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KU Leuven students' survey results: gender schemas and engineering schemas

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Introduction

An Equal Opportunities Working Group was set up in 2000 within the Faculties of Sciences, Engineering Science, Bioscience Engineering and Engineering Technology at this university, for the purpose of an active gender mainstreaming policy, aimed at increasing the inflow of female students in the faculties concerned and correcting the negative image of the occupation of engineer. The group includes academics, assistants, administrative staff and students. Numerous initiatives have been developed, including a 'Female Engineer' project, financed by the European Social Fund (ESF).

Several scientific studies have been carried out with the support of the working group, for the purpose of acquiring more information about the persistently low inflow of female students on virtually all relevant degree courses except for engineer-architects. The abolition of the entry exam in 2004 did not lead to a greater inflow of female students, but to a sharp decline in the general pass rate among students embarking on higher education (from roughly 70% to less than 50%). Since the inflow did not increase at a proportionate rate, the outflow declined and with it, the number of graduating female engineers.

We also see a clear differentiation as far as the decision to take a master's degree is concerned. The ratio of female students is over 50% for courses in architecture, over a third for courses materials science and biomedical technology. However, for maths engineering techniques, energy, mechanics, computer sciences and electrical engineering, the proportion of female students is less than 8%.

Why do promising young women not find the way to engineering or science courses? Below, I will present several studies that have been conducted in collaboration with the Equal Opportunities Working Group. Little by little, we hope to complete the jigsaw to compile a picture that will help us to have a purposeful and efficient inflow policy.

1. What do we know about potential, future engineering students?

In the spring of 2007, Sarah Herbots asked 461 Flemish young people from tutor groups with at least six hours of maths in their final year of secondary school education to complete a written questionnaire. Of these pupils, 52.4% were female. What was their chosen study subject several months before their definite transfer to further education? 34.6% of the boys considered an engineering course and 15.4% a

subject in the Faculty of Sciences. Girls opted in the first instance for medical and paramedical sciences (21.4%) or human sciences (17.4%). Any girls who expressed interest in the Faculty of Sciences preferred to study biology.

When asked about their lack of interest in an engineering degree, significantly more girls than boys were convinced that the studies were too difficult, assigning scores averaging 3.04 and 2.62 respectively on a five-point scale. More girls (31.9%) than boys (22.4%) associated these studies with phrases such as 'tough, lots of studying'. Girls made a closer association between the engineering profession and maths and sciences than boys (an average of 4.02 compared with 3.75). However, they were less convinced than the boys that boys are better at maths and sciences (an average of 2.21 compared with 2.77 on a five-point scale). When asked to rate their own performance in maths and science subjects, all respondents seemed to have a fairly positive self-image, without a significant difference between the sexes.

Before the start of the study, a draft questionnaire was discussed in the Equal Opportunities Working Group. A proposal was made to add a question about leisure activities, based on the hypothesis that boys spend more of their leisure time engaged in activities linked to the work of an engineer. This hypothesis was indeed confirmed: 27.8% of the boys said that they invested time in programming computers and installing all sorts of software, whereas only 2.9% of the girls did so in 2007. Boys were also more frequently busy with technical activities, such as repairing appliances or tinkering with a motorbike. Conclusion: more girls thought that the study would be seriously difficult; more boys were already 'playing' at being an engineer in their leisure time, and both sexes had a positive self-image about their personal performance in sciences and maths. From the study, we learned that future scientific research and implementation strategies must be aimed at younger age groups if they want to grasp the factors that give rise to the development of (negative) notions of engineering studies or an engineer's job.

2. What about the group that did choose to study engineering?

2.1. At the start of the study

All first-year students in engineering studies at KU Leuven were asked by Ans Hoydonckx to complete a written questionnaire in the autumn of 2004. These respondents had only just left secondary school and had only recently made the final decision on their choice of studies. 384 engineering students, or 93% of the entire group, and 131 students in the engineering architects course, or 92% of the total group, completed the questionnaire. Some 80% of the respondents were 19 years old or older. This group was representative in terms of gender.

Only eight – four men and four women – of the 515 respondents had a mother who had studied engineering sciences, so the effect of having a mother as a role model was definitely not a factor.

In relevant literature, we found that parents with a high level of education raised their daughters in a less gender-stereotypical way. Did the parents of female respondents have a higher than average education? Indeed: 35.4% of the female respondents had a mother with a university degree, versus 28% of the male respondents. 57.5% of the fathers of the female respondents had a university degree, compared with 49.4% of the fathers of the male respondents. Slightly less than one third of the engineering students chose the same degree programme as their father; for the architectural engineers the figure was approximately one in four, without any distinction between male and female students.

Who or what contributed to the decision to choose an engineering course? Female students decided later than their male colleagues, took more notice of information events and of conversations with peers and/or a qualified engineer.

What alternatives had these young people considered? More men than women considered a scientific study programme as an alternative study subject, whereas more women had also considered medicine or bioengineering as an alternative option.

For both groups, it appears that conversations with an engineer and/or someone already on the course had been influential, as well as conversations with their father and mother. Female students turned out to be more sensitive to the opinion of their mother and teachers than their male colleagues did: 39.6% of male and 45.8% of female respondents said that they were influenced by their maths teacher, male or female. These figures illustrate the important role of the maths teacher, particularly in the decision-making process of women at the end of their secondary education. This is an important target group for anyone wishing to introduce a policy to increase the inflow of female talent in engineering courses.

2.2. And at the end of the studies

The same group of students was interviewed again by Miet Kuppens at the end of their studies. Between December 2008 and February 2009, all final-year students of engineering at KU Leuven were invited to take part in an online survey, that looked back at the various aspects of their study, such as the degree programme, atmosphere and student support. Other questions probed expectations for their future career. The Equal Opportunities Working Group considered a retrospective test of the curriculum to be important, since a number of changes had been made to increase the programme's appeal to women, such as a stronger emphasis on developing projects, for which group work and communication are important. As part of the negative image of engineers, they are regularly depicted as unworldly loners and poor communicators …

Some 47% of the final-year students responded to the online survey. In general, students appeared to be quite satisfied with their studies. More female engineering students called the five-year study programme difficult and women rated the work pressure higher than men did. In this survey, use was made, inter alia, of a 'scale of professional self-confidence' for a combination of the following statements: 'I feel that I have acquired sufficient knowledge during my studies to make a smooth transition to the professional world', 'I have the feeling that I acquired sufficient skills to make a

smooth transition to the professional world', 'I feel that I have the necessary competencies to be a good engineer/architectural engineer', 'I feel sufficiently equipped to enter the labour market'. On average, women scored lower on this scale. The average scale score was 5.13 out of 7 for male final-year students and 4.65 for female final-year students.

Contrary to the difference in 'professional self-confidence', male and female students assigned parallel squares to concrete components of the course or policy decisions made at the department for organising the studies. Out of a total of eleven items to be assessed, only two ended up showing significant female/male differences. Female students from the general engineering studies confirmed more strongly than their male colleagues that they learned to give presentations and to hold efficient meetings.

The importance of taking care of the culture and atmosphere in the department should not be underestimated by anyone who wishes to make the studies more attractive to female students. In a large-scale study carried out at the initiative of the European Commission, ‘Creating cultures of success for women engineers’, in which seven countries took part in 2002, it became clear that female students have higher expectations and are more demanding in terms of the atmosphere and programme: 46% of female students indicated that the atmosphere is a very important factor, in comparison with 35% of male students. Collaboration and a personal approach turn out to be very important to women. Remarkable in this EU study is that mainly female students insisted on getting more non-engineering related subjects included in the programme, with themes from human sciences and social sciences.

Let us return to the KU Leuven study: both male and female students wanted to perform a job in line with their studies, but more female final-year students indicated that they were slightly less informed of the job opportunities. Lastly, the KU Leuven study revealed another remarkable fact about the future: neither the male nor female engineering students anticipated any problems in combining a full-time job with their home life. However, there was a significant female-male difference in the willingness to take a step back in their professional career: female students appeared to be more readily prepared to put their professional career on the back burner and to give up an ambitious career for their family, whereas they did not mind their partner carving out a career for themselves. Anyone wishing to conduct an active retention policy to keep promising young women in the industry would do well to start investing in measures to facilitate the work-life balance.

2.3. Does the apple not fall far from the tree?

Frequent references are made in literature to the importance of role models. The reference to inspiring role models was at the heart of my collaboration with the Equal Opportunities Working Group. Sometime in 2001, I heard the following argument defended in a debate: ‘mothers who are professionally active as engineers are the best role models for their daughters and hence contribute to an increased inflow of young female engineering talent’. It was suggested that, at least in the US, a striking

number of female engineering students have a mother who is professionally active as an engineer. Up to one third more, it was suggested, in comparison with female students whose mother is not professionally active as an engineer.

To us, it sounded like a suitably challenging proposition worth investigating. As already mentioned, the number of mother-engineers, which was 8 out of a total of 515 students, was particularly low in our first survey. We nevertheless wanted to check out the proposition, encouraged by a survey carried out in late 2006, early 2007, among 1267 professionally active engineers, of which 27% were women and 73% men. Some 88% of this group would recommend the profession to their son, 85% to their daughter.

We remained fascinated by the mother-daughter pattern in the student choice and explicitly set out in search of doubles, made up of a professionally active mother who is an engineer with a daughter who had chosen to study civil engineering. This double was not easy to find. Eventually, Sofie Devriendt managed to obtain eight semi-structured interviews of four doubles of mother and daughter. The mother-engineers in this study turned out to have had little influence from the studies and profession of their parents: their parents did not have any further education. The daughters nevertheless indicated that the studies and occupation of their parents had been influential. For us as researchers, it was surprising to find that all four daughters studying engineering not only had a mother who was a professionally active engineer, but also a professionally active father who was an engineer. One daughter added that her two older brothers are also engineers. Three of the daughters studying engineering told us that their mother had been influential, because they had proved that an engineering degree is also feasible for women. All eight respondents indicated that they were not raised in a gender-stereotypical manner. Seven of the eight respondents were absolutely convinced of the importance of female role models and one mother questioned the 'use' of female engineers as epitomes in this day and age. When asked about the basic characteristics required of a good engineer, the respondents confirmed the findings that also came out of the survey among professionally active engineers: a rational mind and a capacity to resolve problems, to think in abstract terms and be analytical, etc.

3. Where is the voice of female engineering students in high school colleges?

All the surveys that we developed together with the Equal Opportunities Working Group have outlined the opinions of university students. From contacts with colleges for higher education, we learned that in some colleges, the percentage of female students is even lower than the overall percentage of first-year female engineering students at university. These young women’s 'survival' in a pronounced minority position poses an even greater challenge. How do they handle this issue? By way of exploratory research, a number of focused conversations took place with female first-year and final-year students in industrial engineering in two colleges. Two themes were systematically explored by Eva Hobin at some depth: first, the process underlying the subject choice. The second part used a different perspective, new to

our research tradition: do female students experience a conflict between their identity as a woman and as an engineer? What experiences did they have studying industrial engineering, a study subject that is atypical for women? Do they identify themselves as a 'minority group' and are they experiencing any adverse consequences from their minority position?

4. A new theoretical perspective

The question at the centre of the latter study brought a new twist to the whole range of studies we have carried out so far. First, it looked at the consequences of living and working in a strong minority position. Inspiring in that respect as a theoretical framework were, inter alia, the token theories of Rosabeth Moss Kanter. Even more important is the change of course inspired by two specific studies. After all, some researchers have been applying a very different angle for several years: young women choosing to take a science degree or general engineering degree may have a less stereotypical image of women. In other words, these researchers refer to a specific interpretation of gender identity as a possible explanation for low inflow rates. Their approach throws a new light on the problem.

Erin Cech analysed the normative interpretation given by female students within and outside engineering studies to central concepts surrounding 'gender' and 'being an engineer'. Men and women, both engineering students and others, seem to have a different image of the engineering profession. When asked about their ideas of what being a 'woman' entails, female engineering students portray a different image in comparison with female students from other study programmes.

Iris Chu went in search of processes of identity development among engineering students at the Texas A & M University. In 2004-2005, she interviewed 273 engineering students, 86 of whom were female (31.5%). Half of the female students referred to their father as strongly influential in their choice of study subject, due to the specific information he gave them. The role of the mother in the subject choice was described in terms of 'emotional support'. These girls experienced conflicting emotions and ambivalence because they were well aware that the social expectations associated with 'being a woman' seemed to be at odds with the expectations regarding 'being an engineer'. Female engineers seemed to be carrying out a constant balancing act between their (assigned) identity as a woman and their identity of engineer. ‘Women engineering students try to adapt to engineering identity prescriptions and, as a result, they sometimes distance themselves from their gender identity’ (Chu, 2007: 61).

5. Insights into gender identity empirically tested: 'work in progress'

We developed a large-scale survey project, for the purpose of cross-checking the aforementioned ideas on gender identity among a large group of respondents. In collaboration with two colleagues from the Faculty of Psychology and Educational Sciences, Prof. Marlies Lacante and Dr. Veerle Germeijs, a written questionnaire was

compiled in keeping with 1) the image of student's ideal self, 2) the image of the ideal of being an engineer, and 3) a potential conflict between the two.

GRAS is a Dutch instrument attempting to measure gender-stereotyping (or the lack of it). The first version from 1977 was overhauled in 1984. The GRASS questionnaire contains 92 characteristics, which can be analytically divided into four groups: 29 with characteristics associated with masculinity; 29 associated with femininity; and 24 considered as gender-neutral. The reference to how the instrument originated is relevant, since some of us may consider the labelling of the scales as 'associated with masculinity' and 'associated with femininity' as a reinforcement of stereotyping. It will become apparent that female engineering students also prefer characteristics from what is termed the 'M scale' and this trend repeats itself among psychology students. In the M (masculinity) scale, we find characteristics such as: brilliant, original, level-headed, independent, amusing, self-aware, precise, alert, rational, and sober. The F (femininity) scale includes attentive, diligent, modest, romantic, intuitive, concerned, impulsive, obedient, shy, and changeable. Let us leave aside the quite justified debate about whether the names given to the scales reinforce gender stereotyping. As the questionnaire was used on a global scale and is still in circulation, we need to retain this terminology in order to keep the research comparable. The dataset contains a tremendous amount of information. I only present a very limited look at the first results here, with the emphasis on a gender analysis.

5.1. General engineering studies:

The students were asked to complete three GRAS questionnaires. Shortly after the start of their first bachelor year, they were questioned about their concept of the ideal engineer. Several weeks later, the same questionnaire was used to examine how they described themselves and their ideal self. We reached 312 male (86.4%) and 49 female (13.6%) first-year engineering students, which is representative for the actual male/female ratio in the academic year 2010-2011, with 80% response rates for the profile of the ideal engineer, 78% for the self-profile and – presumably as a result of completion fatigue, 66% for the image of the ideal self.

Ideal Engineer:[1] Women and men describe the ideal engineer using characteristics on the M scale, with a significant different mean score of 1.85 (scale 0-3) for the male students and 1.71 for the female students. The mean F score 'Ideal Engineer' is 1.13 among the men and 1.14 among the women.

[1] I want to thank Karen Chaltin for her contribution to this analysis

Personal self-image: the male students assign themselves an average M score of 1.74; among the women, it is significantly lower at 1.44[2]. With the F score, we see the opposite: at 1.53, women score significantly higher than men (1.31)[3]. An additional analysis shows us that male respondents have a more gender-stereotypical self-image than women.

Image of ideal self: male engineering students assign an average M score of 2.06 to their 'ideal me', women a significantly lower score of 1.79[4]. With female students, we see a big discrepancy between the image of their ideal self and their personal self-image: their ideal self leans towards the characteristics from the M scale, the personal self-image relates to the F scale. Additional analyses indicate that with female students, there is a bigger discrepancy between their personal self-image and their image of the ideal engineer than with male engineering students.

5.2. Engineer-architecture studies:

We reached 59 male (48.4%) and 63 female (51.6%) first-year engineering-architecture students, which is representative of the actual male/female ratio in the academic year 2010-2011, with 84% response rates for the profile of the ideal engineer-architect, 75% for the self-profile and 71% for the image of the ideal self.

Ideal engineer-architect: both groups described the ideal engineer-architect using M scale characteristics, with a significant difference of 1.81 (out of 4) for the male students and 1.62 for the female students[5]. There is barely any difference as far as the F score is concerned, with averages of 1.23 (♂) and 1.21 (♀).

Personal self-image: the male engineering-architect students assigned themselves an average M score of 1.82, whereas the woman gave themselves a significantly lower score of 1.62.[6]. For the F score we see the inverse: with 1.69, the women score significantly higher than the men (1.43)[7]. Additional analysis shows us that male respondents have a more gender-stereotypical self-image than women.

Image of ideal self: there is no significant difference between male and female engineering-architect students describing their concept of their ideal self. For the female students, we find a larger discrepancy between the image of the ideal self and their self-image; just as for their female colleagues in the general engineering programme, female engineering-architect students describe their ideal self with characteristics from the M scale. But other than the general engineering students, there is no significant F/M difference between the description of their personal self-image and their idea of the ideal engineer-architect.

[2] F= 47.239, p<0.001
[3] F= 53.795, p<0.001
[4] F= 13.266, p<0.001
[5] F= 122.119, p<0.001
[6] F= 47.239, p<0.001
[7] F= 53.795, p<0.001

This has only given a glance behind the scenes of the research results. We can start comparing with other groups of students: for example, the striking finding among psychology students is that they score less high on the M scale in their description of the ideal psychologist. However, the description of their ideal self is not very different from that of the engineering students. Remarkable is that male psychologists describe their ideal self much more strongly by means of M characteristics than their ideal psychologist.

The data set also offers other options, such as an analysis of the students' confidence to perform certain tasks (such as calculating statistics or repairing a bicycle), or assessing their enthusiasm for specific tasks.

6. General conclusion

Since 2004, research has been carried out in co-operation with the Equal Opportunities Working Group, for the purpose of 1) gaining an insight into the factors that influence the limited inflow of female students in engineering sciences (and other technical and scientific courses) and 2) adjusting the faculty's policy accordingly, if possible.

1) From the studies, we have learned inter alia that policies need to be aimed at primary schools and at the first three years of secondary school, as a starting point for interest in technical and scientific courses and for stereotyping engineering or sciences. In the later years of secondary school, the maths teacher plays an important role.
2) Female respondents appear to be more convinced that engineering studies are difficult. We obtained this result with secondary school pupils as well as with first-year students. Even female final-year engineering students indicate several months before graduating that they feel less prepared for their professional life.
3) The profession's image, personal self-image and notion of the ideal self warrant further investigation. The finding that the discrepancy between female students' self-image and their concept of the ideal engineer is greater than that of male engineering students, whereas there is no difference in this respect among engineer-architecture students in this respect, gives food for thought.

Our studies to date confirm that policy aimed at a greater inflow of female students must address all fronts at the same time: the macro level of politics and society, with targeted measures; the meso level of organisations, in which schools and training courses make resolute efforts to trace and eliminate factors that impede an increased inflow of women; as well as the micro level of individual beliefs among parents, teachers and lecturers as well as students. The issue of a more negative self-image or subsequent professional self-confidence of female students needs particular attention. This calls for adequate policy measures at the meso level, e.g. by stimulating a positive, appreciative approach for the supervision of students.

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