrkesexamen läsåren 1993/1994 – 2006/2007 efter program och kön. Available from: http://www.scb.se/statistik/UF/UF0205/2007A01b/Web_GN3_ProgramNyb.xls (Accessed 9 March 2008)

Steinke, Jocelyn et al. (2007) 'Assessing Media Influences on Middle School Children's Perceptions of Women in Science Using the Draw-A-Scientist Test (DAST)', Science Communication, Volume 29, pp.-35-64.

Thaler, Anita (2005). To succeed or not succeed, that is the woman engineer's question. In: Anita Thaler, Christine Wächter (eds.), Conference Proceedings of the International Conference "Creating Cultures of Success for Women Engineers", 6.-8. 10. 2005, Leibnitz / Graz, IFZ Eigenverlag Graz, pp. 93-103. In: http://www.ifz.tugraz.at/index.php/filemanager/download/1307/Womeng-Proceedings.pdf [23.3.2009]

Thaler, Anita (2009, forthcoming). "Learning technology?" About the informal learning potential of youth magazines. In: Proceedings 8th Annual IAS-STS Conference "Critical Issues in Science and Technology Studies", ISBN: 978-3-9502678-1-5.

Thaler, Anita; Dahmen, Jennifer (2009). Science Education in Europe – Images, Approaches, Innovations. In: Freddy Malpica, Bill Tait, Andrés Tremante & Friedrich Welsch (eds.). Proceedings of the 2nd International Multi-Conference on Society, Cybernetics and Informatics. Volume I. July 10th - 13th, 2009 – Orlando, Florida, USA. ISBN 1-934272-72-8. [Reviewed.]

Thaler, Anita; Wächter, Christine (eds., 2005) Conference Proceedings of the International Conference "Creating Cultures of Success for Women Engineers", 6.-8. 10. 2005, Leibnitz / Graz, IFZ Eigenverlag, Graz.

Thaler, Anita; Zorn, Isabel (2009a). Attracting teenagers to engineering by participatory music technology design. In: Maartje van den Bogaard, Erik de Graf & Gillian Saunders-Smits (eds.). Proceedings of 37th Annual Conference of SEFI. "Attracting young people to engineering. Engineering is fun!", 1st-4th July 2009, Rotterdam. CD-Rom. ISBN 978-2-87352-001-4. [Reviewed – "Best Paper Award".]

Thaler, Anita; Zorn, Isabel (2009b) 'Music as a vehicle to encourage girls' and boys' interest in technology', 5th European Symposium on Gender & ICT. Digital Cultures: Participation – Empowerment – Diversity , March 5 - 7 2009, University of Bremen. Available from: http://www.informatik.uni-bremen.de/soteg/gict2009/proceedings/GICT2009_Thaler.pdf (Accessed 4 March 2009)

Whitelegg, Liz (2001) 'Girls in science education: of rice and fruit trees. In: Muriel Lederman & Ingrid Bartsch (eds.): The gender and science reader. London, pp. 373-381