Challenging Gender Stereotypes in Engineering Education

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***Abstract*—Previous research on gender and engineering education has often tended to work with limited understanding of technology and gender. For instance, the gender equality approach relies on liberal discourses and incorporates a deficit model of women. In the early nineties a paradigm shift took place and post-modern approaches received more attention. But empiricism has often become trapped in comparing women with men. As a result, most studies continue to be reductive and contribute to confirming gender stereotypes. Recently, there have been some attempts to find new ways to transgress such general and dichotomous characterizations of gender. This paper also concerns the methodology of feminist research on gender and technology. The empirical material is based on a data collection of 859 first-semester students studying engineering in higher education in Germany. In this paper their attitudes and interests concerning computers and technology will be analyzed.**

Technical attitudes and interests; gender stereotypes; methodology of feminist research

1. INTRODUCTION: GENDER, TECHNOLOGY AND EDUCATION

In the past there have been a number of critiques of the "equality" or "liberal" approach to understanding why only few women start a career in engineering ("the women problem in technology"). The critiques expose the limitations of equality approaches and their assumptions about the neutrality of technology. These liberal programs were designed simply to increase access for women to technology, but the technology itself was not questioned. The more constructivist accounts of gender and technology relations are in contrast to these liberal approaches. These are concerned with an understanding of why and how women are so often excluded and why technology is perceived as "masculine" ("the technology question in feminism"). However, these constructivist accounts themselves have also so far failed to deliver convincing alternative interventionist strategies. Henwood sees the main reason for this failure in "the universalizing tendency of their theoretical perspective" [1]. They have given rise to interventions that fail to deal with the diverse and fragmented nature of women's experiences and needs. The recognition of this diversity and fragmentation gives only few clues on which to build successful intervention strategies [1].

This paper concerns this dilemma in the context of engineering education in two different educational settings, where the significance of technology varies: we analyze traditional engineering subjects (e.g. electrical engineering, mechanical engineering) and interdisciplinary engineering subjects (e.g. medicine engineering, biotechnology). We draw on empirical research which focuses on the experience,

attitudes and interests of 859 first-semester students studying engineering in higher education at the Hamburg University of Technology and the Hamburg University of Applied Sciences in the winter semester 2003.

Research has found that women are more attracted to engineering courses that emphasize social issues and technical applications than to traditional science-based courses [2]. In terms of numbers alone, our research would seem to support this outcome. Women constituted just 10.4 percent of students in traditional engineering subjects but 37 percent in interdisciplinary engineering subjects. Generally, this difference was conceptualized in terms of men's more technical approach versus women's more communicative approach. Men are deemed to be interested in technical matters, whereas women are deemed to be interested in the social context and communicative task [3]. Presumptions about gender are often confirmed through empirical research and prop up gender stereotypes. But the image of men as interested in technology does not actually refer to all men. Moreover, far more men than women study in both subject areas. This indicates that there are differentiations within the sexes. And also, women do study traditional engineering subjects. Accordingly, Henwood [1] asks how we are to understand and make sense of those that do enter these fields of technology education and occupations. In this paper we would like to demonstrate that both women and men should not be standardized as a sex group, as is often and easily done by means of gender stereotypes [4].

2. THE DISKURSIVE PRODUCTION OF GENDER

2.1. Gender under Construction

As Lie has mentioned, "men and women are changing their practices and entering new relationships with each other and their environments, and the understanding of the concepts of masculine and feminine are just as unstable as men's and women's looks, activities and practices. One challenge is to seek out dynamic definitions of these terms that can deal with the constantly changing content of gender and technology in contemporary society. Another challenge is to construct methodological approaches to study change and variation in ICT-gender relationships" [5]. This means, likewise, challenging gender stereotypes or in other words, opening up gender stereotypes in the sense that the constructions of the gender-technology relationships are not to be taken for granted at the outset of empirical research.

2.2. Constructing Women Differently from Men

One way in which women in engineering have been constructed as different from men is that women are compared with men without any further differentiation. We would like to give an example from our study. One crucial point why only few women choose engineering or complete their studies in this area is seen in the lack of confidence in technical skills among women. "It is in assessing these levels of competence and confidence that it becomes clear how these relate to the extent to which students are able not only to acquire technical skills and achieve status within the hierarchical structure of technical skills, but to own that acquisition at a more subjective level as part of their overall identities" [1]. As shown in figure 1, we can see that in our study women also have less confidence in their technical skills if we compare them with their male colleagues. But if we add only one further variable, such as the subject, then we find a more differentiated picture. In fact, the differences between the sexes within the subjects (traditional and interdisciplinary

subjects) remain. Moreover, while there are no significant differences between the men from both subjects in the three items (regarding myself as competent in technology and computers respectively, having good ideas to solve technical problems), we can find a differentiation between the women, in so far as the women from the traditional subjects have greater self-confidence than those from the interdisciplinary subjects. But regarding the item "I am good at tinkering", the women from the traditional subjects see themselves as competent on a higher level than the men from the interdisciplinary subjects. Thus, this example shows us that we need to look critically at what is done in empirical research. But our example is not yet the solution for challenging gender stereotypes, because we still look at differences within the sexes, albeit from a differentiated perspective.

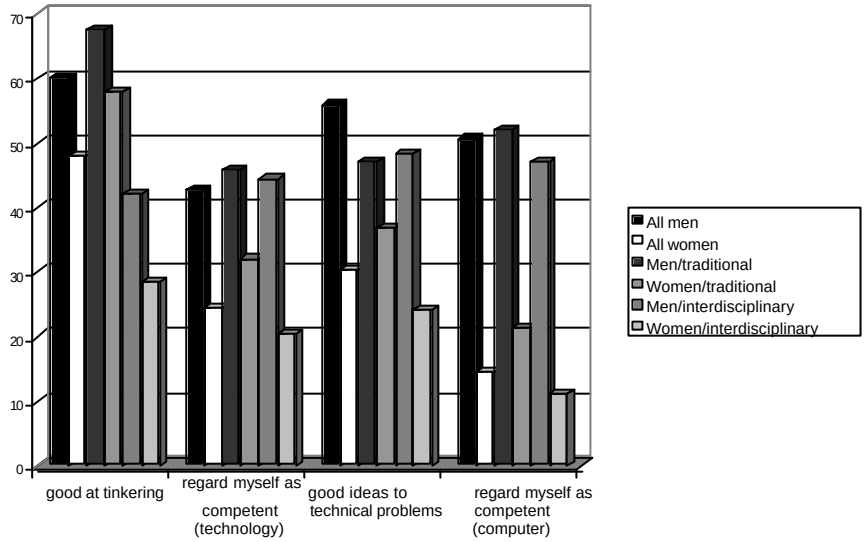

Figure 1. Technical self-confidence of female and male first-semester students in per cent (items: I am good at tinkering; I regard myself as competent to repair gadgets myself; I always have good ideas to solve technical problems; I regard myself as competent to cope with demands regarding computers)

2.3. **Attempts at Opening up Established Discourses**

One strategy for getting rid of established discourses is to look for deviating cases and thereby go beyond what has become accepted knowledge. The aim is to direct the focus away from women and their attitudes to technology, but also to maintain the category of "gender". Because gender does still matter, as the stagnating percentages of women in engineering prove. But by aiming at widening the scope, variations and paradoxes in the relationship of gender and technology can revealed, and lead us to new intervention strategies. A methodological starting point, for example, could be grouping types of students first and than looking in a second step at how women and men may be described within this pattern. In the following chapter we would like to exemplify this approach using the type of the "techie". But before that, we will give a short overview of the framework.

3. TECHNICAL ATTITUDES AND INTERESTS OF FIRST-SEMESTER STUDENTS IN ENGINEERING HIGHER EDUCATION

3.1. The Model of Technical Attitudes and Interests

Our study is based on a theoretical framework of attitudes and interests that is used by some researchers in Germany to explain subject choices in schools and higher education [6] [7]. Attitudes are generally defined as a recapitulated evaluation of an object which finds its expression either in a like or a dislike. Attitudes can be subdivided into three components: behavior, affection, and cognition [8]. Relating to technology, the cognition component consists of opinions on the subject "technology". The affection component refers to expressions of feelings which are released by the object. And the behavior component contains, on one hand, actions which are aimed at the object and, on the other hand, it comprises intentions of behavior [9]. Beyond the model of attitudes, interests represent an independent construct, because interests imply a personal importance and an active inclination towards the object. In contrast to attitudes, interests are intrinsic in regard to the component of behavior. Interests can be determined as a specific relationship between a person and an object. The person directs her attention, thoughts, intentions and finally her activities more or less constantly toward the object, which is then equipped with subjective value and emotions [10]. Regarding dealing with technology actively, interests and attitudes are seen as an important factor for choosing subjects in science and technology [6] [10]. We would now like to characterize first-semester students of engineering on the basis of the described components. We will turn to the image of the "enthusiastic techie", because it represents a significant masculine stereotype in engineering.

3.2. Forget the "Enthusiastic Techie"?

A striking feature of previous research was the frequent reference to a masculine stereotype that can be described as the "enthusiastic techie". In the research area of the computer, the stereotype has been brought to fame as the "hacker". Both images describe an asocial male adolescent, deeply involved with computers and technology respectively [11]. It has been argued that these images act as deterrent examples for girls when making their subject choices. But this image is ambiguous and also unifies positive and desired features, such as the joy of creating something new for example. In figure 2, we can see that men studying traditional engineering subjects are indeed highly affected by technology. Their affection is higher than among the students from the interdisciplinary subjects. The same pattern can be observed among the female students, on a lower level. Roughly the same picture is shown in figure 3, which presents items of intrinsic interest. This pattern is also valid for experience, which is not shown here.

What does this mean for the stereotype of the "enthusiastic techie"? We cannot ignore the fact that, in the traditional engineering subjects in particular, we can find a significant group of male but also female students who could be described using features of this stereotype. But there are also further types of students with other attitudes and interests, which we want to investigate in our continuing work.

Although we meet the techie figure as a kind of a normative construction in our study, because we have constructed it through our items, this construction can no longer be described using the term hegemonic masculinity. It seems that this image also provides female students with possibilities for identification. Thus, this change

in the perception of the techie is perhaps a starting point for challenging gender stereotypes and paves the way for girls to choose engineering studies.

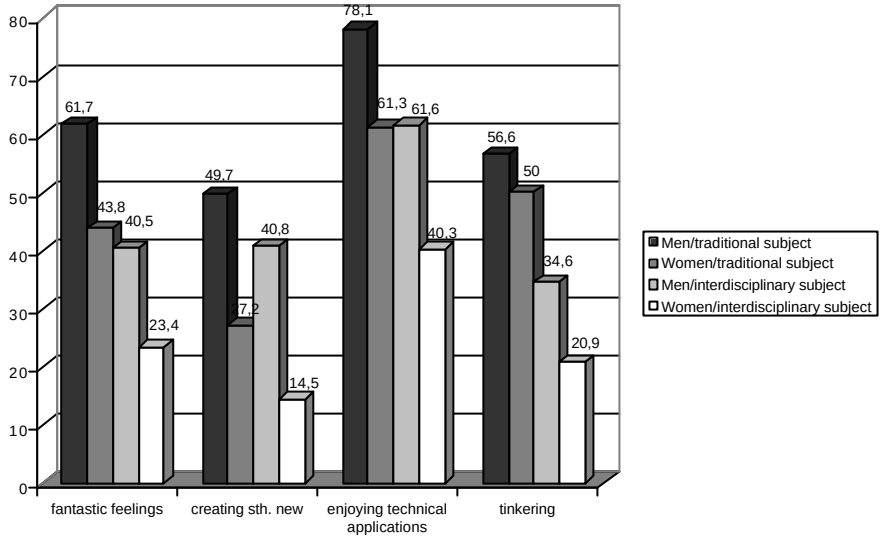

Figure 2. Technical affection in percent (Items: I enjoy repairing machines or gadets; It is a great feeling when they work again; It's great to create something new and have put all my ideas into it; The practical applications of technology appeal to me; I like tinkering most)

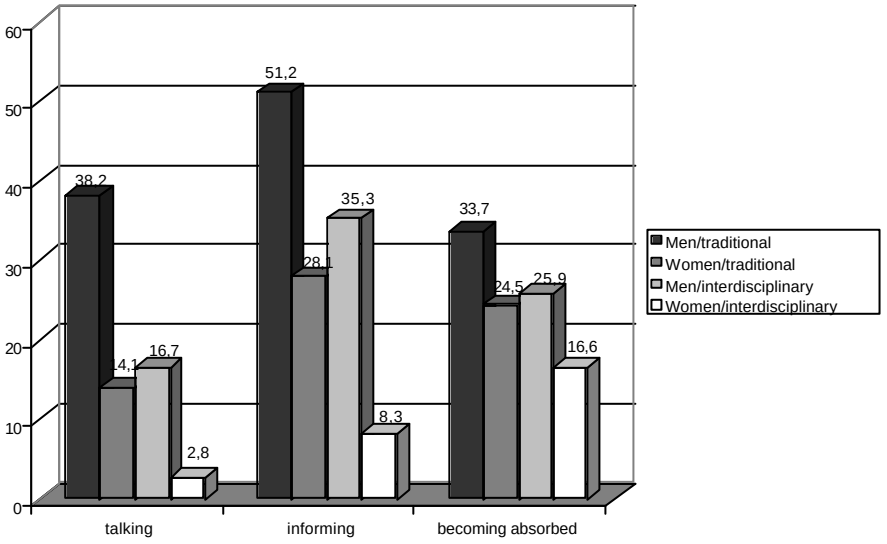

Figure 3. Intrinsic interests in percent (Items: If I am together with other people we could talk about technology for hours; I keep myself informed on technical developments; If I become absorbed with a technical problem, I perceive every interruption as extremely annoying)

4. CONCLUSIONS

As Lie [5] has mentioned, the discourse on gender and technology tends to appear as a knot that is difficult to untie. Our aim was also to loosen it up by throwing a different light on gender-technology relations. We believe that studying different settings as well as varying aspects of such relationships is the first step towards untying the knot. We want to argue for methodological openness, in the sense that the construction of these relationships is not to be taken for granted and that we are conscious of gender stereotypes, so that we do not allow ourselves to be led by our assumptions.

The general discourse on gender and technology has presented women as uninterested in technology and lacking technical skills. In the past studies have been carried out on what the reasons are and how these could be changed. Women's relationship to technology has been studied empirically and was often found to be measured against a norm that was set by men. In so far it is obvious why women fight tooth and nail for "compensatory strategies", such as making it easier for women to choose this area. Here they have been seen as deficient. To encourage greater participation of women in technology alongside a wider critique of technology relations, we need a discourse within institutions of higher education which actively encourages a challenge to dominant constructions of gender-technology relations. Education has an important role to play in the development of such discourses, which seek greater variation and more heterogeneity.

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